Kathryn M. Hibbert
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Radiology Education

The Evaluation and Assessment of Clinical Competence

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Foreword

The publication of this book, the third in a trilogy focused on Radiology Education, follows the tradition of the first two books in the sense that it draws on the interdisciplinary scholarship of bringing educators together with radiologists and medical scholars to generate new understandings. In the first book, Chhem, Hibbert and Van Deven (2009) introduced us to *Radiology Education*: *The Scholarship of Teaching and Learning*. Produced as an outcome of an *International Radiology Education Conference*, the book stimulated discussions around the globe and the editors were encouraged to write a second book that focused on the ways in which the scholarship of teaching and learning was translated into practice at different settings. In 2010, Van Deven, Hibbert and Chhem collaborated for a second time to produce *The Practice of Radiology*: *Challenges and Trends*. This book served to make "practice" visible in ways that allowed for further dialogue and a rich exchange of ideas.

In this third book, Drs. Hibbert, Van Deven and Chhem invited the participation of a fourth editor, *Parker Hughes Professor of Diagnostic Radiology* S.C. Wang. The contributing authors impressively bring experiences from at least eight countries, with experiences that range from clinical educators to national oversight to those with international leadership responsibility.

Radiologists have to fulfil a specific role if they want to perform as well as excellent teachers in a pre- or postgraduate curriculum: in their daily clinical practice, diagnostic competence should serve as the backbone of teaching and learning in medicine. Images are frequently used by many non-radiological and radiological teachers, but teaching should not only be influenced by the quantity of images in a PACS environment for illustrating lectures and courses. For image-centred learning, radiologists have to understand themselves to be more than just a clinical service provider or, in terms of education, as a provider of an apprenticeship style of training. They should be aware of their professional responsibility to take care of the image quality and, even more important, to follow a structured concept of how imaging literacy is taught to students. In this way, radiology enhances the traditional role of pathology which has been an indispensable part of undergraduate curricula and of postgraduate clinical-pathologic conferences or rounds.

Image-centred learning is an important aspect of competency-based education. Two of the major skills within the framework of competencies are diagnostic reasoning and communication. No other medical discipline is committed more than radiology to these competencies. The medical students' increasing interest in radiology clerkships underscores the need for excellent teachers in this field.

In this third book, the authors invite us to consider the evaluation and assessment of clinical competence and guide us to fulfil our responsibilities as committed educators. Through their work, the editors unveil one of the paths to achieving excellence: making the shift from simple teaching to recognizing the complexities involved in education, and in a broader sense, clinical competence that involves continuous feedback and measurable assessment.

Radiological competence should be defined in view of its interface with other disciplines. At these crossroads we find the highest potential for interdisciplinary clinical work, teaching and research. The relationship to medical physics and radiation protection is such an issue: communication to patients needs knowledge about the interactions of the human tissue with rays, waves and magnetic fields as well as confidence in estimating the risk of radiation exposure. Even more important for learning radiological competence is diagnostic reasoning and decision making with a strong focus on the appropriate use of imaging. Every experienced teacher knows how grateful his or her students are, if they receive advice about when and how to use diagnostic tests appropriately. Radiological anatomy is another field of radiology at its borders that forms a very useful link between systematic anatomy and applied clinical sciences. An introductory ultrasound course for medical students is a wonderful form of putting such a concept into practice.

The measurement of clinical competence and performance, discussed in Parts I and II of this book, is an indispensable component of this form of education. Practice has shown that observational as well as experimental studies need a dedicated and thoroughly developed study design based on appropriately defined outcome measures. The data collected with such sophisticated methods offer a much higher potential for improving teaching methods than simple questionnaires filled out by students to describe their satisfaction. Measuring competence is a chance for the continuous development and evaluation of learning outcomes which are an important steering instrument in all types of curricula.

In *Part I*, *Evaluation and Assessment for Non-Educators*, Engle-Hills and Chhem introduce us to *The Nature of Professional Expertise*, and posit that evaluating clinical competence must take into account the continuum of development in professions that make up what we understand as expertise. This chapter provides a backdrop with which to consider the discussions throughout the book, and in particular the cases presented in the third part. The continuum of expertise is evident as we sample professional practice from countries around the world. Educators Hibbert, Van Deven and Ros offer clarification of language in *Fundamentals of Assessment and Evaluation: Clarifying Terminology*. We are reminded in this chapter to attend to how the terminology of this important topic is taken up differently in different professions. The authors offer an understanding drawn from the education literature to help us think about our various purposes. In the third chapter, Hibbert and Chhem take a broad look at *Competence in the Professions*: *Expanding Opportunities and Emerging Practices.* Understanding where notions of competence have come from and how different forms and models of competence have been embraced and articulated in various forms of assessment and evaluation practices is a useful way of again thinking in terms of a continuum of development. Part I concludes with *Medical Competency in Post-Graduate Medical Training Programmes*; Pascual, Ros, Engle-Hills and Chhem present multidimensional tools available for measuring medical competency, drawing specifically on Adult Education principles.

In *Part II*, *Evaluation and Assessment in Radiology Education*, philosopher Richard Gunderman writes of the *Philosophical Considerations in Educational Assessment*. Gunderman makes the argument others such as David Boud have forwarded with respect to enhancing student learning: that while students may be able to escape bad teaching, they cannot escape bad assessment. Wang's chapter, *Competencies and Experiential Requirements in Radiology Training* serves to draw these concepts together at this point, and offers the reader an anchor in an academic radiology teaching and learning context. This is followed by a chapter by Harris et al., who offer insights through their chapter *Accreditation and Evaluation of Programs*: *The Canadian Perspective*, on the perspectives of accreditation bodies drawing on the example from the Royal College of Physicians and Surgeons in Canada. We return to Wang in the following chapter *Assessment and Evaluation in a Transnational Radiodiagnosis Training Program* (*RANZCR*) as he looks at accreditation frameworks and practicalities. The positioning of the chapters in this way allows the reader to think about the affordances and limitations of programs in ways that the editors hope will provoke dialogue and inspire new thinking.

Part III, *Case Studies: Theory into Practice*, reflects the importance of case-based learning. A structured analysis of cases offers a solution for bringing together the attractive aspects of competency-based education with its counterpart, the experiential training. The case studies presented in this book are taken from different academic sites and provide a rich source for educators and curriculum designers as they embed their radiologic teaching program within a local concept of community-based learning with certain social, economic and demographic characteristics.

The topics addressed in this book and especially the philosophy behind them are not only limited to radiology. They are at the cutting edge of curriculum design and many of them may serve as models for developments in other fields of medical education. The messages delivered here, with their timely focus on measuring clinical competence, should continue to stimulate and enthuse radiologists to serve as exceptional teachers and mentors in Radiology Education.

Austria Franz Kainberger

Acknowledgements and Dedication

The Editors would like to first acknowledge that this work would not have been possible without the generous support of the University of Western Ontario, Canada's *Academic Development Fund*: *New Research and Scholarly Initiative Award – Major Grant*. We would like to thank all of the participants in our research; you have highlighted the themes and the issues that pushed our thinking. Your dedication to improving patient care has remained central to our concern, and we hope that our efforts continue to move us in that direction.

As a result of funding, several Research Assistants were able to contribute to the project over a number of years: L. Faden, K. Harris, N. Mehta, M. Caldeira, L. Boyko, M. Hunter, J. Neil, S. Flynn, L. Karnaja, S. Yang, H.Yu, and J. Chong.

In particular, we would like to highlight the efforts of two individuals who worked tirelessly behind the scenes to help ease the communication challenges of bringing together so many diverse voices across so many contents: Thomas Pascual, we thank you for serving as liaison and following up on our behalf. And Holly Ellinor, the Administrative Assistant who has been with us from the beginning. Your delight in attending to details and your efficient, professional and friendly manner have made you a valued and important colleague in the production of all three books.

Sincerely,

Kathy Hibbert, Rethy Chhem, Teresa Van Deven and Ming Wang, Editors.

Kathryn Hibbert

A body of work like this emerges over time and as a result of long term collaboration and support. I would like to dedicate this book to my mentors: Dr. Sharon Rich, Dr. Rethy Chhem and Dr. Lorelei Lingard.

In Canada, the Inukshuk is a stone figure that was used by the Inuit to serve as navigational guides placed on the landscape by those who have come before. Constructed from the careful placement and piling of stones that remind us of our interdependence, they have come to symbolize trust and reassurance. I like to think of my mentors as Inukshuks who have come into my life at various times offering rock solid advice, inspiration and friendship.

And to my family, Bill, Darren and Ali for you enduring love and patience; may you each find the "Inukshuks" in your life.

And, of course, Rethy, Teresa and Ming, my invaluable co-editors.

Teresa Van Deven

As we complete our third book of this series, it is my hope that the collaborative efforts of these medical imaging scholars from around the world have, in some way, improved patient care. At times I wonder if our efforts will contribute to any significant improvements, but I re-visit the wisdom of Mother Teresa as she speaks of the importance of even small changes…

> We ourselves feel that what we are doing is just a drop in the ocean. But the ocean would be less because of that missing drop.

As always, I am grateful for the wisdom, camaraderie and dedication to scholarship of my colleagues, Dr. Rethy Chhem, Dr. Kathy Hibbert, Dr. Shih-chang Wang, and Holly Ellinor.

And for Bill Hunter, as we enjoy our piece of paradise in our Port.

Shih-chang Wang

I am very grateful to my friends and colleagues Rethy, Kathy and Teresa, for offering me the opportunity to join them in completing this series, in a field that I have become more and more fascinated with over the last decade. I have had the amazing good fortune to help design and implement real change in national postgraduate Radiology education in three different countries. Like all students, I continue to learn with the passing years, and being part of the editing team for this volume, and an author through the entire series, has been no less educational.

To my wife, Jenny, for all the love and support she has shown me over the years. See, I wasn't just fooling around on the computer!

Rethy Chhem

In memory of my parents Chhem Kieth and Nhiek Bophal, my very first teachers.

Disclaimer

The opinion of the authors does not necessarily reflect that of the editors.

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Part I

Evaluation and Assessment for Non-Educators

The Nature of Professional Expertise

1

Penelope Engel-Hills and Rethy K. Chhem

1.1 Introduction

The terms professional expertise and the expert professional are understood in different ways and are not consistently applied. Some may see the expert as the competent professional, while others retain the term for someone who is talented, brilliant or a genius, and yet others use it to acknowledge excellence (Van der Heijden 2003). What is accepted is that an expert operates within a highly specific work domain such as a confined area within medical imaging, for example mammography, interventional radiology or MRI.

This chapter is presented to build a conceptual framework within which to understand the construct expertise as it can be applied to the imaging professions. To develop into an expert and retain a level of expertise in a rapidly changing work environment is a continuous journey of becoming. The student must firstly gain appropriate content knowledge, academic and scientific skills and the ability to practise in the imaging sciences through participation in a curriculum where the teaching, learning and assessment activities are designed and presented to build knowledge, competence and confidence. From graduation, the professional must progressively and continuously gain expertise.

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In the UK, the USA and Canada, there was a simultaneous initiative to move beyond the implicit understanding of what makes a good doctor and replace this with specified duties, responsibilities, attitudes and values for the profession. Such expected outcomes mean that professionalism is now expressed through general competencies and codes of practice. These statements make the professional standards explicit and are central to education programmes and registration requirements (Irvine 2009), where competence is a measure of the ability of the professional to achieve the required outcomes and so provide safe and appropriate care with consistency. What is less specific is the definition of expertise, and what it means to be an expert. The conceptual framework for professional expertise will start with the presentation of a brief historical context and current thinking on the medical profession to frame the discussion.

1.2 The Medical Profession

The construct of a medical profession can in part be attributed to those who through their writing on medical history shifted the concept of doctors as practitioners in trades and guilds to becoming self-regulating professionals (Burnham 1998). The development of the profession came with the introduction of recognized qualifications following specific education, work experience with its origins in an apprenticeship model, assessment and regulatory bodies (Bullock and Stephen 1999). Professionals in medical imaging fit the criteria of providing a service to others within a strict code of practice and ethics that provides a framework of values, attitudes and abilities needed to be a member of the profession operating in a multidisciplinary health-care team (Calman 2007). Some of the key values and attitudes include being a virtuous person with moral intent, autonomy and the desire to learn and teach. The abilities of the medical imaging professional are evidenced through the command of a complex body of knowledge and clinical competence, (Cruess and Cruess 2009), both of which are enhanced through continuous practice and which are shared through teaching and learning within the community of practice (Lave and Wenger 1991).

The book *Boys in White: Student Culture in Medical Schools* (Becker et al. 1961) is an ethnographic study of how young medical students in the late 1950s became enculturated as members of the medical fraternity. It presents how they assimilated medical values and coped with the extremes and complexities of their chosen profession. The present environment of the medical student has retained the fundamental professional values and attitudes with socialization of medical students into the profession still being evident. However, the educational philosophy has shifted from the humanist approach of becoming a professional through being in the profession and absorbing professional knowledge, abilities, behaviour and conduct from experts in the profession towards a more structured approach of outcomes, competency-based education with ability, behaviour and even attitudes becoming measurable quantities. Yet becoming an expert relies still on being in the profession, working alongside experts and having the desire and opportunity to develop expertise.

To be fully recognized as a professional, the beginner in the profession must acquire a body of specialized knowledge and competencies, often now expressed in terms of graduate attributes (Calman 2007). This is achieved through higher education studies and engagement in a community of practice (Lave and Wenger 1991). The competencies or attributes have expanded beyond the immediate needs of medical imaging and currently include an emphasis on professionalism demonstrated through advocacy, engagement in the socio-political agendas of modern society and doctors as agents of change. Clinical practice takes place in a scientific context of research and independent enquiry as health-care practitioners strive towards the goal of evidence-based, best practice. Concurrently, there is a growing awareness of the challenges to and limitations of health care and the equitable and efficient use of available resources (Calman 2007). Hence, the knowledge of health sciences includes relevant theoretical content as well as epistemic and enquiry knowledge and problem-solving (Perkins 1991). The new graduate or novice professional has the entry-level, highly specialized knowledge and competence that translates into an ability to participate and contribute in a multi-professional team environment and the theoretical understanding and ability to reflect on experience (Schön 1983), in order to gain expertise through the ability to transfer knowledge and integrate work experience into new cognitive thinking and improved clinical practice (Monkman and Baird 2002). Hence, one of the key elements of being a professional is that after the achievement entry-level competence, one must continue to develop expertise. In this way, all professionals travel the journey of developing expertise, but not all will enjoy the privilege of being considered an expert.

1.3 Expertise and the Working Environment

On the journey towards practice as a qualified medical imaging professional, the notion developed by Lave and Wenger (1991) of learning as a process of participation in a community of practice is applicable. While the construct of a community of practice can be broadly applied, it suits attachment to a profession with a well-defined scope of practice executed within a highly complex environment. The student entering the profession and the entry-level novice practitioner initially participate peripherally and observe the practice of those with experience and expertise. The novice member develops competence and improves performance through exposure to the practices in the professional workplace (Rothman and Perrucci 1970), and their participation increases in engagement and complexity which can be seen as the early milestones of developing expertise. In these communities of practice, the members are united through their participation in common activities (Wenger 1998) such as those belonging to the roles within medical imaging departments. The entry-level professional that has been assessed and found to have achieved the minimum competence for qualification continues to develop higher-level competence through the collective learning of shared practice (Wenger 1998) and may ultimately reach the level of professional ability to be considered an expert in a confined environment or highly specialized area. The level of expertise does not remain static and will either develop or deteriorate. This threat to professionals in the scientific and high-technology environments of medical imaging can be thought of as obsolescence of expertise (Rothman and Perrucci 1970) in the worst-case scenario. The volume of new knowledge and rapidly expanding technology makes retention of currency a challenge that can be understood through the findings of the authors that linked obsolescence to limited technical engagement, time spent on administrative tasks, application of knowledge rather than research and knowledge building and working in relatively stable technology environments.

1.4 Expertise Explained

Professional expertise is multi-dimensional, and Van der Heijden (2003) describes the five dimensions as (1) the knowledge dimension that includes the types of knowledge associated with the professional discipline, (2) the meta-cognitive knowledge dimension that allows the professional to 'know about knowing' and because of this to develop self-knowledge and insight about self that is also one of the professional knowledge areas identified by (Garmston 1998), (3) skills and competence needed for professional practice, (4) acquired social recognition such that the expert is respected by esteemed professionals and (5) the dimension of growth and flexibility found in the expert who is able to succeed in a new area of expertise because of the ability to transform with the changing environment.

According to Fenton-O'Creevy and Hutchinson (2010), there are two perspectives on expertise. One view is that of expertise as a human endeavour that allows the professional individually to adapt their cognitive thinking, behaviour and actions to new or changed situations. Through sustained and deliberate practice, the individual develops expertise within a specific domain, such as image reporting, and it is possible that perceptive ability and the structuring of long-term memory play an increasing role and in some dimension take the place of conscious cognitive processing (Ericsson 2006). The individual expert is able to use, retrieve and process relevant information that has been stored in long-term memory as quickly accessible complex cognitive schemata (Gobet and Simon 1996) that are innovatively transferred to new environments. Hence, the novice professional relies heavily on knowledge in order to process the action required, while the expert has an extensive mental file of previous scenarios and can use these to make quick evaluations of very complex circumstances. The expert in medical imaging almost certainly must have the capacity to transfer knowledge into new situations (Spiro et al. 1987) and must rely on the storage of information from vast opportunities to evaluate and report in practice (Ericsson et al. 1993).

The first view of expertise as an individual endeavour is balanced by the second view that considers expertise as socially embedded and arising from social engagement (Hakkarainen et al. 2004). According to this perspective, all things are social, come from the works of others and cannot be attributed to the individual. Expertise in this view is attributed to groups and environments that encourage expertise, though not experts as that would be related to an individual. This way of interpreting expertise aligns in part with working together in communities of practice (Lave and Wenger 1991) and the development of expertise as a shared networking and access to the resources of the community (Fenton-O'Creevy and Hutchinson 2010). Thinking, in this view, takes place in groups or communities and through the resources or tools of such a group. It is therefore useful to consider the relationship between thinking, acting and learning that leads to knowing in the workplace (Billett 1999). This author draws on Activity theory to develop the concept of 'co-participation at work'. Activity theory is a descriptive theory or theoretical framework from psychology that can be applied to enhance the understanding of human activities, such as reporting on medical images. Activity theory can be a useful model for understanding how the multi-faceted environment of a clinical site impacts on activity, learning and expertise. In order to reach an outcome, it is necessary for the subject (professional) to produce certain objects (clinical decision, report…). The human activity of the professional is mediated by artefacts (images, equipment, request forms, the patient, other team members…) and also by a community, profession, organization or institution that can impose rules on the practitioner. Ultimately, the subject must work as part of the community to achieve the object or outcome and gain experience or expertise in the profession (Bertelsen and Bodker 2003). In the social interpretation of expertise, there is little emphasis on 'the expert' as the key factor is expertise that develops within the community of practice of the multi-disciplinary team.

1.5 Expertise and Learning

The interpretation of expertise as either a social or an individual process is positioned with the understanding of learning as the acquisition of knowledge or occurring through active participation and social interaction (Sfard 1998). This author argues for the presence and need for both learning approaches, and it could in turn be that expertise in medical imaging can be described as both an individual and social activity and that by drawing on both interpretations, more complete insight into expertise and the expert professional can be gained (Fenton-O'Creevy and Hutchinson 2010). This speaks in favour of integration in the curriculum and the acknowledgement of transdisciplinarity (Gibbons et al. 1994) to promote the development of professional expertise that is more than a social activity or an individual endeavour but is the accumulation of cognitive and practice repertoires. The expert professional will demonstrate judgement and be able to transcend disciplinary specialization, be adaptive and flexible.

The authentic workplace offers learning opportunities in which the student participates in actual work. The 'knowing' is deep learning that incorporates problem-solving and the ability to transfer learning. To promote effective learning, there must be appropriate learning opportunities structured within a student-centred environment with effective supervision, good professional role models, feedback and facilitation (Cornford 2000). Rather than the mere acquisition of knowledge, learning in a professional context is enhanced when it takes place within social relationships that exist when there is long-term, consistent engagement in a community of practice (Lave and Wenger 1991) that involves mentoring, guidance and teaching in the workplace (Billett 1999).

Conclusion

Medicine as a trade focused on the doing. The shift to perceiving health-care practitioners as professionals meant that there was the need for expertise, which conveys the notion of more than entry-level competence to practice. While the notion of developing expertise is part of being in a profession, it is not all professionals who are able to develop as innovators and problem solvers and become recognized experts in the discipline. Many medical imaging practitioners function effectively, at an adequate level of expertise, in a somewhat automatic manner. Only the exceptional professional goes beyond this and achieves what can be considered as expert performance because they operate in a critical and reflective paradigm (Schön 1983) to consciously improve their practice (Ericsson 2006).

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Fundamentals of Assessment and Evaluation: Clarifying Terminology

2

Kathryn M. Hibbert, Teresa Van Deven, and Soveacha Ros

2.1 Rationale for Assessment and Evaluation in Radiology Education

For educationalists and medical professionals teaming up to write on assessment and evaluation in clinical competence, we become acutely aware of the fact that the language used to discuss assessment and evaluation in both settings are not universally shared. Within these two disciplines, assessment and evaluation are largely two generic terms, dealing with unique measurement criteria and performance indicators while sharing a common goal: visioning a "quality" education and training program. To make the vision a reality, an organization needs to assess and evaluate its own performance for understanding how its objectives may be implemented and how to plan for improvement. In a national study conducted by Van Deven et al. (2009), we heard from residents, faculty, and administrators about the confusion of terminology and inconsistency in application. The purpose of this chapter then is to assist medical

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professionals in making sense of terms and concepts pertaining to assessment and evaluation in radiology education, specifically in clinical competence.

2.2 Defining "Quality"

Defining quality is a challenging endeavor, as different definitions will be appropriate for different contexts. The pursuit of quality or "excellence" has been recorded since the time of the Greek philosophers and has often included several dimensions: moral, intellectual, physical, and practical. As postindustrial society became concerned with matters of efficiency and choice, they became the "virtues" attended to by institutions chasing markets in a globalized reality (Stein 2001).

In this globalized context where "knowledge" is recognized as a rich renewable commodity to be harnessed, produced, or exploited, knowledge products and services have flourished. To appeal to a mass market, organizations establish a comparable, portable "quality standard" that is measurable. Establishing standards and the language of quantification allows professionals across contexts to engage in mutual discussions based on shared criteria. Training that accompanies the establishment and measurement of standards seeks to achieve a reasonable level of similarity in the ways in which groups agree upon what counts as evidence (e.g., Murphy 1998). Trainees are therefore being taught to view their practice in particular standardized ways. What gets lost in such a quality-controlled environment are opportunities for innovation, creativity, critical thinking, or just *different ways of knowing*.

Conforming and sustaining quality means everyone within an organization meets required measurement standards, knows it is safe to go beyond, and is empowered by their higher level of management. Achieving quality in an audit culture has led to greater scrutiny, comparison, and sometimes confusion. If we think about quality as a relative concept, it can be defined differently across various schools of thought. For example, Crosby (1979) defined quality as fulfillment of client needs. Juran's (1989) definition highlighted the significance of pleasing consumers. Quality for Juran is about "fitness for practicality" which consists of the recognition of customer needs and the efforts to meet these needs. When interpreted within the educational context, quality appears in discussions of learner-oriented method (e.g., McIlroy and Walker 1993). Although the definitions vary – sometimes only slightly – each shares a common goal: ensuring that stakeholders meet their unique needs. A learner-centered focus translates into context-dependent standards that are necessarily flexible and focused on growth. This is quite different from the ways in which quality is considered in the contexts of benchmarks. In this scenario, quality is rigidly measured against predetermined outcomes. Often, this form of quality serves institutional needs (e.g., management, policy, and so on.) but does not always fit well with notions of patient care in a health-care setting (e.g., demonstrating care, taking the time needed for communication, teaching, or follow-up).

Ros (2011) contends that the culture of an organization determines the way it defines and measures quality; therefore, leaders of an organization must understand well what is considered *quality* in their context (vision) and what the necessary processes are to ensure that the vision is realized. This is not always lead to a uniform application of thinking across all contexts within an organization. For example, leaders and curriculum developers of both clinical and educational organizations need to ensure that their institutional quality assurance framework supports their institutional vision when aiming to plan a meaningful curriculum to serve the needs of their learners.

2.3 Differences Between "Assessment" and "Evaluation"

One of the most widely conflated examples can be seen with the use of the words "assessment" and "evaluation." For the purposes of this chapter, we propose to introduce the terms and define them in ways that are helpful to stimulate thinking about the ways in which they might be taken up in your context. We discuss these terms as to learning and teaching.

2.3.1 Assessment of and for Learning and Teaching

It is useful to begin by thinking about why we assess. Formative assessment is information that is gathered and used throughout the teaching and learning process to inform decisions about what next steps to take that are likely to promote improved learning and effective teaching. Assessment suspends judgment. Depending on your organizational vision concerning how far it aims to providing excellence, your organization can choose to comply with its own quality standards or beyond. Atkin et al. (2001) suggest that assessment helps teachers and students answer three basic questions:

- Where am I going?
- Where am I now?
- What needs to be done for me to get from where I am to where I need to be?

2.3.2 Evaluation

Processes of evaluation are generally conducted for very different purposes than processes of assessment. Different parts of the world may use different terms to refer to evaluation. Evaluation, generally speaking, includes some form of judgment. Formative evaluation (evaluation along the way) is a preliminary sampling of progress; think of the chef tasting soup she is making while there is still time to make adjustments to it. Contrasting this with the summative evaluation, it amounts to the food critic's review of the soup (Lockee et al. 2002).

Opportunities for evaluation were found to be far more consistent and formalized in our research across Canada. Forms of evaluation commonly in use were in-training evaluation reports (ITER), objective structured clinical examinations (OSCE), mock orals, and the American College of Radiology (ACR) exam. Moreover, these forms of evaluation were recognized and had a privileged level by staff radiologists, administrators, and residents. As one of the program administrators told us, "I'll have lots of information; 12 months worth of ITERs…the ACR exam…and I'll have two program OSCEs." While gathering this information may satisfy administrative record keeping and program planning, we heard too often from residents that they received their results a month more after the rotation, prohibiting them from making timely changes.

Important to consider in the design and preparation of both assessment and evaluation practices is that they are:

- Practical and timely for their context
- Relevant (between assessment and purpose)
- Authentic, valid, reliable, and representative forms of gathering information and making judgments of knowledge or performance
- Fed back into a curriculum planning cycle to ensure ongoing improvement

The various stakeholder interests can mean that attempts to satisfy all give rise to satisfying none, and indeed, their needs can be in conflict. Jeffrey Stout (1988) describes this as the tensions between *internal* and *external goods*: that it is in the "uneasy relations between our social practices and our institutions that many of the most deeply felt problems of our society lie" (p. 276). In this postindustrial, audit culture, we have witnessed an increase in the demand for accountability that translates into an increase in monitoring and measuring. When this occurs, there is a tendency to reduce both assessment and evaluation to easily identifiable, easily measured indicators. This can lead to generic, decontextualized learning, leaving the learner chasing the least desirable knowledge and missing out on understanding altogether.

2.4 Validity and Reliability

The concept of *validity* when applied to assessment is really asking how well what gets assessed aligns with the intended or planned learning outcomes. Threats to validity occur when assessment includes aspects of learner achievement that are not relevant to the purpose of what is being assessed. It is important not to read more into an assessment than what it actually can tell you about a student's progress. It is always a good idea for stakeholders to review the rhetoric surrounding the goals of their programs and the curriculum that presumably flows from those goals to see if the assessment that should flow from the same goals and curriculum actually matches. In standardized assessments at a regional, national, or international level, sometimes what is being assessed bears little resemblance to what has been taught.

Reliability, on the other hand, is more context dependent. Formative assessment gathered frequently is not concerned as much about issues of reliability because its intended use is to inform the teaching/learning process. Summative forms of assessment, however, demand accuracy, and therefore, reliability comes into play. This is why these forms of assessment begin to take on a more standardized look and feel in institutions. The interest at this stage is often in comparing learners' progress with a defined standard of where a learner should be at various stages along a continuum. To ensure or improve reliability even further, we see efforts to standardize or control the environment of the test-taking scenario (e.g., the OSCE) so that students presumably experience the same items in the same context. The danger here of course is that the scenarios can become so decontextualized and the learning so generic that they cease to have authentic application to the real world setting. Excelling on the test, rather than learning or understanding, becomes the goal. Similarly, when results are "high stakes," educators may feel pressured to focus only on the content that will ensure adequate scores.

2.5 Needs Assessment and Evidence-Based Practice

A needs assessment can help departments take stock of where they are in the process of effective program planning and what they need to put in place to meet their expressed goals. A needs assessment can also inform the program planners about the unique needs and goals of their learners. This will allow educators to plan a meaningful curriculum for their learners while keeping their unique context in mind.

A needs assessment should be conducted prior to each academic semester as a strategy to support curriculum planning, specifically to suggest learning objectives and learning activities. Prior to day one of each academic semester, each departmental management should already be aware of their student expectations. For a sustainable curriculum planning, departments should agree upon principles and implementation strategies by creating a curriculum vision. Departments can begin by first writing answers to three questions:

- What does "curriculum development" mean to your department?
- Why is your department interested in this curriculum activity?
- How would your department achieve this curriculum vision?

In discussing needs assessment, departments consider an approach that could work best for their context. It also draws attention to the weakness of a "best-practice" approach. While much has been made about striving to identify and replicated "best practices" – and there is no disputing that there are many practices that are desirable within radiology education – it is important to keep in mind that practice is never neutral. We must always raise questions about the notion of "best practice," such as:

- For whom?
- In what circumstances?
- Based on what research or evidence?

This final point brings us to a discussion about "evidence-based" practice. Efforts to ensure "knowledge translation" of the most relevant and recent research have increased in recent years. Pressure has mounted for research to inform policy and for policy to translate that research into guidelines that will presumably inform practitioners. During fiscally challenging times, the pressure to demonstrate evidence-based practice has gained legitimacy as it seeks to ensure that public funds are well spent on practices and procedures that are deemed to be proven through rigorous processes of evaluation. What this approach ignores, however, are the individualized processes that educators may develop in response to the needs of their learners based on their own experience. Similarly, students sometimes report practices that are in conflict with their own cultural values.

Table 2.1 Some important distinctions between feedback and measurement (Wheatley and Rogers 2007, p. 10)

Feedback	Measurement
Context-dependent	One size fits all
Self-determined. The system chooses what to notice	Imposed. Criteria are established externally
Information is accepted from anywhere	Information is put in fixed categories
The system creates its own meaning	Meaning is predetermined
Newness and surprise are essential	Prediction and routine are valued
The focus is on adaptability and growth	The focus is on stability and control
Meaning evolves	Meaning remains static
The system coadapts with its environment	The system adapts to the measures

2.6 Feedback Versus Measurement

> I don't know that I've ever had someone point out, for example, a weakness in my training or something I need to focus on more ("Peter,"[1] Site 3).

An issue that is expressed in the literature and confirmed in our research is that people do not like to be in positions that they perceive to be the bearers of bad news. Rather than viewing constructive feedback as integral to developing a quality learning experience, sometimes, the culture of a workplace constructs feedback as "bad," and in such a context, staff radiologists are hesitant to provide negative feedback to the residents. For example, "Andre's" (Site 3) remarked, "I tend to be sort of a nice guy. I don't like to distress or upset. "Others" avoid giving negative feedback to avoid awkward situations with residents." Matt (Site 5) tells us: "In our review process, I'm the only one that gives really bad reviews. I think [others] don't want the awkwardness." These findings are consistent with the literature, which indicates that "when feedback to residents occurred, it was much more likely to be positive than negative" (p. 89), with 80% never receiving negative feedback from staff (Isaacson et al. 1995).

The unintended result from this is that the residents themselves do not pay much attention to it. As Nancy (Site 4) told us, "there's either no feedback or it is not what is called constructive feedback. The feedback doesn't say how you performed unless it is critical." Nancy's observations were echoed by the site administrator, who added that there is "no intervention, just telling them they need to read more."

In an audit culture, it seems prudent then to support faculty in their ability to "translate their observations into specific and constructive feedback" (Brukner 1999, p. 161).

An important distinction to be made is between the notion of feedback and measurement (Table 2.1).

[1] All names are pseudonyms.

2.7 Towards Professional "Habitus"

One of the defining characteristics of becoming a professional is the development of a professional "habitus," that is, the dedication to adopting the scholarly characteristic of ongoing learning to a particular field of knowledge in addition to developing a "wisdom of practice" (Shulman 2004). It requires a fine balance, attending to both the knowledge from the field as well developing intimate knowledge of one's self and one's patients or learners.

Professionals need to be able to problem solve and do the "right thing" in continuously changing and varying contexts. Standardized forms of assessment and evaluation can run the risk of undermining the development of professional discerners vs. disseminators. Opportunities for all learning must be accounted for. To this end, self- and peer evaluations can be critical. However, they cannot be simply downloaded and relegated to the learners with no input or oversight from the field or the instructor. While a goal may be to develop a level of metacognitive self-assessment ability in all professionals, too often, they are asked to self-assess areas before they are reliably able to do so.

The Foundation Programme in the UK offers one model worth considering. It is a 2-year training program where clinical and professional skills are fostered. It was developed in response to concerns about "inadequate supervision, assessment, appraisal and career advice with no defined end-point to training" (The Foundation Programme 2011, http://www.foundationprogramme.nhs.uk/pages/medical-students/faqs). Importantly, staff radiologists have found the workload associated with the program to be manageable, alleviating one of the primary reasons expressed with respect to the lack of assessment and feedback offered in their current context. The national mandate of the program and the approach to ensure multisourced feedback (from eight individuals, colleagues, patients, etc.) encourage everyone to participate in the activity of developing the physicians of the future. To date, residents report positive experiences with the program "because of the ongoing support, trainees believed that any personal weakness would be identified early" (Beard et al. 2005, p. 846). With the opportunity to correct errors before they become bad habits, the quality of care provided to patients grows exponentially. Finally, the Foundation Programme attempts to adjust feeble self-assessments by adopting self-assessment practices as a part of its assessment method, a process that is structured and based on guided reflection. Such a process of adopting accurate self-assessment during residency will prolong excellent patient care as these Foundation Programme graduates can then engage in self-assessment throughout their careers when evaluation opportunities become scarce.

2.8 Abolishing the "Gatekeeper" for Improved Patient Care

"Students can escape bad teaching. They cannot escape bad assessment" (Boud 1995, in Race and Brown 2001, p. 30). The point to be taken from the Foundation Programme is that its focus shifts from the reliance on certifying examinations as gatekeepers to improving medicine and professional conduct throughout residency by catching problems as they occur. This is essential, as "successful completion of a certification examination is not an adequate measure of the overall clinical competence of physicians-in-training" (Holmboe and Hawkins 1998, p. 47). Therefore, radiology departments, and even other medical departments, throughout Canada and internationally should make every effort to evaluate their process of providing feedback to residents and reevaluate their dependence on certifying examinations. Ultimately, clinical and professional acumen can be shaped, but must be done early on in hopes of providing quality care to patients.

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Competence in the Professions: Expanding Opportunities and Emerging Practices

3

Kathryn M. Hibbert and Rethy K. Chhem

> … when the values of the culture are in line with those of the domain, when the expectations of stakeholders match those of the field, and when domain and field are themselves in sync… individual practitioners are free to operate at their best, morale is high, and the professional realm flourishes.
>
> Gardner et al. (2001, p. 27)

3.1 The Emergence of Notions of "Competence" in the Professions

Although "competence-based education" can be traced back almost 100 years (Adams 1996), the competency movement that we know today really began in the late 1960s following the work of Harvard Professor David McClelland. His concern stemmed from the lack of ability for performance of exams to predict success in subsequent job performance in addition to a concern for the inherent bias toward minority groups found in the exams.

In 1982, Boyatzis refined McClelland's work and offered a definition of competence as "an underlying characteristic of an individual which is crucially related to effective or superior performance" (Boyatzis 1982, p. 64). With these words, Boyatzis established competence as effective *performance*. Notably, the competency movement

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initiated in the USA focused on *people*, whereas movements in the UK, for example, placed the *job* at the core of their definition. This had a remarkable effect; the former is concerned with superior performance of individuals, and the latter generates standards that indicate minimum competence levels (Brundrett and Silcock 2002).

Peter Earley and Dick Weindling (2004) explored the contribution that adopting standards provided to management, but recognized that the adoption of standards was insufficient to developing individual and institutional development. Rather, they observed that it was in working with the standards in a collaborative aim to improve overall performance that the most significant gains were realized.

The recognition of the role that social context plays in improving competency draws on the literature of "distributed leadership." Professional competency lies in the "networks of social engagement structured by shared meanings, purposes and loyalties" (Sullivan 2004). A "more engaged, civic professionalism" is needed, Sullivan argues, if we are going to be able to become competent practitioners:

> … and induct students into the distinctive habits of mind that define the domain of a lawyer, a physician, nurse, engineer or teacher… Today that means that the definition of basic knowledge must be expanded to include an understanding of the moral and social ecology within with students will practice. In medicine, the shift to outcomes based or evidence based practice has prompted accreditation bodies to expect professionals to demonstrate that they are indeed achieving what they have set out to do. Coupled with concerns about patient safety, differences in care or access to care depending upon geography and sagging confidence in the capacity of the medical profession to handle the increasing complexities of practice have pressured the profession to adopt measures that may allow them to better regulate themselves (Sullivan 2004 http://www.carnegiefoundation.org/perspectives/preparing-professionals-moral-agents – 2011).

Sullivan's comments draw our attention to four major differences in perspectives of competence discussed in the literature: technical-rational, reflective practitioner, functional competence, and personal competence. Each serves a distinct but different goal as explore further.

3.2 The Commitment to Serve the Public Good

As Gardner and Shulman (2005) among others have noted, a commitment to serving the public good is integral to distinguishing a "professional" from others who require high levels of knowledge and technical skills. Despite this distinction, preparation in the professions attends almost exclusively to the knowledge and skills required and pays minimal attention to the profession's social ends and civic foundations (Colby and Sullivan 2008). The public rightly expects competence in the discharge of professional services (Erault 1994, p. 159).

As such, the role of *occupational standards* can be outlined as follows:

- To inform the public and employers about the claims to competence of the profession, an essential starting point for any public discussions about the role of the profession and the strength of its quality assurance, as well as shaping the expectations of individual clients

- To inform providers of professional education and training, both in higher education and in public or commercial practice, about the goals to be achieved by candidates for entry to the profession
- Where appropriate, to be incorporated into regulations or criteria for the approval of courses and/or practice settings
- To provide guidance for learners (and those who help them to learn through teaching, mentoring or supervision) about what they have to achieve
- To provide a foundation for the design of valid assessment systems for professional qualifications
- To establish … equivalences and/or criteria for granting professional status in [other jurisdictions] (Erault 1994, p. 211)

A focus on occupational competence that is satisfied when one meets the minimal occupational standards gives rise to its own problems. Educational researchers Bereiter and Scardamalia, for example, noted that in such a context, many professionals become "experienced non-experts," content to remain at a routine level of competence (Colby and Sullivan 2008, p. 413).

3.3 The Relationship Between How We Define Competence and How We Measure Competence

Importantly, our notions of occupational competence have changed over time. Consider, for example, earlier variations of competence collected by Hodges (2006):

> In the 1700s a competent doctor was a member of a guild who carried a blade for blood-letting and emetics for purging with the goal of balancing the humours of the body… In 1850 by contrast, a competent doctor was a gentleman … with a walking stick who diagnosed patients by looking at their tongue, and smelling their urine…. By 1950 a competent doctor, still most likely to be a man, wore not a suit but a white coat, discussed a woman's health with her husband, and withheld the true diagnosis from a dying patient so as not to provoke worry. In 2006 blood- letting, smelling urine and withholding diagnoses are all considered incompetent. … competence is a culturally and historically contingent construction that changes over time.
>
> (Hodges 2006, pp. 690–691)

As Erault (1994) has noted, "definitions of competence… may be designed for one purpose, and in practice serve quite a different purpose…the definition of what in practice was meant by 'competence' reflected the political purpose it was intended to serve" (p. 159).

If competence is considered on a binary scale (competent or incompetent), it may be measured in ways that consider rudimentary requirements. If, however, we consider competence on a graduated scale that moves from novice to expert, different sets of information and criteria are required to interpret the more nuanced levels (Hodges 2006). Erault suggests that this variation accounts for both the scope and quality of competence.

Questions to consider in developing assessment of competence:

1. What precisely is being assessed?
2. How is evidence of individual performance/achievement collected?
3. Does the instrument or process of assessment align with what is intended to be assessed?
4. By whom is the evidence collected? Are differences in power relationships considered?
5. How are the various pieces of evidence assessed?
6. How often does the assessment take place? Over what period of time?
7. What is the outcome of assessment? (i.e., is there a process of communication in place that provides meaningful feedback and instructive "next steps"?)
8. How are the assessment measures tied to "quality control"? (e.g., tied to the standards established by accreditation bodies?) (Adapted from Erault 1994)

3.4 The Power and the Limitations of Defining Narrowly and Prescriptively

Erault (1994) has argued that "competence should be viewed as an appropriate cut-off point on a learning continuum, not as a state of mastery" (p. 162). Similarly, Messick (1984) argues that definitions of competence often refer to what might be achieved under "ideal circumstances," whereas "performance refers to what is actually done under existing circumstances" (p. 227). More recently, Daniel Pink (2009) introduced new ideas about drive and motivation that challenge the managerialist approaches of the past. He notes, for example, the significant distinction between a "performance" mindset and a "mastery" mindset; the former focuses on meeting criteria to attain predetermined standards, the latter aims for deep and enduring understanding. Leaders with a "performance" mindset encourage their employees to meet the minimal standards in order to "perform" competency, whereas leaders with a "mastery" mindset create the conditions in which employees are challenged to seek mastery. The process they engage in, whether at work, at school, or at home, aligns with the deep human need to lead their own lives, and to learn and create – through autonomy, mastery, and purpose – in ways that lead to lasting results.

The conditions within which we work influence our abilities to move beyond managerialist conceptions of competence, however. As Leach (2008) observes,

> the current context in which resident formation occurs does not make the task of fostering medical professionalism easy. Relentless pressures of time and economics, fragmentation of care and the relationships supporting care, increasing external regulation, exciting but disruptive new knowledge and technologies, and above all the broken systems of health care… characterize the external environmental context.
>
> (Leach 2008, pp. 515–516)

3.5 Other Ways of Viewing Competence

As the literature indicates, recent concerns have turned to what is required to foster the conditions for the development of professional competence and commitment. Colby and William (2008) arrive at five key qualities they believe to be important:

1. Deep engagement with the profession's public purposes, along with a sense of meaning and satisfaction from one's work that is grounded in or aligned with those purposes.
2. Strong professional identity, that is, an identity as a nurse, engineer, physician, lawyer, clergy person, accountant, dentist, or other professional, in which the field's mission and standards (e.g., integrity and conscientiousness) are essential features of one's conception of the field and the self as a member of that field.
3. Habits of interpretation or salience through which complex situations are understood or framed at least in part in moral terms, that is, in terms of the field's purposes and standards.
4. Habitual patterns of behavioral response to patients, clients, subordinates, authorities, and peers that are well aligned with the profession's standards and ideals rather than with corrosive counter-norms or overriding self-interest.
5. The capacity and inclination to contribute to the ethical quality of the profession and its institutions. This includes a sense of moral agency in relation to morally questionable aspects of the institutional context and the moral imagination and courage to create more constructive institutional structures or practices (pp. 415–416).

Similarly, Epstein and Hundert (2002) consider the "dimensions of professional competence" (see Table 3.1) that must be taken together. Viewed together, it is possible to see the shifting influences of the ways in which competence has been conceptualized and defined over time in these later models.

3.6 Cultural Competence

More recently, labor mobility and globalization have challenged leaders to think about the implications of cultural competence. Fitch (2004) describes cultural competence as "the ability to understand and attend to the total context of the client's situation: it involves knowledge, attitudes and skills" (p. 11). Epstein and Hundert (2002) argue that competence is "the habitual and judicious use of communication, knowledge, technical skills, clinical reasoning, emotions, values and reflection in daily practice for the community being served" (2002, p. 287) They view competence on a graduated scale that moves from novice, advanced beginner, competent, proficient, expert, and master. In Fig. 3.1, Wass et al.'s adaptation of Miller's framework for clinical assessment reflects the expansion of what is included in competency development and the various ways in which it may be "measured" or performed.

Table 3.1 Dimensions of professional competence

Cognitive
Core knowledge
Basic communication skills
Information management
Applying knowledge to real-world situations
Using tacit knowledge and personal experience
Abstract problem-solving
Self-directed acquisition of new knowledge
Recognizing gaps in knowledge
Generating questions
Using resources (e.g., published evidence, colleagues)
Learning from experience
Technical
Physical examination skills
Surgical/procedural skills
Integrative
Incorporating scientific, clinical, and humanistic judgment
Using clinical reasoning strategies appropriately (hypothetico-deductive, pattern recognition, elaborated knowledge)
Linking basic and clinical knowledge across disciplines
Managing uncertainty
Context
Clinical setting
Use of time
Relationship
Communication skills
Handling conflict
Teamwork
Teaching others (e.g., patients, students, and colleagues)
Affective/moral
Tolerance of ambiguity and anxiety
Emotional intelligence
Respect for patients
Responsiveness to patients and society
Caring
Habits of mind
Observations of one's own thinking, emotions, and techniques
Attentiveness
Critical curiosity
Recognition of and response to cognitive and emotional biases
Willingness to acknowledge and correct errors

Epstein and Hundert (2002)

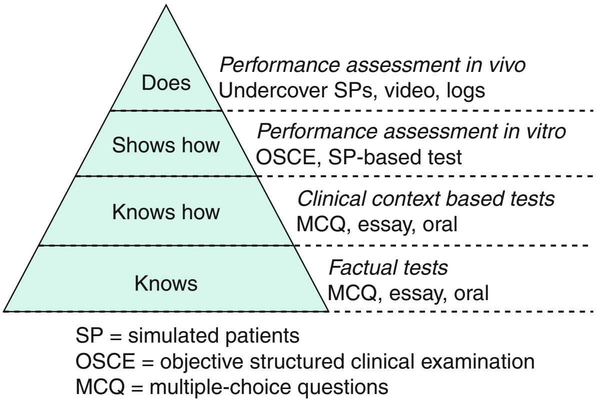

Fig. 3.1 Wass et al.'s adaptation of Miller's framework for clinical assessment

Table 3.2 Assessing competency

Internships	Observation (long and short cases)	Logbooks (verified by supervisor)/ artifacts/images gathered
Case logs	Oral questioning/ postencounter probes	Peer assessment/team exercises
Exams/tests/essay/computer exercises/MCQs	OSCE, video reviews	Simulated scenarios/standardized patient
Problem-based learning	Reflective journals	Task completion (supervised work, rotations)
Portfolio	Team activities – submitted evidence from team members	Guided self-assessment, goal setting, metacognition, ongoing planned professional development, learning plan
Feedback from patients, referring physicians		

3.7 Identifying Competence in Radiology Education

As you will certainly see throughout the chapters in this text, attention to what "counts" as competence is evident in the ways in which programs are structured and, in particular, in the kinds of accountability processes that are valued and implemented in institutions. Some of the processes used in radiology education to assess competence are listed below (Table 3.2). As you review them, consider where they may be placed on the scale from novice to master or where they might sit on Fig. 3.1.

3.8 Preparation of Faculty

No change can occur without a commitment to faculty development in the development and evaluation of robust programs – as a tool to continually improve practice. Whitehead et al. (2011) remind us that competencies, such as the

CanMEDs are "historically and socially derived, and influenced by many forces and factors" (p. 11). Role-based competencies may function at least in part, to shore up professional authority "and retain professional privilege." Whitehead et al. suggest that the competencies may best be used to guide the assessment structures, provided that there is a clear understanding of what is limited by their use. In the time-pressured environments in which radiologists practice, it is tempting to forgo the time needed to collaborate and develop a shared ownership and commitment to the core competencies appropriate to any profession. To ignore this critical piece, however, is to court the erosion of professionalism and, ultimately, patient care.

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Medical Competency in Postgraduate Medical Training Programs

4

Thomas N.B. Pascual, Soveacha Ros, Penelope Engel-Hills, and Rethy K. Chhem

4.1 Introduction

Over the last three decades, stakeholders have focused on the role of the competent physician in postgraduate medical training programs and in the workplace. Although the goal of both undergraduate and graduate medical education programs is to produce physicians full of professional basics, there is a need to further integrate other emerging required roles. Assessment of medical professionals has the broad goal of measuring that the graduates have strong foundational knowledge, clinical competence, and the skills to allow them to practice effectively in the workplace and continuously develop as professionals. This paradigm shift to adopt a model of competence as the basis for learning and program design has resulted in innovative medical curricula worldwide to reflect the philosophical change from teacher-centered to

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learner-focused. The resultant curricula are structured as outcomes-based or competency-based curricula, which emphasize and are initiated by "the product—what sort of doctor will be produced—rather than on the educational process" (Harden et al. 1999, p. 2). Carraccio et al. (2002) have stressed that the changing environment during the 1960s reflects a conscious move toward a curriculum-based on specified competencies. Such a framework of competencies or outcomes provides a descriptive tool to guide the development of a medical curriculum and enables appropriate assessment.

Many medical education institutions have developed new curricula in response to the vision toward teaching and learning on a competency model that identifies what the undergraduate and graduate medical student must be able to do on graduation. Two examples of a new undergraduate medical education curriculum are the Global Minimum Essential Requirements by the Institute of International Medical Education (Schwarz and Wojtczak 2002) and the Scottish Doctor—learning outcomes for the medical undergraduate in Scotland: a foundation for competent and reflective practitioners by the Scottish Deans' Medical Curriculum Group (Simpson et al. 2002, p. 136). These institutions have defined competencies or required abilities for physicians that would "demonstrate from the outset general competence and a range of capabilities that will allow them to function satisfactorily" (Simpson et al. 2002). On a similar note, postgraduate medical training institutions also attempt to define minimum or desired competencies achieved after training, to be able to function or practice within the realms of the specialty.

In the case of graduate medical education, the physicians are perceived to engage in a more holistic role: the competent physician. The development of competency guidelines, such as the ACGME/ABMS Outcome Project where they define six general competencies, and the CanMEDS 2005 model that identifies seven competencies (ACGME 2005 and CanMEDS 2005), was conceptualized to show the abilities and competencies as expected from a competent physician (Table 4.1). The competencies are the foundations for developing a curriculum according to the specification of what a competent physician is. The challenge lies in preparing a curriculum that builds performance, knowledge, and understanding (Farrell et al. 1995) and in the assessment and evaluation of these competencies in a way that reliably measures achievement.

This chapter familiarizes the reader with the concept of an outcomes- or competency-based curriculum and presents the multidimensional tools available to measure competence through the lens of postgraduate medical education competencies of two major medical professional organizations: ACGME/ABMS for the ACGME Competencies and the Royal College of Physicians and Surgeons of Canada for the CanMEDS 2005 Project.

4.1.1 Competence in Postgraduate Medical Education

In the field of human performance technology, competence is defined as "those characteristics—knowledge, skills, mindsets, thought patterns, and the like—that when used whether singularly or in various combinations, result in successful performance" (Dubois 1998, p. v). Heffron et al. (2007) correlated the description of Leach to the Dreyfus model of skill acquisition relating the staged progress of the

Table 4.1 Frameworks for physician competency

Frameworks for physician competency			
Undergraduate medical education		Postgraduate medical education/specialist training	
Institute of International Medical Education (IIME) (educational outcome competence)	The Scottish Doctor (learning outcomes)	CanMEDS (2005) (competency)	ACGME/ABMS (competency)
Professional values, attitudes, behavior, and ethics	Attitudes, ethical understanding, and legal responsibilities	Medical expert Communicator	Medical knowledge Interpersonal and communication skills
Scientific foundation of medicine	Basic, social, and clinical sciences and underlying principles	Collaborator	Patient care
Communication skills	Communication	Manager	System-based practice
Clinical skills	Clinical skills Practical procedures Patient investigation Patient management	 Health advocate Scholar	 Practice and learning and improvement
Population health and health systems	Health promotion and disease prevention Medical informatics The role of the doctor within the health service	 Professional	Professionalism
Management of information			
Critical thinking and research	Decision-making skills and clinical reasoning and judgment Personal development		

Adapted from IIME, Scottish Doctor, ACGME Outcomes Project (2005), and CanMEDS (2005) for comparison
Table shows the different sets of physician competencies as defined by the respective groups. Undergraduate Medical education competencies are included for comparison

learner from a novice to an expert. Cate and Scheele (2007, p. 543) affirm the definition as "the attainment of a state of being able to do something successfully." In current medical education context, several definitions have been proposed in the literature. Carraccio et al. (2002, p. 362) define competence as "a complex set of behaviors built on the components of knowledge, skills, attitudes, and competence." Albanese et al. (2008) defined competence as knowledge, skills, attitudes, and personal qualities essential to the practice of medicine. Carr (2004, p. 64) went beyond the definition and included several domains such as cognitive, integrative, relational, affective, and moral functions building around the "foundation of basic clinical skills, scientific knowledge and moral development." The evolving social context, which takes into account the changing nature of medical practice and patient care, also changes the definition and thus is developmental (Epstein and Hundert 2002). Chhem et al. (2009) stressed that the definition of competence is much complex than a simple learning objective and demands a certain level of integration.

4.1.2 Theoretical Basis for Assessing Competence

Existing literature describes the importance of assessment of learning, which eventually results in competence. Quality Assurance Agency for Higher Education emphasizes that "good assessment practice is designed to ensure that, in order to pass the module or programme, students have to demonstrate they have achieved the intended learning outcomes" (QAA 2006, page 4). Epstein and Hundert (2002, p. 228), in the context of professional competence, highlighted that "assessment must take into account what is assessed, how it is assessed and the assessments usefulness in fostering future learning." Within the context of a competency- and outcomes-based curriculum, there should be clear alignment between intended outcomes or competencies and the assessment methods and tools used to measure its attainment. Sound assessment principles require competent medical educators because "assessment of a physician's competence against an identified set of criteria requires medical educators to link performance with reliable and valid measures" (Heffron et al. 2007). Carr (2004) described several theoretical models by educationists in assessing competence such as Rasmussen's theory that "with time the practical experience increases and is augmented with knowledge" (p. 63), Dreyfus five stage model, to the more medical context specific models, such as Miller's triangle and modified Miller's triangle by Rethan. These theoretical models have introduced the concept of attaining several competencies, but emphasis should be made that "the knowledge, skills, and attitudes underpinning each competency need to be clearly written, measurable and in summation reflect the achievement of that competency" (Carraccio et al. 2002, p. 365).

Assessing medical competency in postgraduate medical training programs is like an approach to assuring quality in higher education. To assure quality in both postgraduate medical training programs and higher education programs, there should be several methods. Ros (2010) listed five methods to quality assurance in higher education: self-assessment, peer review, accreditation, inspection, and check-up.

Self-assessment refers to a self-reflection process by putting one's own performance into an achievable judgment based on an outside view, which is compound (Loacker 1985). Peer review adds value to self-assessment as it offers outside perspectives for improvement (Baker 1997). Accreditation is a process to assure quality and offers appropriate credits to deserving academic institutions (Adivisio 2002). Inspection is another form of external assessment (Brown 2000). Checkup is a follow-up process to assure quality (Franke 2002). As ways to assess medical competency in postgraduate medical training programs, these five quality assurance methods in higher education may already be embedded within the ACGME/ABMS for the ACGME Competencies and the Royal College of Physicians and Surgeons of Canada for the CanMEDS 2005 Project.

4.1.3 Medical Education and Andragogy

Andragogy, the scholarly approach to educating adults, is highly relevant to the work of medical education providers, curriculum planners, and assessment and evaluation of professionals as postgraduate medical training programs deal with adult learners. To benefit different stages of the training programs, the three groups of stakeholders need to be aware of how andragogy informs their thinking about their adult learners. This section proposes developing an explicit awareness of andragogy specifically for those with responsibility for developing assessment and evaluation strategies, in order that they may attend to adult learning principles in their planning of assessment and evaluation practices. To receive a fair assessment and evaluation result, it is critical to understand how adults learn. Understanding how adults learn also informs assessment and evaluation policies for medical competency in postgraduate medical training programs when the stakeholders can better direct the programs and curricula toward the needs of adult medical trainees. The ACGME/ABMS for the ACGME Competencies and the Royal College of Physicians and Surgeons of Canada for the CanMEDS 2005 Project has been in practice without explicitly discussing values of adult learning principles such as andragogy. The absence of an inclusion of andragogy influences sustainability of the two competency models as medical trainees are always adult learners regardless of future directions of postgraduate medical training programs.

Andragogy, referring to the arts and sciences of teaching adults (Knowles 1998), is not new in adult education and has been widely implemented within current curricula and practices in the medical arena. For example, andragogy is present in midwifery education (Ho 1991) and medical education (Misch 2002). Andragogy asserts that adult learners become self-directed and more mentally and financially independent as they grow older. Adult learners carry with them life experiences that affect their learning. They generally come ready to learn, are more problem-based than subject-based in their learning style, are motivated to learn, and are responsive to different motivational factors such as better job performance or greater self-confidence (Knowles 1968). Andragogy suggests that adult learners have their own learning goals and purposes and is the heart of adult education.

Andragogy encourages contemporary adult educational institutions and curriculum planners to focus on creating educational experiences that are developmental and individualized, experiential, life-oriented, and relevant to individual learners. In medical programs, when andragogy is explicitly embedded in the thinking of the relevant stakeholders as abovementioned, there will be a consistent connection between learning objectives stated in curricular and missions of assessment and evaluation. Moreover, the medical institutions need to encourage the adult medical trainees toward a self-directed learning process and demonstrate that their life experiences are valued and integrated in the medical curriculum. Medical educators for adult medical trainees need to offer opportunities for learners to become active participants (Knowles et al. 1998) by creating more practical learning activities. Adult medical trainees need to have room to enhance their critical thinking ability, engage in a social support system for learning, and develop lifelong learning skills. These progressions are highly supported in the context of an outcomes-based curriculum in the context of postgraduate medical training.

4.2 Models and Frameworks for Assessing Medical Competency

4.2.1 Competency Models

Several initiatives worldwide have defined a competent physician at both undergraduate and graduate medical education levels. As previously discussed, several factors were considered incorporating various dimensions and domains that would constitute competency. The derivation of these competencies is not covered within this chapter, and we suggest further reading on the historical background and philosophy and process of how these physician competencies for each model were derived and adapted.

Widely used frameworks for physician competency for undergraduate medical education models include the Global Minimum Essential Requirements by the Institute of International Medical Education (Institute of International Medical Education 2011; Schwarz and Wojtczak 2002) and The Scottish doctor—learning outcomes for the medical undergraduate in Scotland: a foundation for competent and reflective practitioners by The Scottish Deans' Medical Curriculum Group (Simpson et al. 2002).

For postgraduate medical education, the ACGME/ABMS Outcome Project and the CanMEDS (2005) are useful examples. They both define "areas" in which competencies should be demonstrated after finishing the programs, such as professional roles and competencies as stated in CanMEDS and ACGME/ABMS, respectively. Training programs provide the learning experiences for the trainees in order to achieve the defined competencies articulated through learning outcomes and appropriate measurement tools used to validate every outcomes evaluation. Although both models differ in defining the areas to demonstrate competencies, a holistic perspective would show that both aim to achieve the same end which is a "whole spectrum of professional competencies that residents must develop" (Rousseau et al. 2007, p. 563) at the end of the training. Although competency- or roles-based frameworks are useful tools to achieve selected aspects of professional

Table 4.2 Suggested assessment tools for measuring physician competency

Assessment tools	
CanMEDS (An introductory guide to assessment methods for the CanMEDS Competencies)	ACGME/ABNMS ACGME Outcomes Project Toolbox of assessment methods
Written test–constructed response type Essays Short-answer question Multiple choice, matching, extended matching, pick N, and true or false questions	Written examination (MCQ) Chart stimulated recall oral examination (CSR)
Structured oral examination (SOEs)	Standardized oral examination
Direct observation, objective structured clinical examination (OSCE), and objective structured performance–related examinations (OSPREs)	Checklist evaluation of live or recorded performance Global rating of live or recorded performance, objective structured clinical examination (OSCE)
Standardized patients	Standardized patient examination (SP)
Multisource feedback (360° evaluation)	360° evaluation instrument
Portfolios and logbook	Portfolios Procedure, operative, or case logs
Simulation-based assessment	Simulations and models
Encounter cards	Patient surveys Record review

Adapted from ACGME Outcomes Project (2005) and CanMEDS (2005) for comparison

competence, it should be used with caution as this approach, in relation to an outcomes-based curriculum, is not a guarantee that such desired expertise or competencies are achieved. Also, this may impose hindrances on the understanding of aspects of professionalism work or incline toward fragmenting elements of professional competence (Whitehead et al. 2011). Table 4.1 shows the different sets of competencies as defined by the respective groups. Between the ACGME/ABMS and CanMEDS (2005), Professionalism and communication skills share a common ground, and as pointed by (Albanese et al. 2008) for the other competencies, "the alignment becomes less clear as terms used are not directly comparable." However, the order of the competencies has been adjusted in this publication to show where there is some alignment of the competencies.

In the further section, the different competency models used together with the desired assessment tools will be presented. This should serve as a guide for program directors and training officers as they design appropriate and relevant assessments for their respective competency-based or outcomes-based curriculum.

Both ACGME/ABMS and CanMEDS (2005) offer various assessment tools. Table 4.2 shows the suggested assessment methods recommended. It is worth noting that good assessment practice should be observed and that there should be alignment through selecting the best match between the competencies desired and assessment method/s to be used. Valid and accurate assessment tools should be used. We suggest further reading regarding the advantages and limitations of the various assessment tools and practices presented.

4.2.2 CANMEDS Physicians Competency Framework

In 1996, the Royal College of Physicians and Surgeons of Canada adopted a new and innovative structural framework for medical education called the CanMEDS framework of essential physician competencies. The central focus on CanMEDS was to train toward patient-centered practice and improve patient care through articulating a comprehensive definition of the competencies needed for medical education and practice. This CanMEDS model for physician competence has been adapted to many contexts of medical education throughout the world and has been further adapted for uses in other professions.

The organizational framework of CanMEDS requires the competent physician to assume seven roles: medical expert (central role), communicator, collaborator, health advocate, manager, scholar, and professional. These CanMEDS competencies have been integrated into the Royal College's accreditation standards, objectives of training, final in-training evaluations, exam blueprints, and the maintenance of certification program.

CanMEDS meets the goal of professional education by making the recognized professional outcomes of a highly skilled physician explicit and by constantly reviewing and revising the competencies to maintain currency for the changing professional environment of the doctor. The current document was launched in September 2005 (Frank 2005). The following section illustrates the different roles together with the preferred evaluation tools suggested by CanMEDS Assessment Tools Handbook (Bandiera et al. 2006).

4.2.3 The Roles

Medical Expert

As medical experts, physicians integrate all of the CanMEDS roles, applying medical knowledge, clinical skills, and professional attitudes in their provision of patient-centered care. Medical expert is the central physician role in the CanMEDS framework.

Key Competencies

1. Function effectively as consultants, integrating all of the CanMEDS roles to provide optimal, ethical, and patient-centered medical care.
2. Establish and maintain clinical knowledge, skills, and attitudes appropriate to their practice.
3. Perform a complete and appropriate assessment of a patient.
4. Use preventive and therapeutic interventions effectively.
5. Demonstrate proficient and appropriate use of procedural skills, both diagnostic and therapeutic.
6. Seek appropriate consultation from other health professionals, recognizing the limits of their expertise.

Preferred Tools

- Direct observation and in-training evaluation reports (ITER)
- Written examinations
- Oral examinations
- Objective structured clinical examination (OSCE)
- Simulation

Adapted from CanMEDS Assessment Tools Handbook (Bandiera et al. 2006).

Communicator

As *communicators*, physicians effectively facilitate the doctor-patient relationship and the dynamic exchanges that occur before, during, and after the medical encounter.

Key Competencies

1. Develop rapport, trust, and ethical therapeutic relationships with patients and families.
2. Accurately elicit and synthesize relevant information and perspectives of patients and families, colleagues, and other professionals.
3. Accurately convey relevant information and explanations to patients and families, colleagues, and other professionals.
4. Develop a common understanding on issues, problems, and plans with patients and families, colleagues, and other professionals to develop a shared plan of care.
5. Convey effective oral and written information about a medical encounter.

Preferred Tools

- Direct observation and in-training evaluation reports (ITER)
- Logbooks, objective structured clinical examination (OSCE)
- Multisource feedback
- Portfolios and logbooks

Adapted from CanMEDS Assessment Tools Handbook (Bandiera et al. 2006).

Collaborator

As *collaborators*, physicians effectively work within a health care team to achieve optimal patient care.

Key Competencies

1. Participate effectively and appropriately in an interprofessional health care team.
2. Effectively work with other health professionals to prevent, negotiate, and resolve interprofessional conflict.

Preferred Tools

- Written Tests (short-answer questions, essays)
- In-training evaluation reports (ITER)
- Objective structured clinical examination (OSCE)
- Simulation
- Multisource feedback

Adapted from CanMEDS Assessment Tools Handbook (Bandiera et al. 2006).

Manager

As *managers*, physicians are integral participants in health care organizations, organizing sustainable practices, making decisions about allocating resources, and contributing to the effectiveness of the health care system.

Key Competencies

1. Participate in activities that contribute to the effectiveness of their health care organizations and systems.
2. Manage their practice and career effectively.
3. Allocate finite health care resources appropriately.
4. Serve in administration and leadership roles, as appropriate.

Preferred Tools

- Multisource Feedback and peer evaluation
- Simulation
- Portfolio
- Direct observation

Adapted from CanMEDS Assessment Tools Handbook (Bandiera et al. 2006).

Health Advocate

As *health Advocates*, physicians responsibly use their expertise and influence to advance the health and well-being of individual patients, communities, and populations.

Key Competencies

1. Respond to individual patient health needs and issues as part of patient care.
2. Respond to the health needs of the communities that they serve.
3. Identify the determinants of health of the populations that they serve.
4. Promote the health of individual patients, communities, and populations.

Preferred Tools

- Essays
- Short-answer question
- Direct observation and in-training evaluation reports (ITER)
- Objective structured clinical examination (OSCE) and standardized patients

Adapted from CanMEDS Assessment Tools Handbook (Bandiera et al. 2006).

Scholar

As scholars, physicians demonstrate a lifelong commitment to reflective learning as well as the creation, dissemination, application, and translation of medical knowledge.

Key Competencies

1. Maintain and enhance professional activities through ongoing learning.
2. Critically evaluate information and its sources and apply this appropriately to practice decisions.
3. Facilitate the learning of patients, families, students, residents, other health professionals, the public, and others, as appropriate.
4. Contribute to the creation, dissemination, application, and translation of new medical knowledge and practices.

Preferred Tools

- Portfolios
- Short-answer question (SAQ)
- Direct observation and in-training evaluation reports (ITER)
- Multisource feedback and peer assessment

Adapted from CanMEDS Assessment Tools Handbook (Bandiera et al. 2006).

Professional

As professionals, physicians are committed to the health and well-being of individuals and society through ethical practice, profession-led regulation, and high personal standards of behavior.

Key Competencies

1. Demonstrate a commitment to their patients, profession, and society through ethical practice.
2. Demonstrate a commitment to their patients, profession, and society through participation in profession-led regulation.
3. Demonstrate a commitment to physician health and sustainable practice.

Preferred Tools

- Direct observation and in-training evaluation reports (ITER)
- Multisource feedback
- Portfolios

Adapted from CanMEDS Assessment Tools Handbook (Bandiera et al. 2006).

4.2.4 ACGME

The ACGME and the ABMS recently shifted from structure- and process-based to competency-based medical education in order to answer the need for accountability to the public, particularly in view of the reliance on public funding by health care (Carraccio et al. 2002).

Through the Outcomes Project, the ACGME promoted professional outcome assessment within the accreditation process. This expectation of relevant assessment is reflected in requirements that regulate programs to:

- Identify learning objectives related to the ACGME's general competencies
- Use increasingly more objective and unbiased methods of assessing medical students' achievement of the competency-based objectives
- Use outcome data to promote performance improvement of all programs

The recommended process toward change include:

- Development of a set of general competencies
- Identification and development of reliable and appropriate assessment methods and tools for assessing the competencies
- Preparation of model assessment and evaluation systems to promote transparency
- Creation of a support system including assessment experts, ideas for teaching the general competencies, resource material, and a "toolbox" of assessments

In 1999, the ACGME defined and approved six general competencies for use in graduate medical education: (1) patient care, (2) medical knowledge, (3) practice-based learning and improvement, (4) interpersonal and communication skills, (5) professionalism, and (6) systems-based practice. These competencies have been adopted throughout the USA and are the foundation for the maintenance of certification under the American Board of Medical Specialities (Irvine 2009).

The following section shows the different competencies as defined by the ACGME (2005) Outcomes Projects together with the preferred tools of assessment for each competency.

4.2.5 The Competencies

Patient Care

Residents must be able to provide patient care that is compassionate, appropriate, and effective for the treatment of health problems and the promotion of health.

Key Competencies

[as further specified]

Preferred Tools

- Standardized patient
- Patient survey
- Checklist
- OSCE
- Record review
- 360 global rating

ACGME (2005) Outcomes Projects

Medical Knowledge

Residents must demonstrate knowledge of established and evolving biomedical, clinical, epidemiological, and social and behavioral sciences, as well as the application of this knowledge to patient care.

Key Competencies

[as further specified]

Preferred Evaluation Tools

- Exam MCQ
- Oral exam

ACGME (2005) Outcomes Projects

Practice-Based Learning and Improvement

Residents must demonstrate the ability to investigate and evaluate their care of patients, to appraise and assimilate scientific evidence and to continuously improve patient care based on constant self-evaluation and lifelong learning.

Key Competencies

Residents are expected to develop skills and habits to be able to meet the following goals:

- Identify strengths, deficiencies, and limits in one's knowledge and expertise.
- Set learning and improvement goals.
- Identify and perform appropriate learning activities.
- Systematically analyze practice using quality improvement methods and implement changes with the goal of practice improvement.
- Incorporate formative evaluation feedback into daily practice.
- Locate, appraise, and assimilate evidence from scientific studies related to their patients' health problems.
- Use information technology to optimize learning.
- Participate in the education of patients, families, students, residents, and other health professionals.
- [as further specified by the RC]

Preferred Tools

- Portfolios
- Record review
- Chart stimulated recall
- Portfolios
- Exam MCQ
- Exam oral
- 360 global rating

ACGME (2005) Outcomes Projects

Interpersonal and Communication Skills

Residents must demonstrate interpersonal and communication skills that result in the effective exchange of information and collaboration with patients, their families, and health professionals.

Key Competencies

- Communicate effectively with patients, families, and the public, as appropriate, across a broad range of socioeconomic and cultural backgrounds.
- Communicate effectively with physicians, other health professionals, and health-related agencies.
- Work effectively as a member or leader of a health care team or other professional group.
- Act in a consultative role to other physicians and health professionals.
- Maintain comprehensive, timely, and legible medical records, if applicable.
- [as further specified]

Preferred Tools

- OSCE
- SP
- Patient survey

ACGME (2005) Outcomes Projects

Professionalism

Residents must demonstrate a commitment to carrying out professional responsibilities and an adherence to ethical principles.

Key Competencies

- Compassion, integrity, and respect for others.
- Responsiveness to patient needs that supersedes self-interest.
- Respect for patient privacy and autonomy.
- Accountability to patients, society, and the profession.
- Sensitivity and responsiveness to a diverse patient population, including but not limited to diversity in gender, age, culture, race, religion, disabilities, and sexual orientation.
- [as further specified by the RC]

Preferred Tools

- OSCE
- Patient Survey
- 360 Global rating

ACGME (2005) Outcomes Projects

Systems-Based Practice

Residents must demonstrate an awareness of and responsiveness to the larger context and system of health care, as well as the ability to call effectively on other resources in the system to provide optimal health care.

Key Competencies

- Work effectively in various health care delivery settings and systems relevant to their clinical specialty.
- Coordinate patient care within the health care system relevant to their clinical specialty.
- Incorporate considerations of cost-awareness and risk-benefit analysis in patient and/or population-based care as appropriate.
- Advocate for quality patient care and optimal patient care systems.
- Work in interprofessional teams to enhance patient safety and improve patient care quality.
- Participate in identifying system errors and implementing potential systems solutions.
- [as further specified]

Preferred Tools

- 360 global rating
- Exam MCQ
- Checklist
- Patient survey

ACGME (2005) Outcomes Projects

4.3 Making the Principles of Adult Education Explicit for All

Medical education policy makers and curriculum planners, including ACGME and CanMEDS, may have assumed the principles of adult education in the development of the medical competencies; however, links to adult education principles are neither explicitly addressed nor always visible. This chapter proposes that the principles of adult education be explicitly integrated into assessment and evaluation missions over the postgraduate medical training outcome-based programs. This may help medical education policy makers to foreground the principles of adult education as they are developing their programs in ways that seek to be informed by their adult learners' needs, goals, and purposes. To fairly assess learners' medical competency, responsible assessors and evaluators need to also be well aware of their role as adult educators in addition to attending to the institutional needs.

Conclusion

Attainment of desired physician competencies in the context of postgraduate medical training follows a competency or outcomes-based curricula which serves as a roadmap for corresponding outcomes-based assessment. In order to develop and implement effective curricula and achieve successful assessment results, all learning objectives must include learning activities that aim to prepare learners for intended assessment objectives. In other words, we must first ascertain *where we are going*, followed by *what we need to do* to get there, and then be explicit about *how we will know* that we have arrived. Prior to each phase of a training program, curriculum developers must therefore work closely with assessment developers to ensure learning objectives, learning activities, and assessment criteria are compatible and focused on developing the desired competencies within the context of outcomes-based curricula. Learners should only be assessed on what they are taught and need to be prepared for any assessment criteria throughout their training program. For academic pursuit, the ACGME Outcomes Project and the CanMEDS Physicians Competency Framework are useful blueprints for program directors to align their training programs with intended learning outcomes focused on attainment of physician competencies in the desired specialty.

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Part II

Evaluation and Assessment in Radiology Education

Philosophical Considerations in Educational Assessment

5

Richard B. Gunderman

Assessment is one of the three basic components of an educational program. Curriculum addresses the issue of what gets taught. Instructional method addresses how it gets taught. And assessment addresses how effectively it has been taught and learned. Overall, educational effectiveness is like a chain made up of these three links, and a chain can only be as strong as its weakest link. If we are teaching the wrong things, it does not matter how effectively we are teaching them. If our method of instruction is poor, the subject matter is unlikely to be grasped by learners. And if we fail to assess, or assess poorly, the effectiveness of teaching and learning, then there is a good chance that curriculum and instructional methods may not meet the needs of learners.

There are a number of issues worth considering in educational assessment. One concerns what we are attempting to assess. The easiest thing to assess is whether or not learners have memorized particular facts or skills. For example, does a learner know the differential diagnosis for multiple osteoclastic lesions in the skull? But there are multiple levels of understanding, as indicated by widely employed assessment models such as Bloom's taxonomy of learning objectives (Bloom et al. 1956). First created in 1956, Bloom and colleagues ranked various learning objectives, placing recall at the bottom, understanding in the middle, and application in practice near the top. Associated with application is the ability to evaluate and create. To promote the highest forms of learning, it is insufficient to focus assessment on whether or not learners can recall facts. Educators need to determine whether or not they can put that knowledge to use.

Yet knowledge and skills do not exhaust the range of educational objectives that need to be assessed. If learners were robots, this might be sufficient – they would

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know how to carry out the tasks we prescribe to them, like a computer programmer writing software. But our learners are human beings, who need to be able to develop a set of professional commitments, a style of practice, and the ability to weigh alternative points of view and approaches to practical decisions in their daily practice (Gunderman 2011). This is an area in which radiology has not performed as well as it might, because most of the standardized tests that have dominated the learning horizons of radiology residents have focused primarily on knowledge and skills, neglecting issues such as professionalism and how effectively learners interact with patients and other health professionals.

We are moving toward more computer-based testing, in which learners have less face-to-face interaction with educators in real time. This will tend to deemphasize the assessment of noncognitive and nontechnical learning objectives. This shift is driven by a variety of considerations, including finances, convenience, and control (Alderson and Becker 2008). Computer-based testing is less expensive, generally requires less effort in travel on the part of candidates and examiners, and provides those who design the tests more control over how the tests are administered and scored. It also appears to be fairer. The scoring is carried out by a computer, thus reducing the potential for scores to be skewed by individual biases on the part of examiners. On the other hand, it tends to devalue more subjective learning objectives, including attitudes and beliefs.

As outlined in Chap. 2, there are important distinctions to be drawn in assessment. One is between summative and formative types of assessment (Bloom 1971). Summative assessment generally takes place at the end of a course or period of training and attempts to determine what score or grade a learner should receive. Most board exams are an example of summative assessment. By contrast, formative assessment is carried out during learning and aims to help learners learn more effectively. Historically, radiology education has tended to emphasize summative assessment, although recent efforts to ensure that learners receive periodic performance appraisals during their training have mitigated this imbalance somewhat. If enhancing learning is our primary educational objective, then we need to focus more attention on helping learners improve, as opposed to merely grading them.

Another important distinction in educational assessment is between objective and subjective assessment (Gipps 1994). Questions formulated in an objective format have only one correct answer, while subjective assessments may have multiple more or less correct possible responses. Again, educational assessment in radiology has tended to favor the objective approach, which accustoms learners to looking for the one correct answer, as though all others are wrong. This makes scoring examinations relatively straightforward, but it may undermine habits of mind that are crucial for the future advancement of the field, such as critical thinking, innovation, and creativity. To discover new ideas and ways of doing things, you need to focus more on whether an idea is interesting than whether it is correct or incorrect.

Another important distinction is between formal and informal assessment (Nitko 2001). Formal assessment involves the use of standardized assessment instruments, such as paper or computer-based examinations, or a standard form that is used to evaluate all learners. Formal assessments tend to ask educators to assign numerical scores. By contrast, informal assessments can be based on observations of practice, discussion, or learning portfolios, where each learner can be evaluated somewhat differently from others. From some perspectives, the downside of informal assessment is that it requires trust that the evaluator will avoid bias and adapt the assessment to the particular learner at hand. The big drawback of formal assessment is the fact that it tends to homogenize learners and educators, by implicitly encouraging each one to conform to the same pattern.

Another important distinction is between centralized and decentralized assessment. Centralized assessments are generated by organizations outside the institution where learning is taking place. One example would be the American Board of Radiology, which produces a single examination that is taken by learners who train in hundreds of different institutions. Decentralized assessment, by contrast, is designed and implemented locally, at the institution where learning is taking place. Again, centralized assessment tends to homogenize educators and learners, since both want learners to perform well on the standardized exam. The development of distinctive local educational approaches will tend to be stunted, since all learners take the same exam. This, in turn, may limit the diversity of interests and experiences and thereby undermine creativity.

One of the best examples of the pitfalls of educational assessment is the 2001 US No Child Left Behind Act, which mandated the use of standardized testing throughout the United States (American Psychological Association 2011). The goal of the legislation was to increase the accountability of teachers, administrators, and schools for the achievement of objective educational standards. By obtaining objective, nationwide data on learning outcomes, underperforming teachers and schools could be fired or closed. In fact, however, the act resulted in the disappearance of subjects not covered on the test, such as art and music, from the curricula of many schools. Cognitive horizons became narrower and more superficial. Teachers spent more and more time teaching to the test. In some well-publicized cases, teachers and schools actually began cheating to avoid the sanctions associated with poor performance (National Center for Fair and Open Testing 2011).

To gain a deeper appreciation of the importance of how educational assessment is designed and implemented, let us consider in more depth the important differences between centralized and decentralized approaches to assessment. In centralized approaches, a few high-level educators, such as a board of radiology, make the decisions and policies about how educational assessment will take place. In decentralized approaches, such decisions are made by educators at individual institutions. In centralized approaches, knowledge and authority are located centrally, and decisions spread in a central-to-local direction. In decentralized approaches, knowledge and authority reside locally, and ideas and information flow from the local to the central. Both approaches exhibit characteristic advantages and disadvantages.

What are the advantages of centralized educational assessment? First, it makes it easier to compare the performance of different educators, institutions, and learners, all of whom are being assessed by the same objective criteria. Underperformers can be sanctioned and ultimately closed down if they do not meet minimum standards. Moreover, centralized approaches appear to be fairer than decentralized ones, since everyone is assessed by the same instrument, reducing the potential for individual bias. In addition, centralized approaches tend to be efficient. Only one test needs to be designed, rather than each institution "reinventing the wheel," and all the scoring can be performed by a single organization. Finally, centralization generally makes it possible to introduce changes in assessment over a wider area in a shorter period of time, because a single body makes the decisions.

On the other hand, centralization also exhibits characteristic drawbacks, while decentralization offers important advantages. Since current trends seem to be in the direction of centralization, let us explore these in somewhat more depth. One major disadvantage of centralization is the fact that it tends to involve fewer people, and thus draw on fewer perspectives, in its decision-making process. To avoid this pitfall, centralized educational assessors such as boards of radiology need to ensure that their membership reflects diverse points of view and work extra hard to listen to new ideas and criticisms from individual educators and programs. Human beings have a natural tendency to want to be in control and to avoid criticism, which can lead the administrators and staff of such organizations to become more isolated from the educators and learners over whom they exercise authority.

A related pitfall in centralization of educational assessment is for the organization, its survival, and its growth to come to be seen as ends in themselves, as opposed to means by which to promote educational quality and professional flourishing. For example, job security and compensation may both increase as the organization grows, and this may contribute to a natural tendency for such centralized assessment organizations to expand their staffs, budgets, and programs, even when doing so is not raising educational quality. In some cases, the growth of the organization itself may, in the eyes of executives and board members, begin to be regarded as a proxy for organizational success. Yet, the growth in the size and complexity of bureaucracies does not necessarily benefit the constituencies they serve. To avoid such pitfalls, centralized assessment organizations need to work extra hard to be mindful of the needs and missions of local constituencies.

Another pitfall of centralized educational assessment is the fact that those making the rules often do not live under the rules they promulgate. For example, many executives and staff in educational assessment organizations have never served as a program director in one of the programs required to follow their rules. Moreover, current program directors may occupy relatively few seats on the boards of such organizations. As a result, the costs of new programs of educational assessment may not be well proportioned to their benefits. Operating under the presumption that you cannot manage what you cannot measure, centralized authorities may impose onerous requirements for data collection and analysis that hamper important work of educators, unaware of such imbalances because they do not live with the requirements day to day. To avoid this, educators actually doing the daily work of education should play a major role in the development of new programs of educational assessment.

One of the advantages of decentralization of educational assessment is its tendency to promote the engagement of educators at the local level. People are much more likely to play an active and enthusiastic role in programs that they had a hand in designing. When they are merely told what to do by a distant authority, they are less likely to feel committed to the program they are charged with implementing. This represents one of the geniuses of democratic and republican forms of government, which promote the participation of citizens, as opposed to despotisms and tyrannies, where the governed play little or no role in self-government. This, in turn, promotes greater creativity, resourcefulness, and personal and professional development of educators, who are able to think and act responsibly for themselves. One important contribution centralized assessment organizations can make is to focus less on what they can require local educators to do and more on how they can help such educators to acquire the knowledge, skills, and time and resources they need to do their jobs well.

Decentralization can contribute not only to engagement but also to morale. One of the surest ways to undermine morale is to saddle educators with responsibility for achieving objectives for which they lack resources. Another is to saddle them with objectives that they do not believe in. Another is to saddle them with objectives they do not understand. Instead of telling educators how they must assess their learners, centralized assessment organizations may be able to provide more benefit by encouraging innovation and then helping to disseminate new ideas and best practices among different programs. There is a danger that initiatives designed to identify, remediate, and weed out underperformers will stifle the enthusiasm and fulfillment of educators and program directors who are doing a good job and could do even better. Centralized assessment organizations can avoid this pitfall in part by taking the time to visit educational programs, first and foremost to learn about what they are doing, second to explain new initiatives of the centralized authority, and third to ensure compliance.

Decentralization also enables people on the local scene to play a greater role in adapting their approach to assessment to their local circumstances. Institutions differ from one another in all sorts of important respects, including size, mission, personnel, and culture. Small institutions and large institutions face different challenges. Some institutions are focused on educating clinicians, while others have a greater research focus. Some institutions can draw on particular kinds of educational expertise, such as simulation-based methods of learning, which others lack. And institutional cultures vary widely, with varying levels of support for education, different degrees of emphasis between one-on-one and large-group instruction, and divergent attitudes toward the scholarship of teaching and learning. If educators enjoy a free hand, they can adapt assessment to their distinctive needs. To help with this, centralized assessment organizations can help to support the professional development of local educational leaders.

Decentralization also promotes the professional development of individual educators and program directors, by encouraging them to think, innovate, and assess for themselves. As physicians and human beings, these individuals have an innate need to grow and develop as fully as possible in their professional roles. For an educator, this means playing an active role in helping to develop not only curriculum and instructional methods but also assessment programs. When someone at a central assessment organization does the work of designing the assessment program and merely requires local educators to implement it, it tends to stunt the development of the local educators. They may spend all their time and energy logging, documenting, counting, and checking off someone else's boxes rather than looking at and engaging their learners for themselves.

When it comes to educational assessment, a balance needs to be struck between centralized and decentralized approaches. Centralization promotes fairness and efficiency, while decentralization promotes engagement and creativity. Letting the pendulum swing too far in either direction is fraught with peril. For the moment, however, the pendulum is swinging in the direction of centralization, and it may already have passed the point at which risks and costs are outweighing any additional benefits. Radiology educators need to promote thoughtful and vigorous discussion around these issues, focused on deepening our understanding of the purposes and approaches of educational assessment and finding the sweet spot along the continuums between summative and formative, objective and subjective, formal and informal, and centralized and decentralized approaches to assessment.

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Competencies and Experiential Requirements in Radiology Training

6

Shih-chang Wang

6.1 The Compleat Radiologist

com·pleat
adjective
highly skilled and accomplished in all aspects; complete; total: *the compleat actor, at home in comedy and tragedy*.
Origin: 1875–1880; earlier spelling of complete, used phrasally in allusion to "THE COMPLEAT ANGLER"

In Chap. 1 of this volume, the nature of radiological expertise is discussed. The modern radiologist builds an integrated intellectual framework of such expertise upon:

- A foundation of broad and deep anatomical knowledge
- A practical understanding of medical imaging instrumentation and physics
- Matrix knowledge of diseases across most organ systems
- Efficient region-, imaging-, and disease-specific search for abnormal findings
- Deductive and inductive reasoning
- Integration with internal and external knowledge bases
- Synthesis of one or more probable diagnoses
- Understanding of the impact of imaging and imaging-based diagnoses in clinical management
- Use of these competencies to guide, plan, and sometimes perform treatment of the patient

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The medical expert radiologist has many roles to fulfil as a diagnostician, a detective, a consultant, an advisor, and increasingly, as a therapist. As with all medical specialties, there are many other roles of the competent radiologist beyond being a medical expert.

The CanMEDS framework (Frank and Langer 2000; Frank 2005) describing the roles and competencies of the medical professional has been extraordinarily influential in leading international thinking on the nature of the medical expertise, particularly in the arena of training program and curriculum design. It has been left to individual specialty groups across medicine to consider how the general competencies encompassed by the framework are integrated into the specific craft groups.

In doing so, there is invariably recognition that traditional training programs and curricula have either ignored or, for the most part, paid lip service to, the non-medical expert roles highlighted by the CanMEDS framework. The last decade has seen considerable activity around the world in an effort to redesign radiology curricula. Even when the specific CanMEDS competencies are not used, there is explicit recognition by such curricula that non-medical expert roles are critical in designing training programs of the future.

To highlight differing approaches to defining competencies and experiential requirements in radiology training programs, I will describe briefly the approaches in the Australasian, Dutch, and US training systems.

6.1.1 Australia and New Zealand

The Royal Australian College of Radiologists (RANZCR) has explicitly adopted the CanMEDS 2000 framework in the design of its new Radiodiagnosis curriculum (RANZCR 2009) and has recently adopted the CanMEDS 2005 framework internally for continuous improvement and evaluation of the current curriculum. This curriculum is uniquely deployed in numerous training sites across three countries (Australia, New Zealand, and Singapore) and is described in some detail by the author in a previous volume in this series (Wang et al. 2010).

In its new training program, the RANZCR has implemented several workplace-based assessments to address some of the shortcomings of its traditional assessment framework, which was previously exclusively dependent on high-stakes barrier examinations. The rationale, nature, and implementation of these assessments are described in Chap. 9.

Experiential requirements in the RANZCR program vary in type; some numerical requirements are explicitly defined for some modalities, in particular, plain x-rays, ultrasound, and interventional procedures. For other areas, time-based rotational blocks of varying length based on subspecialties or organ systems are required. However, specific subspecialties have not been explicitly defined, as most training departments are not organised in a highly subspecialised manner.

6.1.2 The Netherlands

The Dutch Radiological Society has recently designed and adopted a national training program in radiology for The Netherlands (Jippes et al. 2010) that also integrates the CanMEDS 2000 framework, within the context of the European Society of Radiology's European Training Charter for Clinical Radiology (ETCC).

Unlike many other efforts in this space, the Dutch have decided to *not* implement national barrier examinations in radiology, a feature commonplace in many national programs, particularly in North America, the UK, the Asia-Pacific, and even within Europe. Instead, they have developed a rigorous assessment framework that depends on extremely frequent use of continuous assessment, with a range of tools that have been used in other training programs, including:

- Mini-Clinical Evaluation Exercise (mini-CEX)—10 per year
- Multi-source Feedback (MSF)—1 per year
- Objective Structured Assessment of Technical Skills (OSATS)—10 per year
- Critically Appraised Topic (CAT)—2 per year
- Progression Tests—2 per year
- Portfolio and Programme Director Meetings—5 per year initially, decreasing to 2 per year

The Dutch program has adopted the European Society of Radiology training framework (ESR 2007 and 2011), which incorporates a 3-year core training program followed by 2 years of subspecialist training. Traditionally, most European programs have relied on time-based block rotations between either various imaging modalities or specific subspecialties. Such rotations depend on the specific subspecialty mix within the training centre.

6.1.3 The United States of America

Unlike many countries, which typically have one central body that designs and implements a national training curriculum, and administers all assessments including examinations, the coordination of radiology training and assessment in the USA is split between two bodies. The American College of Radiology is responsible for developing guidelines for resident training and administering the annual ACR Diagnostic Radiology In-Training Radiology Examinations (Monticciolo 2010), while the American Board of Radiology conducts high-stakes barrier certification examinations. Furthermore, the Accreditation Council for Graduate Medical Education (ACGME) has its own requirements for accreditation of residency training programs.

The complexity of this arrangement between three major bodies responsible for different aspects of training, assessment and accreditation makes coordinated implementation of a universal radiology curriculum even more challenging than usual in the USA.

Curriculum and competencies in radiology residency in the USA have been the subject of several publications and changes over the last two decades. Gay and colleagues (Gay 1995) surveyed 202 radiology resident training programs in the USA and found that 80% of the 168 respondents supported national curriculum guidelines, but most did not favour national curriculum requirements. A subsequent analysis of this survey (Rao 1996) showed a strong bias to time-based blocks of rotational exposure to medical imaging modalities and subspecialties as the primary means of meeting experiential training requirements.

Almost a decade later, Goske and Reid (2004) argued for a need to not only devise a national curriculum in radiology, but to also base assessments on this curriculum. The most recent and complete description of radiological training in the USA (Rumack 2011) was curiously published in a Singapore medical journal, presumably in response to the recently announced shift of all graduate specialty medical training in Singapore to US-style residency programs governed by ACGME regulations.

The new US curriculum assumes the first year of a 5-year program is the internship year immediately after medical school (PGY1). PGY years 2–5 include radiology physics, radiation biology, and rotations in time-based block rotations in nine required subspecialties: abdominal, breast, cardiothoracic, musculoskeletal, neuroradiology, nuclear and paediatric radiology, obstetric and vascular ultrasound, and vascular interventional radiology. A core curriculum of lectures must be organised locally. All residents in PGY 2–4 take the yearly American College of Radiology Diagnostic In-Training Examination and take their final certification examinations, organised by the American Board of Radiology, in their fifth year.

Maxfield and colleagues reported on the successful design and implementation of the new radiology curriculum at Duke University (Maxfield et al. 2010). Nicholson and colleagues recently described local resident preferences in designing the rotational program for the fourth year of training at the University of Virginia (Nicholson et al. 2010). Clearly, the US curriculum retains considerable local flexibility in designing rotations and experiential requirements. However, as no other workplace-based assessments are mandated by this curriculum, it would appear that competency assessment relies primarily on a series of examinations, which are run by two different national training organisations!

As for experiential requirements, most training is commenced and completed entirely within a single institution. However, such institutions may encompass several hospitals, clinics, and services, in effect, representing a highly local training network. Time is used as the key marker for experiential requirements, rather than specific numbers of examinations. The combination of exposure to different settings and organ-based systems through a mandated rotational program has the effect of ensuring a broad range of clinical experience in US residency training.

6.2 Competencies

The Royal College of Physicians and Surgeons of Canada, in their summary of the CanMEDS 2005 framework (Frank 2005), describe a number of key competencies that all physicians (in the broadest sense of that word) should possess:

1. Function effectively as consultants.
2. Establish and maintain relevant clinical knowledge, skills, and attitudes.

3. Perform complete and appropriate assessment of a patient.
4. Use preventive and therapeutic interventions effectively.
5. Demonstrate proficient and appropriate use of procedural skills.
6. Seek appropriate consultation from other health professionals.

6.2.1 Radiological Competencies

The CanMEDS competencies for all physicians need some translation into a radiological context. Table 6.1 describes how the six specific CanMEDS competencies can be applied to radiology.

Table 6.1 CanMEDS competencies as relevant to radiology

Competency	Radiological competency
Consultant	Discuss indications for and type imaging Review of case findings and diagnoses Written and oral reports on imaging findings and diagnoses Recommend additional imaging tests or procedures
Knowledge expert	Radiological anatomy Imaging instrumentation and physics Pathology and relevant epidemiology Imaging findings in disease and normals Modality-based expertise in imaging applications and image quality System-based expertise in regional and organ-based diagnosis
Patient assessment	Imaging test selection and appropriateness Radiation safety and ALARA Contrast agent safety Consent for imaging procedures
Use interventions effectively	Be trained and experienced in interventions Modified approaches to reduce radiation and contrast exposure Reduction of risk for contrast reactions in selected cases Selection and use of image-guided interventional procedures
Procedural skills	Region, organ, and modality-specific skills Image-guided biopsy Image-guided injections Image-guided drainage of hollow organs or collections Fluoroscopic procedures Performance of ultrasound studies Angiographic and venographic procedures, including diagnostic studies, revascularisation and embolisation
Appropriate external consultation	Recognition of limits of radiological expertise Recommendation of other imaging experts Recommendation of additional imaging tests Recommendation for non-imaging tests or interventions Appropriate use of published medical literature and reference materials

It is of course one thing to describe these competencies, another to acquire them, and an even greater task to assess and evaluate them.

6.2.2 A Practical, Clinical Specialty

Radiology is ultimately a highly practical medical specialty. Very process-oriented, with a typically high-throughput structured workflow, it has both the primarily diagnostic paradigm of pathology and the production processes seen in industrial manufacturing and service industries.

It is easy and unfortunately common for the casual observer, especially healthcare administrators, external consultants, and government officials, to equate radiology to purely diagnostic endeavours like laboratory biochemistry or anatomic pathology. This impression has been hastened and strengthened by the proliferation of reporting-only teleradiology services, which place a premium only on the rapid production of a report, regardless of its quality.

Yet, radiology is ultimately a clinical discipline. Patients and their families must be dealt with for every examination. The patient must come to the imaging facility, or sometimes, the imaging test is brought to the patient. Indications and clinical history are paramount in determining diagnoses since for many conditions, the imaging findings are very similar. Selection of the appropriate imaging test is an increasingly complex business, with the rapid proliferation of imaging modalities and specific imaging applications within each modality. The radiologist and radiographer, in consultation with the referring clinical team, best determine safety and appropriateness. For complex interventions, discussion with patients and their families regarding consent, alternative procedures, risks, and benefits may be associated with subsequent ward rounds, clinic visits, and long-term follow-up in the same manner as surgeons.

Furthermore, much of radiologic diagnosis is dependent on the radiologist having a direct involvement in the conduct of an imaging procedure. This is particularly true in fluoroscopic, angiographic, ultrasound and interventional procedures, but even for nonprocedural radiology (e.g., CT and MRI), optimal diagnostic imaging is often dependent on pre-imaging consultation, direct control over the imaging protocol and application, interactive review of imaging findings during the imaging examination, and subsequent discussion of imaging findings and putative diagnoses with the referring clinical team.

6.2.3 Acquiring Competence in Radiology

Modern radiological curricula routinely describe a range of competencies expected of the trainee radiologist by the end of his or her training. Such competencies now go well beyond the traditional medical expert role, as we have seen above.

The acquisition of medical expert competencies requires a combination of active and passive learning, workplace-based procedural training, active teaching, and extensive experience in clinical radiology. Radiologists cannot become expert simply by reading and studying, and in today's increasingly complex radiological environment, it is clear that they equally cannot achieve a high level of expertise merely through routine practice.

Practice alone in the absence of explicit curricular goals lacks the challenges, reflection, and integration needed to achieve mastery and to become truly expert on many levels. The radiologist trained without such goals becomes merely competent and proficient and safe, which in itself is no bad thing. But this falls short of what we as radiological professionals, our clinical partners, and our patients expect of truly expert radiologists.

Perhaps it is asking too much of training programs to aspire for mastery within the limited time frame of radiology training. If we assume the "10,000 hour rule" to be true, a typical radiology training program can deliver perhaps only half this duration of direct clinical experiential practice within 5 years, unless trainees never leave the hospital! Since many training programs and local workplace regulations explicitly limit the amount of time that trainees can spend performing clinical work each week, this further exacerbates and limits the ability of trainees to obtain this level of clinical experience.

Somewhat analogous to passing a driving licensing examination, exit certification in diagnostic radiology is an explicit statement of safety, not mastery. Just as the newly minted driver needs substantially more experience and training to become a Formula 1 race car driver, the recent radiology graduate needs considerable future training and experience in order to become a subspecialist, or even a sub-subspecialist, in one or two areas of clinical radiology some years later.

Furthermore, this hard-won mastery does not last forever. Radiology, like most fields in medicine, is rapidly and continuously changing. Competence, especially procedural competence, requires continuity and regular practice to ensure that skills are at least preserved and, hopefully, continue to improve. It is interesting to consider that once "trained", radiologists rarely seek external help to continue to improve or maintain their skills, beyond attending an occasional conference or course, which cannot critique and improve practical skills directly. Gawande, in a recent article in The New Yorker (Gawande 2011), questioned why medical practitioners, in his case, surgeons, do not have consistent and regular external constructive criticism and practice improvement from coaches, such as routinely seen in elite athletes, singers, and musicians.

6.3 Procedural Skills in Radiology

Today, most of radiological practice involves sitting in front of a bank of images printed on film or, in most industrialised societies, a computer that displays medical images, while reporting on them or discussing them with clinical colleagues. Such knowledge-based expertise is developed primarily through a combination of study, training, and personal experience seeing many, many cases.

In addition to primarily knowledge-based expertise including underlying anatomy imaging findings and pathology, procedural skills in radiology require several other competencies to be considered:

- Specific indications and contraindications
- Role of the procedure in management
- Equipment selection
- Image-guidance method
- Specific procedural risks
- Risk minimization strategies and techniques
- Procedure-, pathologic-, and region-specific anatomic considerations
- Specific procedural skills
- Knowing when to stop

These competencies primarily are learned through personal hands-on training—side-by-side with experienced trainers initially, and then through a graduate process of reduced supervision over time to reach independent practice, and then the ability to teach others the procedure.

The new Dutch curriculum (Jippes et al. 2010) has modified Miller's pyramid (Miller 1990) to describe five levels of competency that pertain to radiology, which are particularly salient to the acquisition of procedural skills:

1. Knowledge possession
2. Performing with high supervision by radiologist
3. Performing with moderate supervision by radiologist
4. Performing without supervision by radiologist
5. Supervising and educating during the performance

6.4 Experiential Requirements

6.4.1 The Matrix

Almost all competencies in medicine require direct experience in addition to knowledge. Radiologists in training must understand the complexities and use of each imaging modality, in addition to the appropriate use of each modality for a wide range of indications and medical conditions.

The competency required is a matrix of knowledge and competence between specific modalities and various organ systems and types of disease. Such a matrix can be diagrammatically represented (Fig. 6.1).

Of necessity then, numerically explicit experiential requirements must reflect lowest-common-denominator minimums. The danger of pinning expertise to any specific number of examinations permits other disciplines to claim expertise in specific areas by "cherry-picking" these isolated targets, ignoring the vast array of surrounding related knowledge and expertise that accompanies such explicit experience for most radiologists.

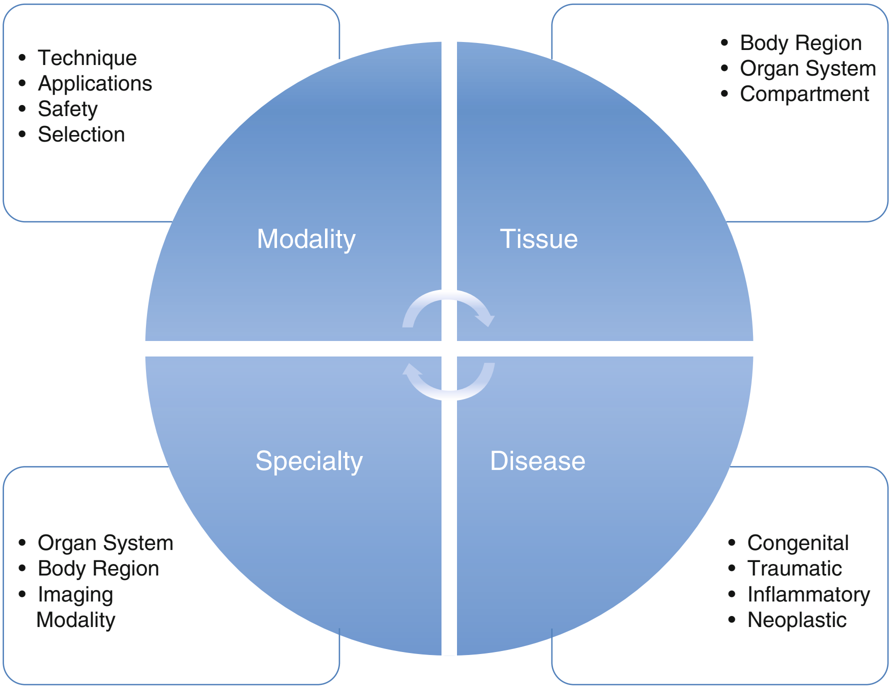

Fig. 6.1 Matrix of radiological knowledge and competencies

6.4.2 Imaging Modality Experiential Requirements

It can be argued that before trainees should undergo specialty-specific rotations, they should at least have some modality-specific training in order to understand the specific strengths, weaknesses, indications, and contraindications for each type of imaging test, and in order to be better informed in the process of test selection and determination of appropriateness.

However, it is difficult for training programs to be both subspecialty-oriented and modality-oriented. Ultimately, for logistic and rostering reasons, they end up being one or the other. In the USA and Europe, most training is based on organ-system rotations. Traditionally, many training programs (including many centres in Australia and New Zealand) have been modality-focussed.

The RANZCR program has deliberately mandated a limited range of explicit numerical minimum targets for certain imaging modalities, specifically to address real limitations in trainee learning and experience in many hospitals. These numerically explicit targets include:

- Ten thousand plain radiographs to be read over 5 years
- Fifty ultrasound scans to be performed by the trainee in the first year of training

- One hundred interventional procedures to be performed by the trainee over 5 years
- Five hundred mammograms to be read within the 5 years of training

Each of these specific requirements was chosen to ensure a minimum level of hands-on direct experience in areas that, left unspecified, had resulted in very low levels of exposure over the period of training in many centres. Interestingly, one of the first responses to these requirements from many training centres was that there was no way that their trainees could read 10,000 plain radiographs in 5 years. Simple arithmetic shows this translates to 50 films per week, or the equivalent of 10 films per day. Since pointing this out, trainees have by and large readily met this numerical criterion, sometimes exceeding the first 3 years' requirements in less than 18 months.

At this time, there is no evidence to support these specific minimums. Unlike screening mammography, where sensitivity and specificity can be shown to be directly correlated with specific minimum exposure and workload, conventional radiologic imaging does not lend itself to such outcomes analysis since for in general, the clinical outcome and final diagnosis may not be discovered or confirmed without detailed subsequent follow-up.

However, examiners in our final Part 2 oral examinations had long complained that trainees were not well-skilled in plain radiograph interpretation, and had judged that poor performance in the interpretation of plain radiographs meant that most candidates simply had not seen enough such cases in their training. Even today, about 50% of all radiology studies in Australia are plain radiographs, even in tertiary centres. It was felt that proactive mandatory curricular requirements were the only way to ensure that all trainees had reported at least a reasonable baseline number of radiographs during their training. It remains to be seen whether this mandated minimum will translate to better performance at the oral examinations in the future.

6.4.3 Organ-System Requirements

Both the US and European curricula for radiology have experiential requirements defined as mandated blocks of time spent learning a particular imaging modality, or being rotated to a specific organ-system-based block within a training system or institution. Most programs do not explicitly define exactly what is done, the specific competencies to be obtained, or the amount of experience in terms of case numbers or types of imaging studies performed during those blocks of time.

There are excellent practical reasons for not attempting to do so. There is a very wide variation in the range of pathology, expertise of supervising consultants, range of imaging modalities, and the caseload of any given rotation within any given training site. Barring some basic numerical requirements, any attempt to mandate, say, 100 knee MRI cases in 3 months, will be met by some centres achieving this with ease and others struggling to reach this target.

Unlike the USA and Canada, most training centres in Australia and New Zealand do not function along subspecialty lines at the time of writing. However, the mandatory requirement in the new national curriculum for "system-focussed" rotations for all trainees in their fourth and fifth years of training has led to several departments switching from modality-based to system-based reporting and supervision recently.

Conclusions

Competency in diagnostic radiology, as for all medical professionals, requires a multilayered and matrixed approach in developing the many skills required. In general, it is difficult to argue with the concepts and principles embodied in the CanMEDS Physician Competency Framework, and most attempts to design a modern national curriculum in diagnostic radiology are strongly influenced by these principles. This chapter has highlighted the varying approaches that may be taken to achieve the experiential requirements in training a radiologist in order to achieve these competencies. As with most educational endeavours, there is a paucity of evidence that the increased level of internal workplace-based assessments that are inherent in such strategies will lead to improved outcomes.

The RANZCR's new curriculum has recognised the highly varied nature of radiology practice across Australia, New Zealand, and Singapore in developing its experiential requirements for radiology training. Some jurisdictions have single-centre-based programs similar to US or Canadian style residency programs. Others have local, regional, or even state-wide networked rotational training programs, where trainees gain an extremely varied exposure to differing styles of radiological practice, as well as widely varying casemix. Unlike the USA, in Australasia the RANZCR controls training site accreditation, the national curriculum, all internal assessments, and all external barrier assessments for all its trainees.

The new Netherlands training program depends on a very high frequency of internal testing and assessment tasks, in lieu of national external examinations. It remains to be seen whether this high frequency is feasible and sustainable, and whether this type of continuous assessment will achieve comparable levels of competence to national programs that have high-stakes barrier external examinations.

The US national curriculum is highly dependent on local residency programs (accredited by the ACGME) to provide subspecialty teaching and required time-based rotations, with assessments being a combination of ACR in-training examinations and ABR external board certification examinations.

It can be argued that each of these three rather divergent approaches will probably all produce competent, safe, and proficient radiologists. All of these programs have undergone significant recent curricular redesign, with major changes in assessment strategies to reflect educational best practice. The impact of these changes, some of which were never actively promoted or assessed in the past, and the subsequent downstream effects on consultant or attending radiologist performance across the full spectrum of CanMEDS competencies, will be the subject of keen educational interest in the coming years.

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Accreditation and Evaluation of Programs: The Canadian Perspective

7

Kenneth A. Harris, Margaret A. Kennedy, and Sarah Taber

7.1 Accreditation and Evaluation of Programs: The Canadian Perspective

Accredit: Give authority or sanction to (someone or something) when recognized standards have been met (Simpson and Weiner 2011).

In Canada, responsibility for accreditation of postgraduate medical education programs lies with the Royal College of Physicians and Surgeons of Canada (Royal College) for all medical and surgical specialties and subspecialties (Royal College of Physicians and Surgeons of Canada 2011b). Responsibility for accreditation of family medicine programs is that of the College of Family Physicians of Canada. There are a large number of key stakeholders involved in the Canadian postgraduate medical education system, and there is significant collaboration between these many organizations. Key stakeholders include the 17 faculties of medicine in Canada who are charged with delivery of the educational content of specialty training, a variety of

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health-care delivery sites including hospitals and clinics, and the national resident organizations. Through a process of assessment and evaluation of programs, Canada has established an international reputation as being one of the leaders in medical education. This chapter will describe the Canadian system within the global concept of accreditation and outline areas where future innovation will be required.

7.2 The Royal College of Physicians and Surgeons of Canada

Created in 1929 by Royal charter, the Royal College is the certification body for 28 specialties, 36 subspecialties, and 2 special programs in Canada. National standards for postgraduate training are developed and maintained by the Royal College in consultation with the specialty committees, one for each specialty recognized by the Royal College. All programs and residents must meet these requirements. Prior to being certified and eligible for membership in the Royal College, trainees must pass a high-stakes examination as well as having been assessed in the workplace by a program director. In Canada, the specialties of diagnostic radiology and nuclear medicine are separately recognized, although close relationships and overlap are acknowledged; neuroradiology and pediatric radiology are recognized subspecialties of diagnostic radiology. Currently, there are 16 accredited training programs in diagnostic radiology, 10 accredited training programs in nuclear medicine, 7 accredited training programs in neuroradiology, and 2 accredited training programs in pediatric radiology in Canada.

The specialty committee is composed of volunteer members of the Royal College who are certified in the discipline of question. Membership consists of an experienced chair, one member from each of the five designated regions of the country, and the chair of the Examination Board. Specialty committees are encouraged to include a member who practices in a community setting (nonacademic health science center). All program directors are corresponding members of the committee, and the national specialty society is invited to have a member sit on the committee.

The accreditation process formally assesses each program against national standards as set out by the Royal College and the specialty committee. Accreditation is granted only to those residency programs that are under the direction of a Canadian university medical school. The medical school must have affiliated teaching hospitals and other education sites, including community-based clinical offices and practices, all of whom share a major commitment to education and quality of patient care. Finally, there must be appropriate arrangements between the university and all sites participating in postgraduate medical education to provide an appropriate education environment, including working conditions and faculty–learner interactions.

7.2.1 Accreditation as a Process

In addition to assuring set standards are met, an accreditation process should enable continuing quality assurance and improvement. This philosophy is articulated by the International Society for Quality in Healthcare (International Society for Quality in Healthcare 2011b). Accreditation of PGME programs in Canada is based on specific content and educational standards for each discipline and thus ensures effective standardization of all postgraduate training in Canada.

7.3 Brief Review of the Royal College Accreditation Process

The Royal College accreditation process is founded on the following components: evaluation against general and specialty-specific standards of accreditation; a regular cycle of review that includes the program's self-assessment against the standards, an internal review, and an on-site review conducted by peers that monitors resources, processes, and performance; the involvement of multiple perspectives, including residents' during the review; and the provision of a final accreditation status with a report that highlights the programs' strengths and areas of weakness.

On a 6-year cycle, each residency program is formally reviewed by the Royal College and an accreditation status is given at that time. The Royal College recognizes that there are standards that apply to the overall university and hospital/clinic environment (A Standards) and standards that are discipline specific (B Standards) and require separate review with each program (Royal College of Physicians and Surgeons of Canada 2011a).

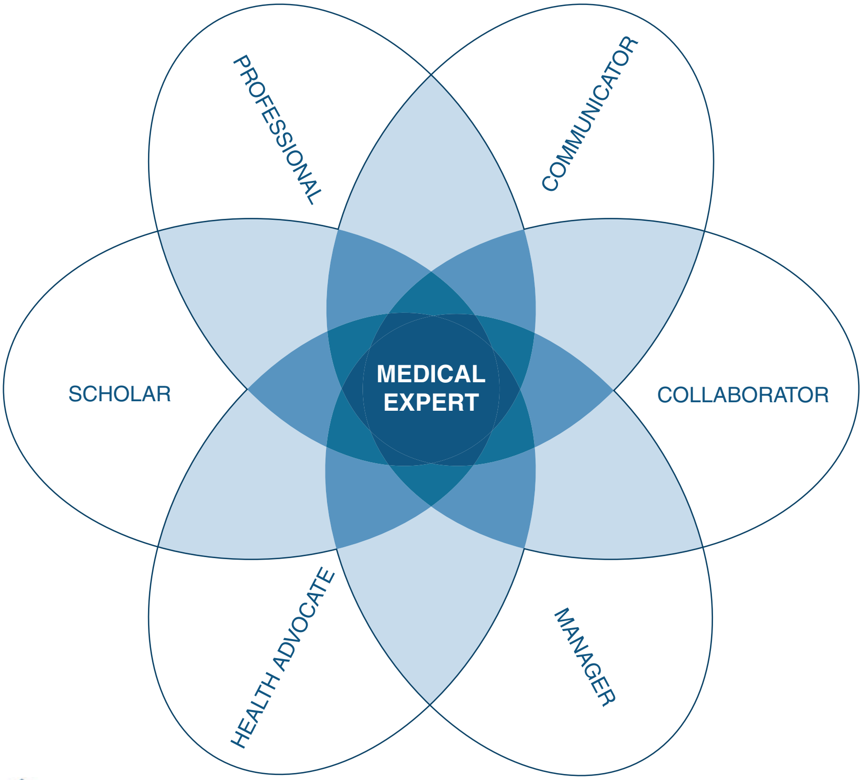
The A Standards are specific to the university postgraduate function and the infrastructure required at that level to support individual residency programs. These standards also include statements regarding the relationship between the university medical school and the hospitals where training occurs and the physical environment of these locations; they also require overall infrastructure support for all residency programs. These standards are generic and the same for all Canadian university medical schools.

The B Standards are those specific to each residency program and on which each program is assessed at the time of the accreditation review. The six main categories of B Standards for residency programs include:

1. Administrative structure
2. Goals and objectives
3. Content and organization of program
4. Resources
5. Educational program
6. Resident evaluation

Programs require discipline-specific content and resources; these are outlined in the specialty-specific standards for accreditation of residency programs and are publically posted. Diagnostic radiology has a specific suite of documents unique from all other disciplines although formatted in a standardized Royal College template.

The process of setting national standards also permits the assurance of the attention paid to all competencies required by existing and training specialists. In Canada, the CanMEDS generic competencies have been in use since 1996, and all programs must have specific training objectives and assessments that are linked to each of the roles (both medical expert and other intrinsic roles). These roles and their descriptions are outlined in Fig. 7.1 and are widely available (Frank 2005).



ROYAL COLLEGE OF PHYSICIANS AND SURGEONS OF CANADA | CANMEDS

Fig. 7.1 CanMEDS roles (Copyright © 2009 The Royal College of Physicians and Surgeons of Canada. http://rcpsc.medical.org/canmeds. Reproduced with permission)

To ensure that adequate resources are available for the practice and teaching of the discipline as defined by the specialty committee, specific questions are asked of each program. In preparation for an on-site accreditation survey, the program completes a pre-survey questionnaire that describes the program and how the program is meeting the standards of accreditation. Examples of the type of questions from the diagnostic radiology questionnaire are given in Table 7.1.

The specialty committee has an opportunity to review the pre-survey questionnaire and provide feedback to the survey team on any specialty-specific issues related to the program that should be addressed at the time of the on-site visit (Fig. 7.2). This input is important as the program reviewer, who is a medical educator, is not a specialist in the discipline of the program under review, and the input of the specialty committee provides the specialty-specific oversight of the program. As outlined above and in Table 7.1, the specific areas that the specialty committee

Table 7.1 Specialty-specific questions asked on the pre-survey questionnaire

Feature	Specifics
Physical facilities	Seminar rooms, resident dedicated space
Equipment	Roentgenographic Nuclear medicine Ultrasound Computed tomographic Magnetic resonance imaging Other computer resources
Volumes (subcategories not listed)	General diagnostic radiology Neuroradiology Vascular/interventional Ultrasound Computed tomographic Magnetic resonance imaging Breast Pediatric

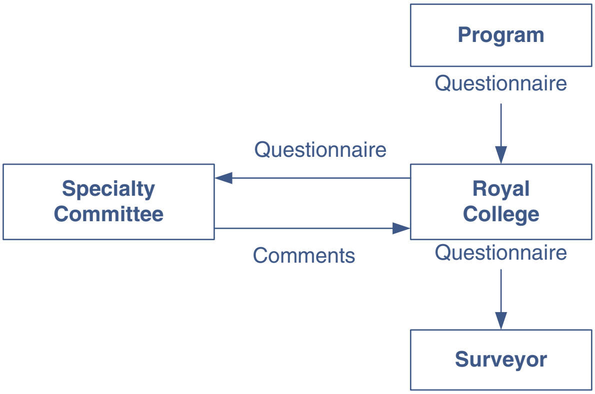


Fig. 7.2 Pre-survey documentation process

evaluates include number and case mix; appropriate equipment, i.e., the type and age of radiology and ultrasound equipment and reporting stations; etc.

The cyclical on-site review of each program is conducted by a team of volunteer specialists, always from a different institution, many of whom are program directors, and all of whom have experience in medical education and receive training on how to conduct program evaluations. Other members of the survey team include residents, appointed by the national resident association, and representatives from the regulatory authorities and the teaching hospitals association. The role of the resident in the accreditation process is extremely important as they conduct an independent survey of residents prior to the visit and during the visit encourages additional trainee input (Maniate 2010). Each program is assessed based on how well it is meeting the standards of accreditation.

All Royal College programs under the auspices of a given university as well as the family medicine program are reviewed over a 5-day period led by an

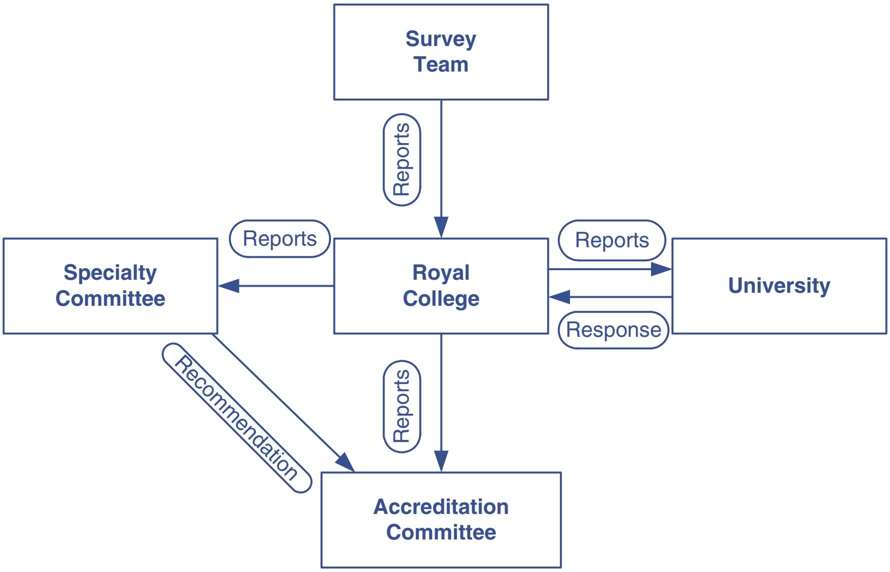


Fig. 7.3 Post-survey documentation process

experienced chair from each of the colleges. Every program, depending upon size, has an individual visit lasting ½ to 2 days, which allows sufficient time to assess the content of the pre-survey questionnaire, as well as meetings with the program director, faculty members, and the residents in a series of coordinated meetings. The review of most diagnostic radiology programs takes approximately 1–1½ days. Through a series of semi-structured interviews, information is gathered regarding the conduct of the program. The survey team meets as a group each evening and, after hearing the report of the surveyor for a program, collectively decides on a recommended accreditation status for that program. Prior to the departure of the survey team, the relevant program director and the Postgraduate Dean are informed of the survey team's recommendations regarding the individual program. These recommendations include the category of accreditation and a summary list of the strengths and weaknesses of the program.

A survey report is filed that describes how the program is meeting the standards as well as providing the list of strengths and weaknesses of the program, each of which are linked to the published A and B Standards. The program and the specialty committee have an opportunity to comment on the report. All information is then discussed by the accreditation committee of the Royal College, which has the responsibility to assign the accreditation status to the program (Fig. 7.3).

The categories of accreditation are:

- Approval for 6 years (full cycle)
- Provisional approval with a repeat review conducted within 2 years either:
  - Internally by the postgraduate medical education office or
  - Externally by experts in the discipline being reviewed

- Notice of intent to withdraw accreditation with a repeat review conducted within 2 years by experts in the discipline under review. This category is given when weaknesses are serious and/or repeated.

There is an official appeal mechanism for contested decisions.

Reports for the 2-year internal and external surveys conducted for programs with provisional approval are also reviewed by the accreditation committee shortly after they have been received.

An important feature of the accreditation process is the requirement for the conduct of an internal review on every program between Royal College on-site surveys. This report, unless otherwise mandated, is not seen by the on-site surveyor in hopes that a robust internal assessment process will lead to identification and correction of any major weaknesses prior to an on-site review. The internal review requirement supports continuing quality improvement in a program through a process of self-assessment and formative review by parties external to the program.

A list of accredited programs and contact information is made publically available on the Royal College website, although the category of accreditation is disclosed only to the program director and Postgraduate Office. Similarly, the actual survey report is considered the property of the program and not publically available; access is however given to the surveyors at the time of the next survey to permit assessment of progress and improvements made on previously identified weaknesses.

7.4 Standard Setting

The Royal College does not deliver educational content but sets the standards for the programs that are delivered by the individual universities. General standards are developed by the Royal College, and individual specialty committees are tasked with developing specialty-specific standards. The process and CanMEDS-based template for laying down the standards is consistent, transparent, and facilitated. The Royal College assists the content experts on the specialty committee to populate the educationally structured templates. The standards are published and on the Royal College website (RCPSC 2011a, b) and are made available to universities, program directors, and trainees. Given the diversity of disease, practice patterns and resources across the country, individual programs within universities may determine how to best meet these educational standards within certain guidelines.

As postgraduate medical education is complex, including interaction between faculty members, hospitals, licensing authorities, universities, and certifying colleges, the transparency of the process must be robust. Postgraduate trainees in Canada have dual roles as learners and as service providers allowing for experiential learning as well as formal curricular teaching. The accreditation process reviews not only the educational content but the educational environment in which this content is delivered, to ensure that appropriate levels of supervision and exposure to clinical material is achieved but workload does not prohibit education.

7.5 Current Process from the Accrediting Organization Perspective

The standardization of accreditation processes has many advantages for the accrediting organization, including:

- Efficiencies in scale, for example, at the time of a survey, all programs at a university are reviewed but the A Standards need to be reviewed only once.
- Opportunities for programs to learn from each other as reviewers make visits.
- Content expertise is obtained from national specialty committees, but the central role of the Royal College maintains a national standard.
- Assurance of an educational environment conducive to learning.
- Peer review occurs during the process, leading to significant investments in and respect for the process.
- Process of recommendation and sanctioning of the recommendations by a formal accreditation committee removes any conflict from the review and removes the ability to pressure surveyors to grant a certain level of accreditation.
- New initiatives in medical education have been introduced through slowly changing accreditation standards. An example is the introduction of the CanMEDS Roles into all residency training programs. The accreditation process is known to serve as a driver for change.

7.6 Current Process from the Academic Program Perspective

From the academic programs perspective, there are a number of advantages to the current accreditation system:

- The ability to advertise national standards for residency training in a given discipline in all programs across the country.
- The ability to refer to national standards has aided programs in defining the resources needed to maintain up-to-date programs. For example, the number and type of CT scanners and ultrasound machines will be assessed and commented upon by the diagnostic radiology specialty committee to ensure that fiscal restraint is not inhibiting adequate educational delivery.
- Given the resident's dual role as learner and service provider, the program is able to ensure adequate time, and resources are available to train residents throughout the program.
- Programs benefit from regular formal review of program strengths and weaknesses to permit program improvement.
- Published standards permit the university to oversee that programs being conducted both within academic health science centers as well as through the increasingly common distributed education sites meet the same standards.
- Most faculties find the presence of an accredited training program an important recruiting tool for new or senior faculty.

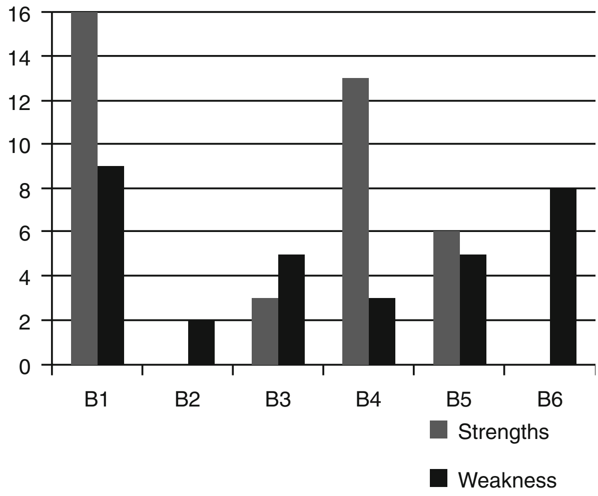


Fig. 7.4 Diagnostic radiology program listed strengths and weaknesses

7.6.1 Accreditation of Diagnostic Radiology Programs in Canada

A review of the strengths and weakness of diagnostic radiology training programs over the past 18 months (reviews of approximately seven programs) demonstrates that programs have many strengths and weaknesses listed. Program directors are frequently listed as a major strength of the program. The majority of weaknesses relate to the assessment of both the individual trainee and the program itself. Those programs that did have resource issues (e.g., exposure to pediatric radiology) have these specifically identified to permit follow-up. Additionally, like many disciplines, some of the intrinsic CanMEDS roles require further teaching and assessment. These are illustrated in Fig. 7.4.

7.6.2 Challenges to the Current Accreditation System

Best practice in accreditation (Australian Council on Healthcare Standards 2010; International Society for Quality and Safety in Healthcare 2007a, b) dictates regular review and ongoing quality improvement of a system's process, standards, and impact to ensure it is keeping pace with its environment. At the apex of two of the most complex systems, education and health, the environment for medical education is ever changing, and thus, it is important that medical education accreditation systems evolve to keep pace. The Royal College in collaboration with the College of Family Physicians of Canada has established a task force to review the current postgraduate medical education accreditation processes and facilitate system evolution. Some of the areas for consideration are outlined in the following sections based on reviewing available evidence.

7.6.2.1 A (Partial) Shift Toward Outcomes-Based Accreditation

The rationale for shift is a desire for PGME (and health service providers) to be held accountable for the outcomes achieved (Leach 2004).

While there is support in the literature (Chen et al. 2004; World Federation for Medical Education 2003; Musick 2006; Buckley et al. 2010; Kassebaum 1990; Philibert 2009), none has endorsed a total shift toward outcomes-based approaches; instead, some have advocated for a mix of structure and/or process, and outcome to ensure a balanced approach (Goroll et al. 2004; Accreditation Canada 2010; World Federation for Medical Education 2003). Others still have indicated that the link between process and outcome with respect to accreditation and performance has still yet to be established (Shaw 2003).

Looking at PGME more specifically, some have advocated for linking medical education accreditation to trainees' results on standardized examinations, including certification examinations (Davis 2006; Goroll et al. 2004; Taylor 2010; World Federation for Medical Education 2003). One author advocates for a balance of flexibility among specialty disciplines in choosing outcome measures, with standardization to ensure objectivity of the accreditation process (Musick 2006). Some have also advocated for using clinical outcome measures as an indicator of the quality of PGME (Goroll et al. 2004; Haan et al. 2008); looking at a set of measures for a clinical team for a particular rotation, the authors argue it is possible to identify areas that need improvement in the curriculum, i.e., all residents are performing poorly on one particular measure, or individual residents in need of remediation, i.e., one resident performing poorly on all/several measures.

There is also support for using clinical measures already identified and/or reported at the local, regional, or national level for health-care quality purposes (Haan et al. 2008) for medical education. A number of authors cite challenges, such as scarce resources or a lack of consensus, with identifying a new set of clinical measures just for the purposes of (medical education) accreditation (Haan et al. 2008; Buckley et al. 2010); instead, they support using data that is already being collected for quality improvement or other purposes. It is believed that this aggregate data can help residents in understanding individual performance improvement data overtime, using self-reflective journals or summaries (Buckley et al. 2010; Fleischut et al. 2011); similarly, it can be discussed with surveyors during both the internal and external reviews (Haan et al. 2008; Buckley et al. 2010). Haan and colleagues also recommended a tiered framework of criteria for the selection of clinical indicators from those already in use.

7.6.2.2 Challenges Associated with Distributed Sites or Distributed Programs

Although not often cited in the literature, the challenges associated with distributed medical education and accreditation have implications for the standards, the survey process, and the control of variables related to both clinical and educational outcomes.

While being discussed increasingly within the context of PGME, it is not necessarily a new phenomenon, especially in family medicine. Is there an opportunity to learn from our family medicine colleagues in terms of how distributed sites are integrated into the residency program?

Similarly, are there lessons that could be learned from our colleagues with similar challenges in terms of rural areas and health service delivery? For example, Australia is one jurisdiction where some research has been done on quality control of medical education programs in rural communities (Denz-Penhey and Murdoch 2010). Denz-Penhey and Murdoch found that, in rural settings, it is possible to achieve the same outcomes, i.e., marks on standardized testing, following the same curriculum standards, but with the flexibility to design the approach to delivering the curriculum.

Likewise, PGME is not alone in this challenge of distributed health-care delivery; it has been faced by health services accreditation bodies in terms of the accreditation of health services in the regional context. Accreditation Canada, for example, has experimented with, an approach to selecting services and sites within a regional context based on risk, i.e., based on the data coming in throughout the accreditation cycle. Are there lessons learned, positive or negative, that could be transferrable to the PGME context?

7.6.2.3 Duplication of Accreditation Processes in the Academic Health Science Organization: the Accreditation Industry

From the perspective of the health service organization, and in particular, the academic health science center, there is a burden of duplication of accreditation processes: undergraduate medical education, postgraduate medical education (family medicine and specialty medicine, until recently not harmonized), regulatory and licensing reviews, health services accreditation, and, in some cases, additional processes for quality assurance audits in specific areas such as the laboratories. It has been acknowledged that the number of organizations focusing on quality and safety is increasing; these organizations have related, and sometimes, overlapping mandates resulting in increasing workload and demand on health-care providers, and duplication in data collection and reporting (Accreditation Canada 2010). So too, the resources required to respond to the requirements of each organization, as well as the costs to each accreditation body to run the program, are extensive. The opportunities to synchronize processes and/or collaborate with respect to requirements for overlapping areas of interest are issues that require discussion among stakeholders. Not only are there opportunities for collaboration and the sharing of data, etc. as it relates to areas of a common interest, but there is also the opportunity to consult broader with stakeholders regarding what makes a good residency program, how those elements could be measured via the Royal College's accreditation standards, and other recommendations to improve the accreditation process.

7.7 Considerations for the Royal College in the Future

7.7.1 The Need for Research and Development

To continue, and perhaps even enhance, the Royal College's reputation as a leader in PGME accreditation, the Royal College should consider a significant commitment to research and development dedicated to accreditation. Although research has been done in health services accreditation (International Society for Quality in Healthcare 2011a; Pomey et al. 2010; Alkhenizan and Shaw 2011), it is limited in terms of its study design, and thus, its generalizability to other programs and systems; much of the research available examines case studies and/or anecdotal evidence regarding the benefits and challenges of accreditation (Kennedy et al. 2011; Pomey et al. 2010). In a recent Cochrane review on the effectiveness of external inspection of compliance with standards, only two studies met the Cochrane Collaboration's inclusion criteria with respect to methodological design, highlighting the lack of rigorous research, and meaning no firm conclusions could be drawn (Flodgren et al. 2011). Other authors have cited a lack of evidence that accreditation brings in terms of long-term processes and outcomes (Shaw 2003); in particular, Shaw states that the "process-outcome link… has not been established between institutional accreditation and performance." Commonplace in other accreditation bodies, a research and development (R&D) group allows the accreditation body to regularly review the environment with respect to changes in the field, stay ahead of trends in accreditation, and engage in pure research with respect to the outcomes/impact of accreditation, factor analysis of its standards, the rigor of the measurement framework, etc. This research is a major gap in PGME accreditation, and an opportunity for the Royal College to remain a leader in this area.

7.7.2 Quality Improvement Versus a Seal of Quality: Formative Versus Summative Assessment

A challenge of almost every accreditation body is to decide where on the spectrum between a purely formative, and on the other end, purely summative, the accreditation program should sit. On the one hand, purely formative processes are characterized by a quality improvement "journey," where the accreditation body makes recommendations toward an optimal or "gold" standard, and supports the accredited organizations through that journey. On the other hand, purely summative approaches tend to focus on an audit-like review against the standards, with non-compliance often resulting in a (partial) loss of the accreditation status.

There are a number of models between each extreme, and in particular, the majority of accreditation programs have settled on some combination of formative and summative assessment. The "musts" and the "shoulds" used by the Royal College are one example of this; so too are the "required organizational practices" used by Accreditation Canada; yet still others have implemented a "basic," "intermediate," and "advanced" type model of gradation in the standards.

7.7.3 A Balance of Structure, Process, and Outcome

As highlighted above, there is a growing trend toward outcomes measurement and outcomes-based accreditation, with an eye for a balance of structure and process measures to protect some of the fundamental infrastructures and process-based best practices in PGME. Drawing perhaps on recommendations resulting from consultation with stakeholders regarding what makes an excellent residency program (see above), the Royal College could look to evolve its current standards, keeping those elements that are still relevant and important, eliminating those less necessary, and adding, in an incremental fashion, new outcomes measures to begin to shift the program in that direction.

7.7.4 International Best Practices in Standards Development

The International Society for Quality in Healthcare (ISQua) has, as part of its accreditation program for accrediting bodies, requirements for the standards and the standards development process (International Society for Quality in Healthcare 2007a). Although not all of the standards are entirely applicable to PGME, i.e., requirements for standards focused on patient care, the Royal College could stand to gain from the adoption of certain principles from the ISQua standards, perhaps, most notably, the adoption of the international best practices to bring rigor to the standards development process.

7.7.5 Rigor of the Measurement Framework, Including the Accreditation Decision

Again, the Royal College may look to international standards in this area, as significant work has been done to ensure that accreditation standards enable the consistent and transparent rating and measurement of achievement (International Society for Quality in Healthcare 2007b). A variety of frameworks are used, including different types of rating scales as well as algorithms to decide the accreditation decision; however, there is general agreement that no one framework fits all purposes, and that the measurement framework should follow the intent of what is being measured as well as the accrediting body's philosophy with respect to formative vs. summative assessment. Nevertheless, the ISQua standards do require that there be a defined methodology for measuring overall achievement of the standards in a consistent way (International Society for Quality in Healthcare 2007b), which not only improves surveyors' inter-rater reliability, but also the consistency of the accreditation decision. There is an opportunity for the Royal College to review its measurement framework with these ideas in mind, with the potential to reduce the judgment involved in the current accreditation decision, as well as workload for the accreditation committee and Royal College staff.

7.7.6 Continuous Quality Improvement

Last, but certainly not least, is the notion of moving from a cycle of accreditation that is associated with several peaks and several valleys—to one that is more continuous in that it promotes ongoing connection to the Royal College vis-à-vis the exchange of data, reports on progress, etc., truly allowing the residency programs to achieve an ongoing philosophy of improvement. Encompassed in this are a number of things, including a review of the self-assessment (PSQs) to ensure they are best designed and actually used for their intended purpose, examining the touch points between the residency programs and the Royal College to allow for updates on progress toward recommendations, and considering the options for the entire accreditation cycle as a whole.

7.8 Summary

The accreditation of residency education in Canada is a respected process held to be valuable by medical educators and Faculties of Medicine. It has facilitated the creation of a robust medical education system and is considered a value of membership in the Royal College. The potential impact of Royal College accreditation is ensuring all programs have structures, resources, curriculum, and teaching and assessment methods in place to allow for residents' achievement of the defined set of competencies (Davis and Ringsted 2006). This design does not limit excellence but facilitates a nationally established standard for the delivery of residency education. The maintenance of both the educational and specialty-specific content standards is one of the hallmarks of the Canadian system. It should not be a static focus and the Royal College continually looks to improve its processes as training programs and medical education advance.

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8 Assessment and Evaluation in a Transnational Radiodiagnosis Training Program

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8.1 Introduction

Diagnostic radiology assessment has long had components attempting to capture competence. However, it can be argued that such assessments were not particularly realistic, and did not necessarily reflect competence in the workplace, or 'real life'. Furthermore, such formal assessments have rarely attempted to capture procedural or process competence, focussing primarily on diagnostic skills and knowledge recall.

Oral assessments, long popular in many postgraduate medical disciplines, suffer from an intrinsic lack of reliability, even if they are usually considered quite valid in their approach. Yet almost all high stakes barrier assessments in diagnostic radiology rely strongly on the impressions obtained by one or more examiners presenting a small number of cases in a very high-stress oral examination format.

In the early twentieth century shortly after the discovery of x-rays, radiology had no formal training programs or curricula, as most people who decided to learn the new discipline were self-taught. Since the 1950s, formal training programs in radiology have become widespread in developed nations, and more recently in developing nations as well. In the last few decades, measuring radiology competence has depended strongly on three major types of assessment, which have been widely used in various training programs, either locally or nationally:

- Written knowledge testing, which may take the form of essays, short answer questions, multiple choice questions, or some combination of all three

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- Formal report writing, where a limited range of imaging cases are presented with a short history, requiring the candidate to construct a structured report detailing key findings and the most likely diagnosis
- Face-to-face viva voce examinations, where candidates are presented with imaging cases and are asked to orally describe findings and report on the most likely diagnosis

In addition, all programs have some form of annual or biannual evaluation report, usually collated or coordinated by a key individual such as the Director of Training or Residency Program Director.

Some programs are linked to university degrees such as master's programs, and if so may demand a research project that culminates in a dissertation or thesis submitted for completion of the higher degree.

All such traditional assessment programs have evolved in a stepwise fashion over time. Until quite recently, the development of radiology training programs had not been systematically informed by best educational practice. The last decade has seen a revolution in thinking in postgraduate medical education, to capture competence as an assessable outcome of training. radiology has been swept up in this approach, and several national or transnational curricula have been developed to reflect this trend. It is one thing to accept this trend, however, and another to embrace and implement it.

This chapter aims to describe the assessment and evaluation framework of the current (or 'new') curriculum and training program in diagnostic radiology of the Royal Australian and New Zealand College of Radiologists (RANZCR, or 'the College').

8.2 The RANZCR Radiodiagnosis Training Program

RANZCR recently commenced a new curriculum and training program in diagnostic radiology that has been described previously by the author (Wang et al. 2010). RANZCR is a professional peak body for diagnostic radiology and radiation oncology in Australia and New Zealand. It has many roles—educational, administrative, advisory, political, financial, and strategic.

RANZCR's role in training and education spans from training site or network accreditation, to curriculum, to assessment and evaluation, and to policies and guidelines to support trainees and ensure that a good and consistent standard of training is delivered. However, it has no direct control over how trainees are employed, rostered, or paid. It has no direct involvement in training at specific accredited training sites.

From its inception, the College has set standards for radiology trainee performance and has conducted national examinations in diagnostic radiology. For most of the last four decades, apart from annual Director of Training reports on trainee progress, these were the only assessments conducted by the College.

The planning for a new curriculum and training program in diagnostic radiology, based on modern pedagogical principles and educational best practice, commenced in 2005. The CanMEDS 2000 framework was adopted for its core principles and a variety of additional methods of assessment were reviewed and adopted. These additional assessments were introduced for the first time on launch of the new training program and curriculum in December 2009.

8.3 The 'Old' Training Program

Only trainees commencing their training after December 2009 (New Zealand) or January 2010 (Australia and Singapore) are enrolled in the new training program. The changes inherent in the new program are fundamental and major, particularly where in-training workplace-based assessments and experiential requirements are concerned. From the outset, a deliberately phased rollout of the curriculum year by year was considered to give College staff training centres and trainees alike time to evolve and restructure many processes in order to support the full implementation of the new training program.

The majority of our trainees are therefore, at the time of writing, still in the 'old' program, where there are very few in-training assessments, little structured training evaluation, and few barriers to progression apart from highly intensive summative examinations taken in the first and fourth years of training.

The 'old' program served the College well, producing qualified radiologists of competent standard, and sometimes exceptional young consultants who went on to distinguished academic careers and leadership positions in the profession, sometimes with global impact. However, that program relied heavily on the commitment and personal involvement of consultant supervisors at a small number of major training sites, which developed often very high-quality local training programs.

At the best sites, similar to residency programs in major training centres in the USA, consultants would mentor, supervise, train, and teach trainees in a continuous, comprehensive, and closely monitored fashion to ensure high standards and good results at the national barrier examinations. In such sites, candidates from such centres would routinely pass all or almost all elements of the major examinations with ease; for these candidates, the final examinations were more of a confirmation of the good quality of training they received than a true barrier.

Unfortunately, many training sites did not meet this standard, which led to some trainees being disadvantaged and poorly trained. The consequence of this inability to meet the demands of the training model was poor performance at the national examinations for a large proportion of candidates, with some candidates failing some or even all elements of the examination on more than one occasion.

The 'old' program was characterised by a lack of a clearly defined syllabus, and challenging examinations in the first-year and fourth-year of training. Such examinations functioned as a barrier to progression in training. The RANZCR's role in training was limited to accrediting training centres, and to setting and running the examinations. Apart from annual Director of Training (DoT) reports on trainees, no other assessments were conducted as part of the 'old' training program.

Over the last 30 years, the rapid evolution of radiology technology and applications, and the shift of many types of radiological investigation and procedures to community settings, has meant that the simpler, more laissez-faire mode of assessments conducted in the past are becoming increasingly less relevant and incomplete, from both competency and curricular perspectives.

Furthermore, over the last two decades, a rapid rise in the utilisation and demand for medical imaging across a wide range of clinical settings, across all our training jurisdictions, has meant that there is increasing pressure for departments to increase the number of trainees in each centre. Furthermore, a lack of practising radiologists resident in regional communities has become progressively more acute. Governments have pushed for regional training networks to be developed, in an effort to not only broaden the range of experiences trainees will encounter, but also to encourage some to stay in the regional areas after completing their training. Large training networks have been encouraged, and are well developed in the North Island of New Zealand, Western Australia, South Australia, and Queensland.

This new challenge, of decentralising training outside of traditional centres of training excellence, comes at a time when there is also recognition of the need to improve our assessments, particularly to cover areas that were not assessed or evaluated at all when the College relied exclusively on the examinations.

In a tightly controlled local residency program, trainers and trainees get to know each other and work together for a number of years. Supervision and mentorship, and evaluation of trainee competence, exam-readiness, and other aspects indicating satisfactory progression, are believed to be a fairly intuitive process. Training can be calibrated locally for trainees who are progressing less well than others. Unfortunately, humans being as they are, such systems are also prone to allegations of favouritism, bias, and inappropriate and unreliable evaluations, regardless of how justified these may be. This is particularly evident in small centres with a small number of trainees.

A rotational system on the other hand, where trainees spend a large proportion of their training time based in other centres, breaks this traditional close link, and means that Directors of Training, supervisors, and heads of department have much less ability to monitor and evaluate the progression of their trainees than in the past. The 'intuitive evaluation' approach cannot work reliably (if it ever did), and a more structured and systematic approach becomes essential.

8.4 The Current Program

The 'new', or current, radiodiagnosis training program is characterised by two discrete phases in a 5-year training program, a 3-year general or core phase 1, followed by a 2-year systems-focused phase 2. While the examination framework has not changed from the previous program, there is a major barrier to progression at the end of phase 1, such that trainees who have not satisfactorily completed all the training elements at that time cannot progress to sit the part 2 examinations in the fourth year.

The current program demands a significant increase in the level and degree of supervision provided at training sites. These include several on-site in-training formative assessments, and define a minimum level of supervision, off-roster learning, and teaching time. There is also a learning portfolio and more explicit experiential requirements. Concomitantly, there has been more emphasis on improving learning and education at all training sites, along with development of new processes and documentation to improve the quality, validity, and reliability of assessments.

The current program also places greater weight on periodic trainee performance evaluation and on training site evaluation by trainees. The frequency of these evaluations was raised from annual to biannual, with revised and more structured documentation.

This chapter aims to describe the rationale, nature, and implementation of the new assessment tools and methods of evaluation of trainees in the RANZCR radiodiagnosis training program, highlighting where relevant how the implementation of such tools had to take account of differences in training institutions in three different medical systems where future RANZCR fellows are being trained: in Australia, New Zealand, and Singapore.

8.5 Trans-National Issues

8.5.1 Three Countries, One System

The RANZCR has a unique radiodiagnosis training program, in that a single centrally developed curriculum, assessment, and accreditation framework is delivered in multiple hospitals and training networks in three different countries (Australia, New Zealand, and Singapore). Although the UK FRCR examinations are sat and passed by radiologists from many countries, the Royal College of Radiologists only controls the curriculum, accreditation, and training program within the United Kingdom.

Each country in which the RANZCR training program operates has significant differences in the structure of the health-care system and the approach to postgraduate training of medical specialists.

Australia has a federal system of national government and has a universal health insurance scheme called Medicare, which is broadly modelled on the Canadian system. However, unlike Canada, Australia permits private practice in medicine and has a large and vibrant private insurance industry. Like Canada, each state has its own government that organises its own internal health-care resources in the public sector. Each hospital within the state has considerable autonomy over local staffing with radiologists and trainees. Costs that trainees incur in training and to take examinations are for the most part funded by trainees themselves, with limited support from the hospitals.

Since the introduction of the Australian national public health insurance scheme in 1972, the delivery of health care has shifted substantially to a mixed public–private system. At large public teaching hospitals, where almost all radiology training is conducted, the casemix is predominantly a combination of acute emergencies, chronic complex conditions, and tertiary level medicine requiring multidisciplinary care. Straightforward elective medical procedures are for the most part performed primarily in the private sector. This effect impacts significantly on the ability of major training centres to deliver the full range of experience in all aspects of diagnostic radiology training. For some years now, trainees completing their radiology training exclusively in the public sector have found, on joining private practices, that substantial additional training is required in order to function independently within private practice settings.

In New Zealand, there has been a similar but less dramatic shift in the delivery of health care over the last two decades, towards a mixed public–private system. There is a national system for managing postgraduate medical trainees, whereby the national government directly funds most of the costs of employing the trainees at accredited training centres. All major costs of training are borne by the government rather than the trainee, provided they are considered mandatory by a medical training body such as RANZCR.

In Singapore, the public health system operates through a unique health insurance scheme, whereby subsidies for public health care are obtained through direct and employer contributions to a universal health savings fund. Unlike universal health insurance schemes, such funds are quarantined for each individual to use for his or herself and can be pooled and shared within families. Private health care is not subsidised to any significant degree by the government. Training centres for medical specialists are all large public hospitals that all see a very broad casemix from routine community health-care episodes to acute emergencies, to complex tertiary care.

The funding mechanisms for health care thus drive the mix of cases seen in public hospitals, which for all three countries is where virtually all radiology training occurs. Singapore's public hospitals have the broadest casemix of all three countries, ensuring that trainees in that system are more likely to be exposed to the full range of radiology procedures and imaging services. Furthermore, radiology case loads in Singapore are typically much higher than in most Australian or New Zealand hospitals. This has to be closely monitored, as the College places an upper limit on the gross number of cases per consultant radiologist at accredited training sites.

Our exposure as a College to these large differences in health-care systems and the capacity to train radiologists, to a large extent affected by type and level of government health-care funding, has a direct impact on how policies and guidelines for radiologist training are formulated.

As a consequence, RANZCR has had to develop a comprehensive yet regionally sensitive approach to accreditation, training site and trainee monitoring, onsite assessment, as well as evaluation of the training program. This approach has tried to incorporate modern pedagogical and andragogical thinking, to be informed by some modern medical education evidence, and to be cognisant of significant differences between health jurisdictions, local recognition of medical qualifications, employment conditions, national health regulations and policies, as well as differences in training, experience, and teaching between institutions, networks, and countries.

8.5.2 A Parallel Training Program

It has only been practical to adopt and implement the curriculum in countries where the RANZCR qualification is automatically recognised for the purposes of specialist recognition. This is the case in Australia, New Zealand, and Singapore. Our accreditation framework requires that all training sites must have at least one consultant radiologist who is a fellow of our College, who fulfils the role of the local DoT.

In Australia and New Zealand, all radiodiagnosis training is conducted under the auspices of RANZCR. There are significant differences in the way the programs are managed in New Zealand and the various states of Australia. New Zealand has a centralised selection process and a predominantly local system of managing and training trainees. There is very limited rotation of trainees between centres. Some states in Australia have a statewide centralised selection process with a planned network-based rotational program. Others have a predominantly local selection and training process though limited rotational postings may be part of a local network.

There are a small number of RANZCR trainees in one hospital in Singapore, who train side by side with local trainees. Training for Singapore's radiologists has a generally similar structure to the current RANZCR program, although local trainees sit for the examinations set by the Royal College of Radiologists in the United Kingdom. The Singapore government has recently decided to shift to residency training programs for *all* medical specialties, following the US Accreditation Council for Graduate Medical Education (ACGME) guidelines for training site accreditation. It is unclear how significant this impact will be on RANZCR trainees.

There is a good understanding of RANZCR requirements at the training institution in Singapore, and a commitment to continue recruiting and training radiologists within the RANZCR curriculum has been given. This parallel conduct of two different training programs in the one department is unique, but has been a useful option for those wishing to obtain the RANZCR qualification in Singapore.

8.6 Training the Trainers

8.6.1 Workplace Assessments

In the 'old' training program, supervisors were not directly involved in assessment of trainees, unless they were also examiners for the College. Most such examinations were written assessments using either short answer or multiple-choice formats. The College did not deliver in-training assessments of any type, other than requiring that Directors of Training provide an annual report on the progress of trainees. The most direct involvement for the majority of examiners was at the part 2 oral examinations, where pairs of examiners assessed candidates using images in a series of seven organ system case-based oral examinations.

In the current curriculum, workplace-based in-training assessments have been developed to test trainees' abilities to either perform radiological procedures (Directly Observed Procedural Skills (DOPS)) or to present a radiological case to a supervisor (Individual Patient Examinations (IPX)). Two of these assessments are conducted every 6 months throughout the training program. Details are discussed below. These assessments are formative in intent, so as to identify areas of strength and weakness, and are intended to highlight to trainee and supervisor alike areas that could be improved.

Providing formal training to all supervisors on how to conduct these exercises is not feasible. Instead, regular biannual workshops with Directors of Training from various training sites are conducted by the College, to explain the nature and role of these assessments, to discuss problems with local implementation, and to provide support to DoTs. In turn, DoTs are asked to disseminate this information to supervisors at their training sites.

Comprehensive documentation has been developed to explain the intent of the assessments and how they should be conducted. This combination seems to have been effective so far, and in general this type of assessment appears to have been conducted satisfactorily with few issues or complaints to date.

Systematic evaluation of their effectiveness awaits future evaluation processes that the College is developing. We hypothesise that the in-training assessments will prove valuable for qualitative formative purposes, will provide additional information to training sites about specific areas of trainee performance, and will improve the quality and reliability of DoT evaluations, and that these findings will correlate positively with our eventual summative part 2 examinations.

8.6.2 Training in Evidence-Based Medicine

New to the curriculum are the introduction of mandatory evidence-based medicine (EBM) training and the application of EBM principles to journal articles in the form of critically appraised topic (CAT) assessments. Considered basic to the radiation oncology training program in the College, EBM training is deemed essential for the modern radiologist, as well as for the development of research skills and conduct of research projects, which the current curriculum requires.

The College has partnered with a major Australian University to deliver an online teaching course in EBM to trainees, regardless of jurisdiction and location, in their second year of training. This course, adapted for radiologists, is based on a pre-existing online course in EBM. While quite basic in content, it is intended to ensure that all trainees have a minimum understanding of EBM, in order to complete mandatory critically appraised topic (CAT) assessments.

A logical corollary to this requirement is that supervisors and trainers also require training in EBM, in order to adequately assess the performance of trainees performing CAT assessments. Most senior radiologists have had minimal prior training in EBM. A face-to-face weekend course in principles of EBM, and conducting CATs in particular, has been developed and delivered in partnership with the same Australian *University* on a biannual basis. For the first 2 years, this course has been focussed on the basics of EBM and the mechanics of a CAT exercise.

A future course on advanced EBM concepts, to consolidate and strengthen such skills and to assist with the planning, conducting and supervision of research projects, is being developed.

8.6.3 Trainee Evaluation

Evaluation of the trainee in the workplace is the province of the training sites and the Directors of Training. A combination of the on-site assessments, an annual multi-source feedback (MSF) exercise, and six monthly DoT progress reports, provides a more complete and better rounded view of trainee performance and progression than the prior once-yearly DoT report.

Directors of Training in experienced training centres anecdotally report that they can consistently judge how trainees are progressing. In particular, they are often quite accurate in judging whether a trainee is appropriately prepared to sit for and pass the part 2 radiodiagnosis examinations. However, written DoT reports may not accurately reflect DoT opinions of trainee performance that are elicited in conversation.

There is some evidence that written evaluations of trainees correlate fairly well with results at structured written examinations. In a report from 2000, Adusumilli reported on a retrospective review of radiology trainees from 1991 to 2000 at the University of Michigan and compared their evaluation reports with their results from the annual American College of Radiology in-training examinations in the first 3 years of training and the American Board of Radiology Board Certification results during the fourth year of training (Adusumilli et al. 2000). The study concluded that after the first year of training, evaluation reports correlated positively with subsequent examination results.

At the time of writing, 18 months of new curriculum trainee evaluation has been completed, and, like most first-run exercises, some teething problems and logistic issues have become apparent. These appear to be largely related to recognition of appropriate responsibilities; the curriculum makes it clear that trainees are the ones primarily responsible for ensuring that the assessments are completed by the end of each 6-month period. It has been necessary for College staff to remind them of this through regular emails and to also remind them that progression in the training program was contingent on them completing the various requirements for each year of training. This is a major cultural shift for trainees, and it is recognised that they will take time to adjust to this new paradigm. Furthermore, the College has started to advise DoTs of the importance of mentorship and guidance to support trainees broadly in their educational journey to attain specific goals and requirements.

The volume and frequency of the assessments and trainee evaluation reports is such that College staff require computerised assistance to manage this process going forward. The College has been planning a computerised trainee information management system that will automate many of these processes, and this system should be in place in 2012.

The RANZCR training program has approximately 500 trainees in toto across all training sites. The many experiential requirements, assessment tasks, evaluations, and examinations, all with differing time points, cannot be satisfactorily tracked centrally without such electronic systems.

8.7 The Training Portfolio

All current curriculum trainees have a training portfolio that is for the most part a binder divided into sections and that contains a hardcopy record of the trainee's experiential and learning records, in-training assessments, DoT reports, published and presented works (satisfying our mandatory Project requirements), and other learning activities. It is intended to provide a source of reflection for the trainee and as a regularly updated record of the trainee's progression through the training program.

As a majority of trainees in our program rotate to a variety of training sites during the course of their training, it is impossible for trainees, DoTs, and the College to evaluate the spectrum of their learning activities without such a portfolio. Unlike traditional residency programs, where there is usually tight control over the local training program, rotations, and rostering, our training sites are often parts of local or even large regional training networks. Trainees may be formally rotated to hospitals and other training sites even hundreds of kilometres away from major training sites, for periods of 6 months or longer.

While for the most part the portfolio serves as a record for documentary and reflective learning purposes, its formal evaluation will be used as a barrier to progression between phases 1 and 2 and to confirm exit certification at the end of the training program. This summative role for the portfolio is a major change in our assessment strategy and is an attempt to ensure that all required elements of the training program including all experiential requirements, reports, and assessments have been completed.

8.8 Workplace Assessments

As mentioned above, prior to the current curriculum, the only workplace assessments available to our College were annual DoT reports of trainee progress. Unfortunately, these have proved unreliable for evaluating the state of trainee progress. There was minimal documentation provided to DoTs to evaluate trainees, no guidelines on formal departmental evaluation were provided, and there were no mandatory requirements for on-site in-training assessments that could be used by DoTs to develop structured, systematic, or reliable evaluations of trainee learning and progression at any stage of the program.

This is not unique to the RANZCR program. Long (2001) reported that modifications of the Royal College of Radiologist training evaluation forms by local training programs yielded improved satisfaction with the quality and fairness of the form, with the new forms encouraging appraisal, setting of objectives, and feedback from the trainees.

DoT roles under the 'old' training program included:

- Ensuring that an appropriate and regular teaching program was coordinated
- Ensuring trainees had some rostered non-clinical time for learning activities
- Confirming trainees had completed certain specific rotations
- Enabling trainees to complete minimal experiential requirements within defined timeframes
- Confirming that trainees had sat and passed the College examinations

However, DoTs had no responsibility to ensure that any local assessments were conducted in-house. Some centres have organised such local assessments independently, but these are by no means standardised, and their educational and assessment intent is neither well defined nor consistent.

The current curriculum has defined a number of required workplace assessments of trainee progression and expertise. These include directly observed procedural skills (DOPS), individual patient examinations (IPX), critically appraised topic (CAT) presentations, and multi-source feedback (MSF). These were selected from a range of available assessment and evaluation tools that have been developed by various medical specialties, and adapted to be suitable for our program. Augustine et al. (2010) reviews the challenges and key issues in implementing such assessment tools in radiology training.

The forms used for our in-training workplace assessments are based on forms used for these types of assessment by other medical colleges in Australia and overseas. The forms were piloted prior to implementation in a small number of sites. However, it will be important to re-evaluate the quality and structure of these forms and revise them as necessary, as they may not satisfy some characteristics of assessment that are desirable.

8.9 Directly Observed Procedural Skills (DOPS)

It is a truism that conventional summative assessment in diagnostic radiology is unable to comprehensively test the ability of trainees to actually perform imaging procedures. Written examinations and oral assessments are all very well, but actually, observing the trainee performing a procedure, such as a CT-guided biopsy, arthrogram, ultrasound, or fluoroscopic barium study, enables a supervising consultant to observe a wide range of skills and their implementation in practice, including:

- Taking informed consent
- Observation of sterility and no-touch principles
- Radiation safety practices
- Protocoling of examinations
- Understanding and appropriate use of imaging equipment
- Selection and use of appropriate interventional devices
- Appropriate use of local anaesthesia and sedation

- Selection and use of contrast media
- Satisfactory performance and completion the procedure

Our DOPS assessment can have a non-radiologist expert as a supervisor. For example, DOPS of the performance of an obstetric ultrasound may be best conducted by a sonographer rather than a radiologist. The DOPS assessment uses a one-page form that has been designed to be easy to fill in, and that requires a discussion between the observing supervisor and the trainee after the procedure about the conduct of the procedure, any problems, errors or omissions involved, and recommendations from the supervisor. Both the trainee and the supervisor are to sign the form, a copy is retained for the trainee's portfolio, and a copy is submitted to the College.

8.10 Mini-Individual Patient Examinations (mini-IPX)

The mini-IPX is a familiar assessment format for most radiologists. It consists of a mini-oral examination of a single case, to be selected by mutual consent by the trainee and supervising consultant. The trainee has to present the case in an oral short-case format to the consultant.

In the process, several elements can be assessed by the mini-IPX:

- Appropriateness of the test
- Test selection
- Options and alternatives for the imaging protocol
- Specific imaging findings
- Correlation with other imaging
- Understanding and explanation of the differential diagnosis
- Probable or definitive final diagnosis
- Ways to further investigate the patient
- Depth of understanding of the final diagnosis
- Fluency of description and understanding of anatomic location and imaging features
- Communication of results and impact on management

This format mimics many aspects of daily consultation work with other clinicians and also the format used in our part 2 oral examinations.

8.11 Multi-Source Feedback (MSF)

Multi-source feedback is a way to obtain opinions about trainees that is not available through more traditional direct observation or other assessments. It is difficult to administer, and its value in evaluation of the trainee is controversial. However, there is little doubt that when properly conducted, it can reveal surprising insights into trainee behaviour and how other staff members at the training site regard that individual. Such insights are often a surprise not only to the DoT or head of department, but even to the trainees themselves.

Our MSF assessment is an annual exercise. A minimum of 12 respondents from various defined categories at the training site must be approached by trainees to complete a brief evaluation of the trainee using an online submission survey. The anonymised results with specific quoted comments are summarised and sent back to the trainee and the DoT to include as part of the annual DoT assessment.

The MSF has several roles in the assessment framework:

- Identify challenging or inappropriate behaviours of the trainee
- Identify problematic working relationships for that trainee within the department
- Enumerate strengths and desirable behaviours of the trainee
- Highlight areas that need further personal development
- Provide a spectrum of opinions about trainee performance
- Provide feedback to the trainee about how others see him/her

Perhaps predictably, trainee perceptions are that this is a waste of time. They approach people they 'know' will provide favourable feedback, and will thus obtain universally good responses.

However, after just one full round of this exercise, it is clear that this is not the case. Under the cloak of anonymity, surprisingly blunt and frank opinions about poor trainee behaviour, attitudes and practices have been revealed. Trainees have been surprised by the range of opinions provided and to learn how they are perceived by others. DoTs have found this information revealing and informative. We plan therefore to continue this exercise and to monitor its value to the trainee and training centre over time. It may transpire that the value of this tool may decline in later years of training, thus justifying reducing its use later on in training, but this remains to be seen.

8.12 Mandatory Projects

Diagnostic radiology in Australia and New Zealand has been traditionally recognised to be of high quality. Trainees who exit from our training program who have gone on to work in Europe and North America are highly regarded, and we have received regular anecdotal feedback over the years that they are well trained, very broadly knowledgeable, safe, and highly competent.

However, despite evidence of excellent clinical training over many years, diagnostic radiologists within Australia and New Zealand publish very little compared to our European and North American counterparts. There is, with few exceptions, very little systematic research conducted in our training centres, which represent the bulk of academically oriented departments and our centres of excellence. Yet, many of our junior fellows find, when they go to such centres overseas, that it is easy to conduct research and publish high-quality articles in peer-reviewed journals. Anecdotally, they report much better infrastructural support, mentoring, and recognition for such activities in such overseas centres of excellence.

Clearly, there is a disconnect between the quality of our clinical training and our academic radiology training. The College has agonised over this long-standing problem over the years. In the best centres, trainees are encouraged and supported to conduct projects that enhance education and that can be presented at conferences. Some trainees go on to produce publications generated through prospective or retrospective research projects, but they are in the minority.

The development of a new curriculum and training program, launched in 2009, provided an opportunity to actively redress this limitation by mandating that two projects be conducted by new trainees during the course of their training. The first project, to be completed during the first 3 years of training, must be presented at a scientific forum, which could be even within the trainee's department or hospital. In most cases, this is expected to be a case series, educational poster of radiological findings, a quality assurance project or audit. The second, to be completed before the end of the 5-year training program, is more substantial. It should be prospective in design, and must be reported as either an article submitted to a reputable peer-reviewed journal, or a dissertation, the latter submitted either to the College for internal review, or as part of a University-linked research degree, such as a Masters or Doctor of Philosophy.

In both cases, the project is to be formally assessed using College-defined guidelines and forms. Satisfactory completion of Project 1 is a mandatory requirement for eligibility to sit for the part 2 radiodiagnosis examinations (see below) conducted in the fourth year of training. Satisfactory completion of project 2 is a mandatory requirement for exit certification by the College as a specialist radiologist.

Evaluation of this major shift in training policy, which will no doubt be challenging to implement and consistently deliver, will take some years and will probably require at least two full cycles of the current curriculum.

8.13 Examinations

The RANZCR has two major barrier examination series, a part 1 examination taken in the first year of training, and a part 2 examination taken in the fourth year of training. RANZCR is unique amongst radiology training programs in requiring not only training, but also formal examinations, in pathology relevant to radiology.

The part 1 examination in radiology consists of assessments in anatomy and physics:

1. Two anatomy papers
   (a) One short answer—15 non-penalty short answer questions
   (b) One radiographic anatomy—8 non-penalty image based questionsand
2. Two applied imaging technology (or medical physics) papers
   (a) One essay paper consisting of 3 non-penalty questions
   (b) One MCQ paper comprising 160 non-penalty questions

The part 2 examination in radiology consists of several components in diagnostic radiology and pathology:

1. One radiology paper of 100, five-part non-penalty single best answer MCQs
2. One practical film reporting session of eight stations where a limited number of imaging studies are presented, and which must be reported using a written report format

3. Six oral case-based examinations, each of 25 min duration in the following areas:
   (a) Abdominal Imaging
   (b) Thoracic and cardiovascular radiology
   (c) Neuroradiology, head and neck radiology
   (d) Breast imaging and obstetrics and gynaecology
   (e) Paediatric radiology
   (f) Musculoskeletal radiology
4. One pathology written examination, of 100 5-part best single answer MCQ
5. One pathology oral examination of 25 min duration

The format of these examinations did not change substantially for many years. In the late 1990s, the oral examinations were changed from two general oral examinations to six organ and system-based oral examinations. This change was modelled on the American Board of Radiology's organ system-based multiple oral examination system. Recently, the American Board of Radiology has announced it will abandon oral examinations altogether as part of its shift to the digital radiology exam of the future (ABR Website, http://www.abr.edu). This has led to a re-evaluation of the American College of Radiology's in-training examinations (Monticciolo 2010).

Alongside the development and implementation of the current curriculum, there has been increasing pressure from trainees and examiners to change our current film-based examinations to a digital electronic presentation format. The vast majority of trainees in our program no longer work in film-based departments and are unfamiliar with handling and using film to search for abnormalities. The College is actively exploring the technologies and options involved in implementing such examinations. Given that the ABR has decided to abandon oral examinations altogether, it is also salient for the College, as a parallel exercise, to re-evaluate our existing examination format and to decide whether to preserve, modify, or to entirely abandon such oral examinations, before any attempt to deliver an electronic version of these exams.

Conclusions

Assessment and evaluation of trainees in RANZCR radiodiagnosis training program has changed dramatically with the introduction of the current curriculum. Although the major barrier summative examinations have not changed, these are being reviewed. The major change for training centres has been the introduction of several workplace-based assessments and an increase in frequency and quality of the regular Director of Training trainee evaluations.

The development and selection of these assessment tools was approached using education best practice principles and was informed by adoption by many other training programs in other disciplines.

The implementation of these tools has highlighted the significant administrative load that such assessments have brought to training centres, and has raised questions about the value, validity, and effectiveness of so many assessments. Clearly the new curriculum requires a cultural shift in the assessment and evaluation culture for all training centres. The College is actively committed to helping this shift to occur through roadshows and DoT Workshops that are regularly conducted to discuss problems and provide assistance and support as required.

Despite these teething problems, training centres have actively adopted the tools and have for the most part managed to use them effectively to date. As the program evolves, the proportion and number of trainees having to undertake these assessments will progressively rise, which will undoubtedly lead to additional stresses on the training centres and trainees alike.

Many fellows in personal communication, the senior College executive, and College staff are strongly supportive of the major changes in assessment and evaluation that are part of the new training program. The recognition for the benefits of such changes is widespread, even if the implementation is challenging.

The College is aware of these issues and plans to evaluate the training program's assessment tools, utilisation, administrative burden, and effectiveness actively over the coming years. The College is committed to a move towards becoming not only an educational organisation but also a learning organisation. Such evaluation is essential to determine which of these tools is providing the most useful formative assessments and contributing meaningfully to training site evaluations of trainee performance. The correlation between such workplace assessments and final examination outcomes will be of particular interest.

Finally, as part of a re-engineering of the entire curriculum, the introduction of digital technology to the examination process not only permits but almost mandates a formal review of the examination system, in order to better align its assessment objectives and methodology with the changes and increased frequency of other types of assessment and evaluation that have been introduced into our training program.

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Part III

Case Studies: Theory into Practice

Strategies and Actions to Improve Risk Communication Competency in Radiation Medicine

9

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9.1 Introduction

This chapter will outline some innovative strategies, actions, and approaches to improve risk communication competency in radiation medicine. Competency in risk communication in radiation medicine is a practitioner's ability to explain and answer questions to a patient, in lay terms before, during, and after a procedure about its pros and cons, based on training, knowledge, and experience. Radiation medicine practitioners include medical specialists, i.e., radiologists, nuclear medicine specialists, radiation oncologists, and clinicians performing imaging-guided interventions; technologists, i.e., radiographers, medical imaging technologists, radiation therapists; and medical physicists, etc.

Five strategies and a range of actions will be discussed (Table 9.1). Improvements in teaching, learning, clinical application, and competency evaluation are the core strategies. The key to successful teaching is to provide content and employ methodologies appropriate to the learners. Actions that would encourage the learning and application of these skills in practice are complementary. Other strategies include the advocacy and promotion of education, the research into radiation effects and adult education, the strengthening of teaching and learning infrastructures, and the implementation of policies to realize these actions. To initiate and support these

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Table 9.1 Risk communication competency improvement strategies

Provide teaching, encourage learning and application, and undertake evaluation
Encourage research
Promote awareness
Strengthen infrastructure
Apply policies

Fig. 9.1 Approaches and strategies to improve risk communication competency

actions, an inclusive approach by leadership, collaboration, and participation will ensure their success (Fig. 9.1).

9.2 Communication Issues

9.2.1 Emerging Trends

New technologies and equipment designs have led to new approaches to diagnostic radiology, nuclear medicine, medical imaging, imaging-guided treatment, and radiation therapy. Patients benefit from earlier diagnoses and less invasive therapies. The use of radiation in medicine has increased exponentially, especially with the use of multi-detector computed tomography (MDCT). In the United States, medical to total population exposure from ionizing radiation has increased from 15% in 1980 to 50% in 2006 (National Council on Radiation Protection and Measurements 2009).

The public and payers of these procedures are more aware of and wish to be better informed on the risks, benefits, and appropriate use of radiation in medicine. Radiation medicine practitioners should be able to provide such information when

Table 9.2 Top ten risks in radiology

Missed diagnosis
Misinterpretation of results
Failure to communicate results
Failure to manage adverse events
Complication from procedures
Informed consent
Wrong procedure on wrong patient
Patient safety
Failure to communicate with patient
Performing procedure without adequate training

required. However, one of the most common indemnity claims for radiology is a failure to communicate to a patient or to offer an effective explanation following an adverse event (Table 9.2).

9.2.2 Public Comprehension

Radiation risks and benefits' issues are complex and confusing to the public because of technicality, dose terminology, misleading or incomplete information, bias, or misconception. This could be compounded by: explanation in incomprehensible terms; confusion with doses; disagreement between experts on dose, detriment, or risks; or application of a paternalistic approach, etc. (Ng and Cameron 2001). A common error for the inexperienced when explaining risks is by assuming the public is either technically knowledgeable or completely ignorant (Jorgensen and Moscovitch 2011).

9.2.3 Knowledge Gap

Medical students and practitioners are not well informed on radiation effects, radiation safety, and radiation protection (Georgen 2010; Smith-Bindman 2010). A study of medical students and junior doctors showed 25% and 11% incorrectly believed that radiation is used in MRI and ultrasound, respectively (Zhou et al. 2010). The majority of radiation medicine practitioners have little to no formal training in risk communication. Studies have underscored the need to improve the teaching of basic radiation physics and the application of risk communication to these practitioners (Cardinal et al. 2011; Fahey et al. 2011). Education can improve awareness (Soye and Paterson 2008), capacity, and capability to address this need.

Although the physical principles of radiation are taught in undergraduate courses and postgraduate radiation medicine programs, these subjects are usually presented at the start of a program. Retention is therefore generally poor in clinical years and worse in practice. To communicate effectively, it is useful to have knowledge in dose measurements, exposures for different procedures to different organs, possible

Table 9.3 Quality elements

Accessibility
Patient centeredness
Integrated care
Appropriateness
Capability
Safety
Timeliness
Efficiency
Effectiveness
Sustainability

effects, lifetime risks, etc. (Balter et al. 2011). Many programs do not have structured teaching in communication. It is important to fill this gap.

9.2.4 Communication at Risk

In many practices, the images obtained by the technologists are sent to picture archive and communication systems (PACS) for interpretation by the practitioners. For the majority, the practitioners make diagnoses without ever seeing the patients. This modus operandi, especially for teleradiology, means there is little to no communication between the practitioners and patients. Like other skills, communication will suffer from "disuse atrophy." If a skill is infrequently used, confidence would be low and incompetency would be exacerbated under stress.

9.2.5 Quality Care

Practitioner capability and patient centeredness are two key elements in quality care (National Health Performance Committee 2001) (Table 9.3). Capability means the procedures are undertaken with skill, competency, and knowledge. For radiation medicine practitioners, good knowledge in radiation issues and an ability to discuss these with the patients prior to procedures promote patient autonomy, alleviate anxiety, and reduce medicolegal liability.

9.2.6 CanMEDS Framework

In 1996, the Royal College of Physicians and Surgeons of Canada adopted the CanMEDS framework of essential physician competencies for medical education and practice to improve patient care (Royal College of Physicians and Surgeons of Canada 2010). These competencies include: medical expert, communicator, collaborator, advocator, manager, scholar, and professional. This model is being adapted around the world as well as in other professions. As communicators, radiation

Table 9.4 Teaching improvement strategies

Identify cohorts
Strengthen curricula
Define contents
Understand needs
Improve skills
Develop modules
Collaborate education
Build capacity
Innovate delivery
Improve system

medicine practitioners facilitate the dynamic exchanges that occur before, during, and after procedures, including the communication of the associated risks.

9.2.7 Shared Responsibilities

It is important for the patients and referrers to play their roles by fully disclosing relevant details before attending radiation medicine procedures. These include: indication, history, findings of past procedures, allergies, pregnancy status, etc. which could impact on potential radiation risks. These individual-specific details would enable the practitioners to better assess the benefits and risks for such procedures and to communicate these to the referrers and or patients. The goal is to build trust, share knowledge, and make informed decisions.

9.3 Teaching Improvements

To improve the teaching of risk communication competency in radiation medicine, ten actions are suggested (Table 9.4).

9.3.1 Identify Cohorts

The first task is to identify the students, who would benefit most from the teaching of risk communication in radiation medicine. They include: (1) undergraduates in medicine and other allied health disciplines, (2) trainees in radiation medicine, and (3) radiation medicine practitioners who have no prior training.

9.3.2 Strengthen Curricula

The teaching of radiology, radiation effects, and radiation risk communication requires an integrated approach. The curricula would be geared to meet the needs and competencies for each cohort. For medical students, some basic knowledge in radiation risks and communication are useful to improve awareness and facilitate appropriate referrals. For example, a "spiral curriculum" could be applied by firstly introducing the basic physical principles of radiation at the start of the program, returning to the teaching of communication as a component of clinical medicine, and finally offering essential radiation safety and protection as part of the medical imaging module at the end of the program to solidify the learning. For radiation medicine practitioners, more in-depth teaching is needed.

Education institutions and professional organizations conduct regular curricular reviews. These are good opportunities to advocate the incorporation of risk communication topics. However, it could be a challenge to compete with requests from other groups for an inclusion of these topics into the already cramped curricula. At a global level, promoting awareness to and obtaining support from organizations such as the World Federation for Medical Education (WFME), would be a synergistic action.

9.3.3 Understand Needs

Radiation medicine procedures are used to reduce uncertainty, make diagnoses and institute timely treatments. Radiation is likely one of the lesser risks when compared to other procedural risks, alternative procedures or simply monitoring. The students would become more competent and proficient in communication if they understand how human behavior, psychology, education, social, cultural, and other factors influence the perception of values and risks. The role emotions play in risk communication and the special needs for people under stress should be appreciated.

9.3.4 Define Contents

The teaching modules would cover three areas: medical radiation, alternative procedures, and communication. Teaching in medical radiation includes the benefits, risks, and side effects of radiation used for diagnosis and treatment, radiation safety and radiation protection. The radiation risks arising from clinical use are low, the reports are limited, and current thinking is evolving. Knowledge in alternative procedures not employing ionizing radiation will ensure more balanced discussions and facilitate informed decisions (Balter 2011). Although the emphasis is in radiation risk communication, students would benefit from an awareness of other risks, risk quantification, and risk reduction measures.

9.3.5 Improve Technique

Communication includes oral and written skills. When required, information technology and computer skills are very helpful. Communication skills must be matched

Table 9.5 Positive communication attributes

Respect
Advocacy
Trustworthiness
Creditability
Patience (by listening)
Care
Compassion
Honesty
Openness
Expertise
Competency
Wisdom
Dedication
Commitment
Responsiveness
Objectiveness
Consistency
Fairness

by knowledge and technique, which is appropriate for the recipient and scenario. Different means of communication and messages are needed for varying situations. In any case, the messages should be kept simple and clear. The discussions should be frank and based on scientific knowledge.

A dialog is a two-way communication between practitioners and patients. Appropriate use of positive communication attributes (Table 9.5) will enhance outcome. The principle is to explain potentially complex issues by positive expressions, plain languages in decoded nontechnical terms, and not by jargons or acronyms (Dauer et al. 2011). An awareness of the body languages and patient feedback is important, e.g., using eye contact, avoiding cross arms.

To improve public understanding and reduce confusion, it is useful to: (1) quote correct facts, (2) use correct units, (3) place risk into correct perspective by comparing with relevant scenarios, and (4) adopt correct attitude by treating questions as insightful and with respect (Ng and Cameron 2001; Balter et al. 2011).

9.3.6 Develop Modules

For diagnostic radiology, interventional radiology, nuclear medicine, and radiation oncology these scenarios include: routine practice, adverse events, accidental exposures, public advocacy, and crisis management. In routine practice, this simply means an outline of the benefits versus the risks for procedures or the rationale for alternative procedures.

However, the task would be more challenging when communicating risks or possible harm already inflicted. To manage adverse events, accidental exposures, outrage, and crisis, it is important to respond and communicate early, to show care and concern, to offer an apology, to explain what has gone wrong frankly, to embrace the primacy of the patients, to indicate what actions are instituted to reduce the impact and to treat the request for a second opinion with respect.

Providing education and trustworthy messages to the public is an important action to improve understanding of radiation safety, risk, and protection issues and confidence in decision making. There are many examples of useful web-based resources developed to communicate the procedures, radiation effects, and radiation protection to the public such as: Radiation Protection of Patients (IAEA 2011), Image Gently (The Alliance for Radiation Safety in Pediatric Imaging 2011), Image Wisely (2011), Radiology Safety Resources (American College of Radiology 2011), RadiologyInfo (American College of Radiology and Radiological Society of North America 2011), InsideRadiology (The Royal Australian and New Zealand College of Radiologists 2011), and Virtual Departments (The Royal College of Radiologists 2011). However, this generic information does not replace risk communication for an individual, as specific circumstances must be considered.

Better skills, knowledge, experience and competency are needed to handle communication in major exposure events, e.g., Epinal radiotherapy accident (Peiffert et al. 2007) or nonclinical nuclear accidents of Chernobyl and Fukushima. Appropriate methodology and good coordination are essential to deliver a prompt and composed response to a large community, which is highly charged with emotion and fear. Such major incidences are demanding both in time and resources. Suitable radiation medicine practitioners following appropriate training could play useful roles as members in the response team by communicating radiation risks to the public from a medical perspective.

The possible teaching modules in communication could include: (1) communication skills, covering oral, written, and information technology; (2) communication techniques, e.g., use of appropriate visual aids, body language, positive communication attributes and patient feedback; and (3) communication scenarios.

9.3.7 Collaborate Education

Tertiary institutions and professional organizations are the leading partners to improve the teaching of risk communication in radiation medicine at undergraduate and postgraduate levels, respectively. Supporting local actions, international and regional agencies and organizations such as the International Atomic Energy Agency (IAEA), International Organization for Medical Physics (IOMP), International Society of Radiology (ISR), International Society of Radiographers and Radiological Technologists (ISRRT), United Nations Educational Scientific and Cultural Organization (UNESCO), United Nations Department of Economic and Social Affairs (UN/DESA), World Federation for Medical Education (WFME), World Health Organization (WHO), and European Commission (EC), play complementary roles by raising awareness; strengthening advocacy; providing education resources, teaching syllabi, and tools; and conducting "train-the-trainer" programs. Collaborations between these bodies with their national counterparts, donors, and development agencies provide synergy and are encouraged.

9.3.8 Build Capacity

There is a global shortage of health-care practitioners. With limited training capacity and resources, there is pressure to train as many and as quickly as possible to fill this void. Despite such urgency, competency in radiation risk communication should not be overlooked. The availability of qualified teachers in risk communication is limited. To fast track the inclusion of the subject and to optimize the content delivery, a well-constructed "train-the-trainer" program is a good start. The sharing of existing teaching material would reduce the lead-time for those institutions trying to make a start. When available, suitable tools such as imaging referral guidelines or technique optimization publications could provide additional means to disseminate basic risk communication knowledge to the end users.

9.3.9 Innovate Delivery

Traditional in-person teaching is the norm for undergraduates and trainees in radiation medicine. However, innovative self-learning could be used if contact time is limited. Another alternative is to provide basic risk communication teaching as part of preemployment induction. Offering timely guidance to the interns by providing knowledge on radiation medicine procedures that could be used immediately would enhance their appropriate use, patient care, and radiation safety. The challenge is to fit this and other subjects into a very tight schedule.

With practitioners, the elements that work best for adult education should be incorporated. The inclusion of the subject into symposia and conferences will promote awareness and cater for those who have not received prior training. "Train-the-trainer" programs will provide leverage, accelerate the teaching, and educate a larger population with less lead-time. The use of information technology, e.g., CD-ROM, enables multimedia self-directed learning.

With good Internet access, online e-learning resources would reach more students. The adoption of mobile devices facilitates teaching and learning by making these programs more portable and flexible. The International Society of Radiology initiated Go RAD (The International Society of Radiology 2011a) to offer free access to journal articles and Virtual Congress of Radiology (The International Society of Radiology 2011b) to provide free access to radiology lectures. The United Nations Educational, Scientific and Cultural Organization launched the Avicenna Virtual Campus in collaboration with European Commission and other stakeholders as a sustainable platform to accelerate open distance learning in 15 Mediterranean universities (The United Nations Educational, Scientific and Cultural Organization 2011). Following its success, this was followed by the launch of the African Virtual Campus. The International Atomic Energy Agency's Radiation Protection of Patients website (IAEA 2011) is an important action supporting the International Action Plan for the Radiological Protection of Patients by providing free access to education resources on radiation protection.

As alternative to de novo development and to avoid duplication, collaborations with other stakeholders to adapt or expand an existing module to the teaching of risk communication could be further explored.

9.3.10 Improve System

Institutions could improve the teaching programs by applying well-established quality improvement processes. System performance could be evaluated by: conducting an informal internal audit, benchmarking with others or participating in accreditation, and being assessed against external standards. The purposes are to identify gaps or issues, develop solutions, and implement improvements.

These reviews could cover: the training, qualification, and appraisal of the teaching faculty; the teaching facility and resources; the teaching program, i.e., curricula, methodology, delivery, and student assessment; and the system performance, i.e., outcome, effectiveness, and student feedback, etc.

9.4 Learning and Implementation Improvements

9.4.1 Motivate Learning

Practitioner capability and patient-centeredness are two key elements for quality care (National Health Performance Committee 2001). Patients, payers, and health-care systems expect quality, safety, value, and good care. The importance of patient-centered primary health care is stressed (World Health Organization 2008a). Radiation medicine practitioners and trainees support professionalism and their professional responsibilities (Medical Professionalism Project 2002). With other stakeholders, they advocate for better quality, safer, more appropriate and sustainable use of radiation in medicine.

An awareness of their responsibilities, possible knowledge gaps, and duty of care motivates radiation medicine practitioners to learn and acquire communication skills. Good communication competency is an integral part of practice. Through learning, practitioners would become more competent in general communication and have acquired the skills necessary to handle the various scenarios. The learning of these skills is largely voluntary, but could become mandatory when they are incorporated into formal teaching, continuing professional development (CPD) or maintenance of certification (MOC) programs.

9.4.2 Select Learning

Enrolment in undergraduate or postgraduate programs, which provide such teaching, is one possibility. Other possibilities include learning in the workplace or self-direct learning. The traditional model used in the teaching and learning of medical procedures could be used, i.e., see one, do one, and teach one. The idea is to learn from peers who have some prior experience. The advantages are that it is informal and readily available from within the workplace and holds the potential of educating many practitioners. The disadvantages are the variability in knowledge and skills of the teachers. Ultimately, the student would play the role of the teacher further reinforcing the lessons learnt and passing the skill to other practitioners.

The Internet has revolutionized learning by offering new options. Students could customize the subject and pace to suit their learning style and timetable. The challenge is to locate these resources and to select the ones most suitable. Advice from peers is helpful, and professional organizations could play a facilitating role by providing guidance.

9.4.3 Apply Learning

Simply learning the facts or theories is not enough, whether in practice or by any other means. These skills must be applied in practice over time to improve confidence and experience. The development of a team culture toward quality and safety improvements in practice will encourage group learning and use of these skills in the workplace.

The risk communication principles could be taught, but competency would evolve and improve over time from practice and experience!

9.4.4 Reward Learning

Some medical indemnity providers recognize that an improvement in skills and competency in risk communication is an effective action to manage risk in practice. Some insurance vendors offer incentives by premium reductions to individuals or practices taking part in risk reduction activities.

9.5 Evaluation Improvements

9.5.1 Define Competency

Competency is an individual's ability to undertake a specific role or perform a certain task to a predefined target or goal.

9.5.2 Confirm Competency

Following completion of training, competency is confirmed by certification. For practitioners, there is a trend toward recertification by examination or participation in CPD or MOC programs, which are designed to facilitate and document ongoing professional development. Institutions grant credentialing and privilege of practice following confirmation of training, competency, experience, insurance, and participation in ongoing learning.

In practice, competency assessment is used to manage staff, e.g., promotion, and to improve services, e.g., succession planning. Competent champions and less competent team members will benefit from recognition and further training, respectively. Improvement actions by addressing gaps would indicate to the public service

Table 9.6 An evaluation model for risk communication competency

Evaluation model for risk communication in clinical practice	
Skill	Risk communication in clinical practice
Description	Ability to discuss with patients the risks and benefits of procedures and alternatives; and the nature of adverse events and corrective actions.
Aim	To provide information, answer queries and facilitate informed decisions.
Level (%)	Competency descriptors
0	No knowledge or training in risk communication in radiation medicine
25	Limited knowledge or training in risk communication in radiation medicine
50	Familiar with either medical radiation risks or communication
75	Competent. Familiar with risk communication in radiation medicine
100	Competent. Ability to train others in risk communication in radiation medicine

providers' commitment to quality and safety services. Retention of records by documenting competency would comply with regulations and assist with monitoring of improvements.

9.5.3 Evaluate Competency

Methodologies differ between settings. For education institutions, monitoring of attendance, evaluation by ongoing questionnaires or quizzes, and pre-certification by examination could be applied. Information technology solutions could be applied to streamline questionnaires or quiz modules. In general, simple evaluation techniques provide crude data on skill and competency. On the other hand, better designed and more comprehensive evaluation tools offer better assessment and quantification of the different elements of risk communication competency.

In the workplace, on-the-job assessment is a good approach by evaluating risk communication skill in practice rather than by assessing knowledge in isolation. The undertaking of a project and the submission and publication of the findings are excellent means of acquiring new skills for an individual or a team.

9.5.4 Grade Competency

It is essential that an unambiguous evaluation scheme be used to assess, report, compare, and monitor competency. Achievement could be documented by indicating whether competency is or is not attained or by putting achievements into grades. The former is perhaps more suitable for education institutions and the latter for the workplace. When grading is used, percentages or levels with matching clearly defined descriptors would enable standardization and improve interpretation (Table 9.6).

9.6 Synergistic Strategies

9.6.1 Promote Awareness

Organizations conduct campaigns to promote evidence-based messages to inform and lobby the stakeholders. There are recent successful campaigns by rallying support to lower radiation exposure to patients, especially in children (The Alliance for Radiation Safety in Pediatric Imaging 2011; Image Wisely 2011). The emphasis is to reduce dose by improvement in technique. To improve risk communication education, targeted campaigns could raise awareness for the need for teaching and learning to institutions and practitioners, respectively. While the messages are straightforward, their regular reinforcement will maximize support and deliver the desired outcome.

9.6.2 Encourage Research

Research provides the scientific evidence on which the teaching would be based. Research into the safety, risks, and effects of medical radiation includes basic science, experimental, epidemiological, and clinical elements (Perez and Lau 2010). Studies in atomic bomb and Chernobyl accident survivors who had received fetal or childhood exposure showed a higher cancer risk. Second cancers (Crump and Hodgson 2009) were reported following childhood radiotherapy after sufficiently long follow-up. The radiation risks from routine radiation medicine procedures are low and are difficult to detect. Multicenter epidemiological collaborations with larger datasets and meta-analyses would improve this evaluation.

In parallel, studies to improve: (1) the understanding of the factors affecting patient communication, e.g., their comprehension of medical radiation, what they want to know and how best to communicate such information; and (2) the teaching methodology and learning of risk communication skills for radiation medicine practitioners are useful topics (Cardinal et al. 2011). These efforts should be encouraged.

9.6.3 Strengthen Infrastructure and Apply Policies

Promoting teamwork in the workplace would encourage group learning and the collective use of quality improvement, risk reduction, and risk communication actions. The development of a safety and quality culture based on competency, knowledge, attitude, transparency, and clearly defined responsibilities is encouraged. These efforts would improve awareness and encourage the use of communication skills in practice.

To strengthen the education infrastructure, capacity building in both institutional structure and teaching personnel is needed. Partnership between academic institutions, professional organizations, international agencies, donors, and development agencies is encouraged. These actions range from workforce planning, revitalization of institutions, collaboration between partners, and the use of innovative technologies to education. The support of policy makers is required to incorporate the subject into curricula and to include communication competency as part of primary certification and recertification.

Integrated quality initiatives such as the World Health Organization's Global Initiative on Radiation Safety in Health Care Settings and the Royal Australian and New Zealand College of Radiologists' Quality Use of Diagnostic Imaging (QUDI) Program provide a platform for stakeholder collaboration toward a safer and more effective use of radiation in medicine. The Global Initiative's areas of work include risk assessment, risk management, and risk communication (World Health Organization 2008b). The QUDI Program aims to support improvements in quality, safety, and sustainability of imaging in Australia. It is committed to the principles of quality health service delivery and places the consumer at the center of the process (Lau 2007; Quality Use of Diagnostic Imaging Program 2011). These frameworks could facilitate the education of risk communication by promoting stakeholder engagement and by incorporating and prioritizing these actions.

Seeding and ongoing grants are needed to bring these actions into fruition. Public agencies, private insurers, governments, politicians, and bureaucrats must demonstrate their commitment to quality and safety in radiation medicine by working with the stakeholders to develop and manage sustainable quality improvement strategies and actions. Funding for research, development, and education in quality and safety in radiation medicine is minuscule when compared to other enterprises with similar budgets. Investments in this infrastructure will benefit all stakeholders.

9.7 The Panacea for Success

The challenge for the stakeholders is to develop and value sustainable, long-term, system-based strategies and actions that will improve practitioner competency and patient care. The skills and resources for an individual, institution, organization, and agency are limited. Collaboration is strength and will provide synergy. Champions will lead and rally the supporters. Actions from these leaders will inform the uninformed and convert the skeptics and resisters. However, commitments from all stakeholders toward a common goal and the active participations from radiation medicine practitioners will ensure success.

To improve risk communication competency in radiation medicine, there is no single action that will provide a comprehensive solution. Based on the considerations, a range of strategies and actions is required. The application of quality improvement principles (Lau 2006) to the teaching, learning, use, and assessment of risk communication competency by conducting audit, identifying gap, developing solution, implementing changes, and verifying results will improve these skills in radiation medicine practitioners. Improvement is a continuous process (Fig. 9.2). These improvement actions, whether initiated from the "ground-up" in the workplace

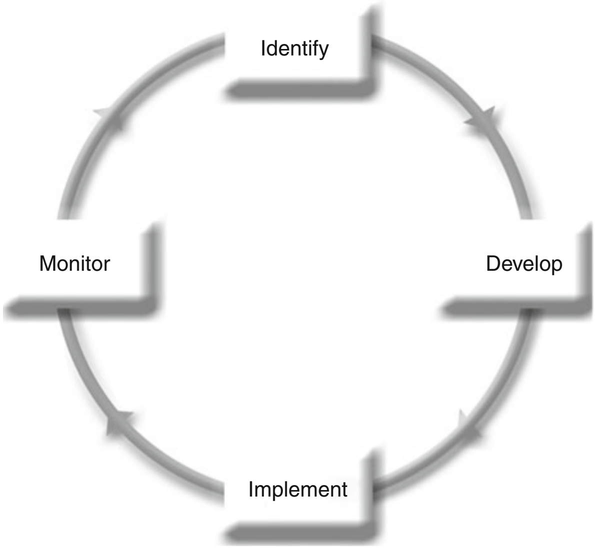

Fig. 9.2 A quality improvement cycle

or "top-down" from agencies and organizations, require persistence, patience, leadership, partnership, collaboration, and stakeholders' participation. Closer collaborations and partnerships between all stakeholders will lead to better risk communication in radiation medicine and better patient care.

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Assessing Clinical Competence in Radiation Oncology Education

10

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10.1 The Discipline of Radiation Oncology

Radiotherapy is the clinical modality dealing with the use of ionizing radiation in the treatment of patients with malignant neoplasia and occasionally non-malignant disease.

Radiation oncology is that discipline of medicine concerned with the generation, conservation and dissemination of knowledge on the causes, prevention and treatment of cancer and other diseases involving special expertise in the therapeutic applications of ionizing radiation. Radiation oncology can be practiced as an independent oncological speciality or may be integrated into the broader medical practice of 'clinical oncology' with the use of chemotherapeutic agents and targeted molecules to enhance the effectiveness of radiation in a multimodality setting, thus providing a comprehensive treatment to cancer patients (Halperin et al. 2008).

The dual terminology of radiotherapy or radiation oncology is still used since a number of countries adopt either of these nomenclatures to indicate this speciality. The term radiotherapy is preferred by those who treat a large number of patients with non-malignant disorders. This is the case in Central and Eastern Europe. The specialist following successful completion of training could be considered either a radiotherapist or radiation oncologist, depending on the country of his training. However, due to its broader scope, the term radiation oncology is preferred.

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10.2 Training Residents

The current scope of practice of radiation oncology demands that residents be trained in areas such as systemic therapies, toxicity of combined-modality therapy, treatment of non-malignant disease, new and emerging technologies, principles of quality assurance, palliative and supportive care and multidisciplinarity.

Standard training programmes include exposure to disciplines such as medical physics, radiobiology and pathology and imaging (radiology and nuclear medicine) and should also include rotations through the internal medicine wards. The amount of training in medical oncology varies from limited exposure to a full comprehensive programme that combines both medical and radiation oncology. The former programmes should allow the radiation oncologist to be able to prescribe radiation-sensitizing chemotherapy drugs and combined regimes that are standard practice today in the management of most tumour sites. The latter programmes may be adequate for small countries where a limited number of practitioners must handle all oncology cases. For practitioners in these countries, a comprehensive knowledge of both disciplines (medical and radiation oncology) becomes extremely useful.

New radiotherapy techniques are currently being introduced and are rapidly becoming popular. These require additional training for clinicians. Three-dimensional conformal radiotherapy (3D-CRT) has become the standard approach for planning and delivery of radiotherapy treatments. In recent years, the new paradigm of intensity-modulated radiation therapy (IMRT) and other advanced techniques are also becoming more and more popular. These newer techniques demand that the radiation oncologist define the target volumes to be treated by the radiation beam as well as the organs at risk whose exposure to radiation must be calculated and kept below pre-determined dose-volume constraints. The delineation of volumes on a computerized treatment planning system requires knowledge of cross-sectional anatomy and a robust interpretation of structures as seen on CT, MRI or PET/CT scans. Therefore, learning of cross-sectional imaging must be included in all radiation oncology training programmes. Training of a radiation oncologist must be such that the graduate from such programme would be able to practice as a competent and independent specialist.

The training programme must include both basic sciences of oncology and organ- or site-orientated clinical applications. It must have dedicated hours for theoretical teaching (lectures, seminars, journal club) as well as clinical skills training through the supervised care of patients.

Recent trends in medical education demand the inclusion of disciplines and competencies not taught as recently as a few years ago. These include competencies such as principles of management, basics of medical research, interpersonal and communication skills and professionalism. Contemporary medical practice has determined that postgraduate training is moving from emphasis on knowledge only to a spectrum of core competencies on which the education is based. Competencies include knowledge but also skills and attitudes. In the CanMEDS framework (Frank 2005), for example, seven competencies are identified:

1. Medical expertise
2. Communication

3. Collaboration
4. Knowledge and science (scholar)
5. Health advocacy
6. Management
7. Professionalism

Similarly, the learning outcomes required by the Accreditation Council of Graduate Medical Education (ACGME) are as follows (2009):

1. Patient care that is compassionate, appropriate and effective for the treatment of health problems and the promotion of health
2. Medical knowledge about established and evolving biomedical, clinical and cognate (e.g. epidemiological and social-behavioural) sciences and the application of this knowledge to patient care
3. Practice-based learning and improvement that involves investigation and evaluation of their own patient care, appraisal and assimilation of scientific evidence and improvements in patient care
4. Interpersonal and communication skills that result in effective information exchange and collaboration with patients, their families and other health professionals
5. Professionalism, as manifested through a commitment to carrying out professional responsibilities, adherence to ethical principles and sensitivity to a diverse patient population
6. Systems-based practice, as manifested by actions that demonstrate an awareness of and responsiveness to the larger context and system of health care and the ability to effectively call on system resources to provide care that is of optimal value

10.3 Assessment of Clinical Competence

Assessment for formative purposes is designed to stimulate growth, change and improvement in teaching through reflective practice. Evaluation, in contrast, is used for summative purposes to give an overview of a particular instructor's teaching in a particular course and setting. Informed judgements on teaching effectiveness can best be made when both assessment and evaluation are conducted, using several techniques to elicit information from various perspectives on different characteristics of teaching. In assessment, information is gathered in a formative way in order to improve teaching, set goals for learning, 'see how things are going', raise awareness of any gaps in learning and decide if the teaching approach is effective for learners. Assessment constitutes an ongoing process of gathering and interpreting information about a learner's knowledge, skills and/or behaviour. It is the process of documenting, usually in measurable terms, the extent to which the learning outcomes have been achieved (Bologna Working Group on Qualifications Frameworks 2005) and can cover knowledge, skills, attitudes and beliefs. Evaluation is a process that leads to accreditation and subsequent certification of the trainee. Methods of evaluation and assessment of medical residents should be studied relative to their comparative validity and reliability.

Evaluation should be an integral component of course design, and the amount and level of evaluation should be consistent with the defined learning outcomes. It is about finding out what the student has achieved and giving it a value.

As noted in Chap. 2, assessment can be classified in many different ways, some of the most usual are:

- Formative or summative
- Objective or subjective
- Formal or informal

To review then, *summative assessment* occurs at the end of a training course, and its purpose is generally to enable the awarding of a grade or attaching some type of value judgement to the achievement or performance. An evaluation must document the resident's performance during the final period of training and verify that the resident has demonstrated sufficient competence to enter practice without supervision. *Formative assessment* takes place throughout a course, a rotation or project and is used to aid both teaching and learning as it offers continuous feedback on performance to students and those who instruct or supervise them. These two methods are routinely used to complement each other.

Objective assessment is the use of a form of questioning where there is a single correct answer. This could perhaps be something like multiple choice questions (MCQs) or a mathematical calculation as in dose/fractionation calculations. *Subjective assessment*, on the other hand, may have more than one correct answer, or there may be more than one way of answering the questions. An obvious example to consider is the 'essay' examining the treatment of a tumour site where more than one option could be considered correct. It is important to recognize that even 'objective' assessment is not neutral. The questions that are included or excluded underline a particular subjective bias of the test creator and assume that only one answer is possible. Their success (validity and reliability) can depend largely on the skills of the person creating the MCQs.

Informal assessment can be very useful in guiding students during class or practical sessions. Informal assessment can include observation, peer and self-evaluation, discussion or checklists. *Formal assessment*, on the other hand, usually implies a written examination in some format. Teaching centres are increasingly making use of technology to document such assessments, such as videotaping orals or objective structured clinical examinations (OSCEs). In this way, a formal assessment provides the required documentation of progress for the institution but can also serve as a teaching tool for ongoing review and new learning.

10.4 Methods of Evaluation

Evaluation can and should take many forms, thereby testing a wide range of knowledge, skills and attitudes consistent with the taxonomy defined by Bloom (Bloom et al. 1956; Bloom 1994). In all evaluation that will be allocated a mark or grade, it must be made clear to the student at the outset as to how the marks are going to be allocated. This will also indicate to them the level of detail required on each aspect of the topic.

The evaluation of radiation oncology residents has traditionally included the following approaches: ward evaluations, written examinations usually of the MCQ type, oral examinations and a portfolio including the case logbook.

10.4.1 Ward Evaluations

In ward evaluations, the resident is presented one or more patients admitted to the hospital ward or visiting the outpatient clinic and is requested to proceed through the steps of a regular patient-doctor interaction including some or all of the following: history taking, physical examination followed by a discussion on the diagnosis, diagnostic tests, staging, treatment plan and prognosis.

This method has been scrutinized by many qualified individuals in an attempt to determine its validity and reliability. The ward evaluation, and particularly its use in conjunction with a rating scale, has been labelled as highly subjective and unreliable (Dauphinee 1995). If the limitations of the ward evaluation are acknowledged and some of the deficiencies in current practice are amended, the ward evaluation can be effective. What is needed is a 'standard' format and technique for evaluating residents in all programmes. A universal evaluation form could be devised, tested and implemented. This will overcome the current ward evaluation which is empirical and dissimilar across the various programmes (Reddy and Vijayakumar 2000). Keep in mind that standard formats must be flexible enough to account for differences in context.

10.4.2 Written Examinations

These are usually seen at the end of a block of learning, either a module or end of a full academic year. This type of assessment is generally fair and consistent from the student perspective, and what is returned is verifiable as the student's own work. They do not, however, allow for feedback and improvement often as a result of the timing at the end of a module, and it is quite difficult to write clear and unambiguous examination questions. Some students are naturally better at sitting examinations, have greater ability to recall large numbers of facts, to set out answers clearly and even to write faster. The answers may not always reflect either the level of understanding of the student or the ability to apply knowledge in a wider context.

10.4.3 Multiple Choice Questions (MCQs)

In this form of assessment, students are asked a question or presented with a statement (the *stem*) and given a set of possible answers from which, in its simplest form, they are required to select the correct answer. The correct answer is termed the *key* and the incorrect answers the *distractors*. Stems should be clear, the key should leave no area for doubt and the distractors should be incorrect but not ridiculous.

They should test the students' knowledge directly. MCQs can take a range of forms and can include diagrams, short clinical scenarios or case studies. It is also possible to test depth of knowledge by developing a linking series of MCQs on a single topic. Well-written MCQs can be a very effective method of assessment.

10.4.4 Oral Examinations

These are usually used in conjunction with other assessment methods and give students an opportunity to clarify points that were unclear from their examination papers or to demonstrate a higher level of knowledge and understanding. They can also be used in place of a practical examination to test the application of knowledge to the clinical setting. This can be useful when resources are scarce and practical examinations cannot be arranged.

10.4.5 Portfolio

The portfolio is a compilation and documentation of a range of work built up by the trainee and has the advantage of showing evidence of the student's achievement over time. The portfolio can also be very useful for graduates applying for positions or for continued professional development (CPD) points in the future. It is an excellent method of documenting clinical practice. The main disadvantage is for the teacher as they are time consuming and difficult to rate. The resident's portfolio may include: (1) personal data, (2) scientific training documentation and courses, (3) clinical training documentation (this includes the case log-book), (4) record of formal presentations given by the trainee and (5) publications (Hunter et al. 2004).

10.5 New Evaluation Methods

10.5.1 Objective Structured Clinical Examination (OSCE)

These are frequently used in the medical setting to test practical skills or affective skills such as communication. They normally consist of several stations, where a station is a discrete section within a specially laid out room where a single topic is assessed. Students are expected to move through each of the stations and to answer the problem set within a defined time period usually 5–10 min (Harden and Gleeson 1979). The stations may ask a dose calculation question or may set a case scenario and ask the student how they would deal with it. In more sophisticated systems, actors may be used to present the student with a problem where their ability to communicate can be tested. OSCE are very useful in testing a range of skills but can be subjective. Great care must be taken in both setting and marking the stations.

Validity and reliability are high (Sloan et al. 1996). The main problem and disadvantage of the OSCE is that its administration is costly and demanding. The time and cost involved in setting up an OSCE is greater than that for a traditional pen-and-paper examination. Harden (1979) himself concedes that the compartmentalized nature of testing in the OSCE does not allow the evaluator to assess a resident's ability to look at one patient as a whole.

10.5.2 Standardized Patient

A 'standardized patient' is a healthy person who is specifically trained to be a professional patient to test students in a patient-doctor relationship scenario. The standardized patients can then provide an oral or written assessment of the trainee's performance based upon a set of previously determined criteria.

10.6 The USA Model

Over the past decade, the primary organization which oversees physician residency education (Accreditation Council for Graduate Medical Education (ACGME)) and the primary organization which oversees physician specialty board certification (American Board of Medical Specialties (ABMS)) implemented what are currently referred to as the Six Core Competencies, which every physician should achieve in their medical education and training and ultimately in their daily practice. The six competencies are (1) medical knowledge, (2) patient care, (3) professionalism, (4) communication, (5) practice-based learning and (6) systems-based practice.

The specialty boards strive through their initial certification process and maintenance of certification process that each of their graduates demonstrates achievement and maintenance of these competencies through a life-long process of continued medical education, self-assessment and practice improvement. We hereby focus on the assessment of competencies in residency training and education in radiation oncology.

The ACGME has a residency review committee for each specialty. The residency review committee, composed of specialists and administrative staff, periodically reviews every residency programme at least every 5 years. The residency review committee in radiation oncology is composed of six radiation oncologists, a resident member, administrative staff and an ad hoc member from the American Board of Radiology to assure that the training programme is reasonably aligned with the certification process. The rigorous review process includes an online application and an on-site visit and report. Following submission of the online application form, an on-site review takes place, where the details of the application are reviewed and confirmed by a trained site visitor. Each programme is approved for a specified length of time (up to a maximum of 5 years) and a specified number of trainees.

In radiation oncology, as with many of the other specialties, competencies are assessed based on individual evaluations of each trainee during each of their rotations. While programmes are allowed flexibility in how they structure their rotations, trainees will typically rotate on a given service with one or two faculty, for a period of 2–4 months. Detailed evaluations of the resident are generated after each rotation by the supervising physician or physicians. In addition, other personnel, such as radiotherapy technologists, physicists, dosimetrists and nurses will often evaluate residents in what is referred to as a 360° global evaluation. Currently, most programmes have structured their evaluation forms such that the trainee is evaluated in each of the six competencies. Evaluations from nursing, and dosimetry staff are valuable in assessing the residents' competency in communication, professionalism and systems-based practice. While the supervising physician also addresses these areas, medical knowledge, patient care and practice-based learning are more thoroughly assessed by the supervising physician. The programme director is expected to sit with the trainee at least twice yearly over the 4-year residency program, to go over their evaluations and identify areas which require improvement. Case logbooks are also reviewed during these sessions to assure that each trainee has the appropriate level of experience expected during their rotations. Over the course of 4 years of training, current requirements indicate that the resident is expected to participate in at least 450 external beam radiation therapy cases, 12 paediatric cases, 15 intracavitary brachytherapy cases, 5 interstitial cases, 10 radiosurgery cases and 6 cases of unsealed sources. These specific requirements may be modified from time to time as procedures in the specialty evolve. As residents progress in their training, they are expected to assume increasing levels of responsibility with increasing understanding and competency in management of the patient undergoing radiation treatments.

In addition to these global evaluations of each trainee throughout their rotations, other assessment methods include a yearly 'in-service' examination, which is a typical multiple choice written examination covering clinical radiation oncology, physics and radiation biology. These examinations are scored nationally such that each trainee receives a score of how he or she performed in relation to their peers of equivalent training around the country. Programme directors receive scores for each resident as well as aggregate scores for their programme compared to others, so they are able to identify strengths and weaknesses in their training.

In general, competencies in medical knowledge, patient care, professionalism and communication are assessed through the routine evaluation process outlined above. Practice-based learning and systems-based practice are not as familiar to physicians in the evaluation process and have been somewhat more difficult to assess. However, trainee involvement in quality assurance programmes, including chart rounds, and other quality assurance and quality improvement initiatives, participation in multidisciplinary clinics and tumour boards, as well as chart reviews and clinical research projects helps to fulfil these competencies. Resident involvement in research as well as quality assurance and quality improvement programmes is expected for all trainees in radiation oncology, and residents are assessed and evaluated in these areas routinely.

At the completion of the 4 years of training, provided the trainee has fulfilled his/her requirements, the programme director is expected to verify that the resident has demonstrated sufficient competence to enter practice without direct supervision.

While the current system of evaluation and assessment is considered to be a marked improvement and has helped to establish more uniform standards expected of any practicing physician, the ACGME is moving toward the creation of milestones of resident competency. These milestones will define the behavioural attributes essential to be demonstrated in each competency before a resident moves on to the next level or graduates. Development of milestones in other medical specialties is well underway. Radiation oncology has not yet fully developed its milestones, but this process is moving forward and will likely unfold in the next few years.

10.7 The European Model

Over the last 20 years, the European Society of Radiation Oncology (ESTRO) has been working on designing core curricula for the training of radiation oncologists in Europe. These were meant to serve as a template for the national curricula, which is the responsibility of national authorities. The aim of creating core curricula has been to harmonize the radiation oncology training programmes across Europe, which should facilitate the free movement of medical specialists throughout the region based on an increasing confidence that their training is sufficiently homogeneous to make such an exchange possible.

The core curricula were based on a combination of knowledge and skills. In the first two versions (1991 and 2004), areas of required knowledge and clinical skills were identified. Being aware of the differences in cancer epidemiology, and in the availability of resources across Europe, the core curricula were drafted in such a way that national authorities could adapt them to their own circumstances and realities. The risk of this approach was of course that much freedom was allowed for interpretation and deviation from the general goal. But, on the other hand, being too stringent, would result in the risk that implementation of core curricula guidelines would not be accepted by all European national authorities.

The change and challenge in establishing the radiation oncology curriculum nowadays is to move from implicit professional behaviour to an explicit auditing of the professional performance of the medical specialists.

The latest core curriculum of ESTRO is consequently based on the seven general competencies described in the CanMEDS system (Frank 2005).

The training of radiation oncologists has to prepare physicians to be effective in the current health-care environment while truly meeting the needs of patients. The ‘outcomes movement’ in medical education places emphasis on preparation for practice and for optimal outcomes for patients and society as opposed to intellectual sake only. Accordingly, education has moved away from medical knowledge only to knowledge and skills in a number of pre-defined competencies. The new way of learning is naturally accompanied by new ways in assessment and evaluation.

The evaluation of competencies should be introduced in our training programmes, which then becomes different from the classic way of resident evaluation. The new ways of testing competencies are: feedback at the workplace, workplace assessment, the 360° evaluation and the individual portfolio including the logbook.

In the previous training programmes, performance of trainees in the daily practice was relatively hidden from the tutors. In the new training programmes, this is no longer the case. Feedback at the workplace and workplace assessment means that the resident is being observed, carrying out actions in practice such as history taking, physical examination, obtaining informed consent, delivering bad news and other tasks.

The 360° feedback as a structured evaluation of resident by members of the staff, secretaries, technologists and fellow residents focusing mainly, but not only, on the competencies of communication and collaboration has been accepted by the national representatives in Europe as a useful tool for evaluating trainees' performance.

ESTRO has created a web-based portfolio (Hunter et al. 2004), which could serve as a 'European passport' for graduates in radiation oncology demonstrating the achieved skills and knowledge during the training. In the portfolio, the trainee should record the training schedules, the supervisors' assessments, the 360° evaluations and the results of examinations, publications, attended conferences and other academic achievements reflecting the trainee's performance over the years of training. ESTRO is strongly encouraging the use of this European portfolio/logbook and hopes it will be used in all European countries as it will help not only to harmonize training programmes but also to support trainees in demonstrating that their training has been conducted according to European standards.

The major change in the new European core curriculum is that what was implicit in the old curricula has been made explicit in the new one. Professional behaviour is now an item to be evaluated; therefore, professional behaviour is more explicitly described in the curriculum with more emphasis on communication, health advocacy, management and professionalism.

Although not everybody supports these changes, they are being driven by changes in medical practice and society. Therefore, it is better to be prepared for these changes in the radiation oncology community and train our residents for the demands they are going to face in the nearby future. The new ESTRO core curriculum and its consequences in training and evaluation represent an effort in keeping up with these new developments.

The situation in Europe is different from that in the United States. In Europe, specialists' training programmes are the responsibility of national authorities. European professional organizations such as ESTRO can only provide guidelines for these national authorities to base their national programmes on, taking into account their national regulations and resources. Consequently, we cannot expect a European standard or a European examination with formal statutory consequences. The best we can achieve is an agreement on a core curriculum and a common system of evaluation of competencies.

The ESTRO annual meeting in Barcelona in 2010, where ESTRO agreed on a common ground on how to evaluate competencies, showed that European countries have more in common than we previously believed. ESTRO is planning a series of workshops to support national authorities implement the current guidelines of the competency-based curriculum.

The concepts and approach to training and assessment presented hereby have been incorporated in the International Atomic Energy Agency (IAEA) Syllabus for the

Education and Training of Radiation Oncologists (2009). This syllabus has been endorsed by ESTRO and the American Society of Radiation Oncology (ASTRO) for the establishment of radiation oncology training programmes in developing countries.

Conclusions

As a result of what we have learned, radiation oncology training and evaluation is now moving from the traditional knowledge-based focus to training and assessment based on new competencies such as clinical skills, attitudes, beliefs, management, communication and professionalism.

10.8 A Test Case

The teaching staff at the Department of Radiation Oncology, Nijmegen (The Netherlands), made a video of an interview between a trainee and a patient during treatment and during follow-up in our department (Jan Willem Leer). The video was then subtitled in English and shown to national representatives of 22 European countries during the ESTRO meeting in Barcelona 2010.

The ‘test’ case in Barcelona consisted of three parts:

1. A theoretical introduction on competency-based training and evaluation.
2. Assessment of the performance of a radiation oncology trainee based on videos showing a trainee talking with a patient.
   (a) During treatment
   (b) In follow-up
3. An exercise with expert support and comments on how to discuss with a trainee the results of his/her assessment. This was done using role play.

To our surprise, representatives of these countries had a similar judgement on the performance of the trainee shown in the video. This reassured us that the appraisal of the performance of a trainee is less dependent on the local culture as we assumed before, and standards can be used in the different states of the European Union. Also, the tutor-trainee communication was demonstrated in this meeting by professionals. While we found that cultural differences were not as significant as we expected (at least within the European Union), difference in teaching and learning must always be considered and accounted for along the way.

Building on this experience, ESTRO has decided to make a programme within its Education and Training Committee to train national representatives on education from European countries to be able to set up their own national systems following a train-the-trainers approach.

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Measuring Competence of Radiology Education Programs and Residents: The Egyptian Experience

11

Sahar N. Saleem and Youssriah Y. Sabri

11.1 Introduction

Ancient Egypt was one of the largest and most advanced elaborate medical education and practice in the ancient world. Medicine was not practiced by witch doctors, as in primitive tribes with magic, but was a highly organized profession being practiced and taught in institutions called Houses of Life (Peri-Ankh). The first medical school opened there in the first dynasty (4,000 BC), and many others followed. Teachers were carefully chosen from priests of good and honest characters with scientific background (El-Gammal 1993; Nunn 1966).

Medical information in ancient Egypt was documented in medical papyri according to specialization to be references for physicians. The most famous were Ebers Papyrus (3,000 BC), an internal medicine reference; Kahun Papyrus (1,825 BC), which dealt with gynaecology and paediatrics; and Edwin Smith Papyrus (1,600 BC), which was concerned with surgery. The medical information in these papyri discussed clinical cases in the same steps we follow in our modern medical education books. Interrogation of the patient as a first step was followed by inspection, palpation and the percussion of the body and diseased organs. This was followed by 'diagnosis' and—if considered treatable—the 'recommended treatment'. Most of the cases also include an additional subheading 'explanation' for the medical students in which unfamiliar terms used in the case description was clarified (Breasted 1930; Nunn 1966; Sanchez and Burridge 2007; Walker 1996).

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According to Herodotus, there was a high degree of specialization among physicians: *The practice of medicine is very specialized among them. The country is full of physicians. Each physician treats just one disease* (Herodotus et al. 2005).

Physicians in ancient Egypt were organized with ranks. The lay physician (named swnw) was overranked by overseer of physicians (imy-r swnw), a chief physician (wr swnw), eldest physician (smsw swnw), inspector of physicians (shd swnw) and finally overseer of physicians of Upper and Lower Egypt. The competent medical bureaucracy was responsible to apprentice physicians to practicing healers (El-Gammal 1993). In the prologue to the *Instruction of Ankhsheshonq*, *the* physician was called to the royal court and underwent some quizzing by the king himself and then became a member of the medical team looking after the pharaoh: *Pharaoh asked him many [things] and he answered them all* (Lichtheim 2006). In ancient Egypt, women succeeded not just in acquiring medical knowledge but also in climbing to the top of the scribal hierarchy. An Old Kingdom female physician named Peseshet had a title of 'Lady Overseer of the Lady Physicians'. She supervised women who were qualified physicians, not midwives. She also taught and graduated midwives at the *peri-ankh* (medical school) of Sais (El-Gammal 1993; Nunn 1966).

In modern history, the Faculty of Medicine at Cairo University (Kasr Al-Ainy), established in 1827, continues the glory of Egypt in medical education as one of the biggest and oldest medical schools in Africa and the Middle East. A central Radiology Department is responsible not only for the clinical services in the hospital but also for providing multiple calibre radiology education programs for trainees from Egypt and neighbour countries.

11.2 Facilities of Faculty of Medicine of Kasr Al-Ainy, Cairo University

Kasr Al-Ainy Medical School is composed of 16 facilities (Table 11.1) with more than 5,000 beds and serves about one million patients annually.

A central Radiology Department with total 77 staff members (professors, assistant professors and lecturers) in 9 subspecialty units (Table 11.2) is responsible for the clinical services in these facilities as well as for educating about 100 radiologists annually. All education programs (under- and postgraduates), clinical reports (including radiology), patients clinical files and interdepartmental communications at Kasr Al-Ainy Hospital are in English.

11.3 Objectives and Goals of Education Programs and Training in Radiology Department at Kasr Al-Ainy, Cairo University

11.3.1 General Philosophy and Principles of Radiology Academic Programs

The Radiology Department at Kasr Al-Ainy provides different training programs that enable candidates to specialize in the field of diagnostic radiology: junior radiology

Table 11.1 Cairo University hospitals and health facilities

1. Manial University Hospital
2. Manial Specialized Hospital
3. Obstetrics and Gynecology Hospital
4. Emergency Hospital
5. Oncology and Nuclear Medicine Center
6. King Fahd Renal Failure and Surgery Unit
7. Intensive Care Unit
8. Internal Medicine Hospital
9. Abu El Reesh Children Hospital
10. Mubarak Hospital
11. Social Preventive Medical Center
12. National Clinical and Environmental Toxicology Center
13. Outpatient Clinic
14. New Kasr Al Ainy Teaching Hospital
15. Medical Treatment Unit
16. Operative Unit

Table 11.2 List of the subspecialty units in Radiology Department at Kasr Al-Ainy

Subspecialty	Number of radiology staff
1. Neuroimaging and head and neck	12
2. Musculoskeletal imaging	12
3. Vascular imaging and intervention	9
4. Ultrasound and Doppler	3
5. Cardiothoracic imaging	8
6. Urogenital imaging	4
7. Women's imaging	9
8. Abdominal imaging	11
9. Paediatric imaging	9

resident candidates for the first part of master of radiology (M.Sc.), senior radiology resident candidates for the second part of M.Sc. of radiology and assistant lecturer candidates for the medical doctorate (M.D.) in radiology, as well as visitor trainees from other Egyptian hospitals or foreign countries. In the academic year 2010–2011, there were 37 and 25 candidates for the first and second parts of M.Sc., respectively, and 21 candidates for medical doctorate (M.D.) in addition to 20 visitor trainees from foreign countries, with a total of 103 candidates.

The general training philosophy and principles of the training in our department is to establish a qualified specialized radiologist who will be able to transfer his/her experience to colleagues and fulfil the following at the end of the program:

- To run a radio-diagnostic unit that provides basic and common diagnostic procedures
- To write a comprehensive report on a radiological study with clinical radiological interpretation to deduce the correct diagnosis or the possible differential diagnosis

- To be aware of current and advanced diagnostic imaging modalities and their applications in medicine for the purpose of diagnosis and treatment
- To be aware of clinical problems of the community and interact efficiently
- To communicate and keep pace with radiology practice in other parts of the world
- To investigate published scientific research and to present a short talk on an assigned topic
- To conduct research
- To have sufficient preliminary knowledge about the use of computers and information technology in radiology practice and research

11.3.2 Intended Learning Outcomes (ILOs) for Training Programs

The intended learning outcomes (ILOs) depend on the level of the training program. These include the development of both knowledge and practical skills and the enhancement of intellectual and communicating capabilities at different levels according to that of the training program (M.Sc. or M.D.).

1. Knowledge: recognition of scientific knowledge related to diagnostic radiology
   (a) Basic: includes physics, radiobiology, radiological anatomy
   (b) Clinical: medical, surgical and pathological.
   (c) Concepts of diagnostic modalities and appearances of different pathologies in different imaging modalities
2. Practical skills: applying different diagnostic imaging procedures competently and independently
3. Intellectual skills: to be able to review and search literature and perform research with sound methodology
4. Communications: working with colleagues in teams, referral to senior colleagues, responding to staff guidance and remarks, treating patients with respect and being aware and effectively responding to community's clinical problems

More specific objectives are assigned for each group of trainees in our department: residents (candidates for first and second parts of M.Sc. in Radiology) and assistant lecturers (candidates for M.D. in Radiology) in addition to visitor trainees from foreign countries.

11.4 Education and Training Programs for Radiologists in Radiology Department at Kasr Al-Ainy, Cairo University

11.4.1 Education and Training Programs for Residents

The Radiology Department offers 36 months of residency training in which both academic and practical training are given. Program admission requirements, according to the Faculty of Medicine, Cairo University Bylaws for Post Graduate Programs (2009), applicants should have a bachelor degree in medicine (MBBCh or equivalent).

Table 11.3 List of different imaging techniques practiced by residents in Radiology Department in Kasr Al-Ainy

Gastrointestinal barium techniques
Hysterosalpingography
Urology conventional techniques
Special paediatrics techniques
Ultrasound and Doppler examinations
CT angiography
High-resolution computed tomography HRCT
Magnetic resonance angiography
Virtual endoscopic techniques
Angiographic and interventional procedures

Candidates should fulfil preliminary courses in English language (TOEFL), medical statistics and computer skills (ICDL or equivalent). Preliminary courses are given at the Medical Education Center (MEDC) at Kasr Al-Ainy Hospital. Different imaging modalities are discussed in early morning and late afternoon lectures on a daily basis for all residents (6 days a week). Each resident spends a period of 2 months in each subspecialty unit (Table 11.2) as well as in the Emergency Unit as a junior resident and then repeats the cycle again as a senior resident.

Under the supervision of an assistant lecturer and an attending staff member, each resident is trained to attain different skills (Table 11.3) in performing radiological techniques and ultrasound examinations, as well as different special CT and MRI techniques warranting reconstruction of images on a separate work station.

Training objectives for senior residents include training them how to approach an imaging study, analyze it in a systematic way, and write a comprehensive report deducing a diagnosis or possible differential diagnoses. Weekly conferences are thus held with the residents to discuss different clinical cases. The residents are requested to share in the preparation of these meetings by presenting the case, preparing a short review on its theoretical background and sharing in discussions of the findings and diagnosis. Residents are also encouraged to spend time in the department's imaging library to study archival films and make use of its digital facilities. According to the Faculty of Medicine, Cairo University Bylaws for Residency Training Programs, a logbook is required for each resident. The logbook contains participation of the candidate in the scientific activities in the department.

11.4.2 Education and Training Programs for Assistant Lecturers in Radiology Department in Kasr Al-Ainy

Assistant lecturers are junior practicing radiologists who have completed radiology residency, passed their master's exams (M.Sc.), and are preparing for an M.D. (medical doctorate) degree in Radiology. An assistant lecturer is trained for a minimum of 3 years under the supervision of staff members in the different subspecialty units.

Assistant lecturers in the Radiology Department practice radiology as well as carry out academic duties while they study for their degree in M.D. in Radiology. The education objective is to prepare candidates who are capable of applying the recent trends in radiology.

The requirements for M.D. degree are preliminary 6 months course in surgery, internal medicine and pathology, then a minimum of 2-year course in radiology practice and lectures, after which the candidate may apply for the M.D. exams, which are held twice a year.

During this period, the candidate is supposed to complete a research project under the supervision of two senior radiology staff members as well as a senior member in a clinical department.

11.4.3 Education and Training Programs for Visitor Trainees in Radiology Department in Kasr Al-Ainy

Visitor trainees are medical doctors with bachelor degree in medicine (MBBCh) from faculties other than Cairo University who attend training program in radiology at Kasr Al-Ainy Hospital. The trainees are from Egypt as well as other countries such as Sudan, Libya, Yemen, Palestine, Syria and Iraq. The number of visitor trainees is usually 10–15 per academic year.

Candidates for M.Sc. degree have to attend a 2-year training course at Kasr Al-Ainy Hospital to achieve the required skills in performing and interpreting the different radiological examinations. Visitor trainees attend the same academic program for residents. Those trainees number vary from about 10–15 per academic year.

Junior radiologist trainees with a master's degree are also present, submitting for an M.D. degree exam. There are usually two training sessions annually that follow the same training procedure as for assistant lecturers.

11.5 Assessment and Evaluation of Trainees in Radiology Department Kasr Al-Ainy

11.5.1 General Evaluation

The Radiology Department training program is planned to enable candidates to specialize in the area of diagnostic radiology. The program is designed to evaluate the trainees for their competency, knowledge and skills as a part of a general evaluation that is done every 2 months by the administration of the department. According to the program, candidates are expected to achieve satisfactory levels in knowledge in all subspecialties in radiology practice, to be able to interact with community problems, to respect ethical values of the community culture, to promote their medical standards through engaging in continuing medical education and to introduce them to scientific medical research. Assessment is fulfilled by the head of each radiology subspecialty unit for all trainees in the unit (residents, assistant lecturers, visitor trainees). Assessment includes attendance, participating in the scientific and administrative activities, general performance, attitude with colleagues and patients, improvements in technical skills and capabilities of solving problems.

The progress of learning of each trainee is followed up by the staff members through the evaluation reports. We implemented logbooks to register the progress of the trainee based on research studies in the faculty about standards of postmedical education (Selim 2008). The logbook documents the skills and experience attained by using credit points. The candidate of the program should fulfil 152 credit points through completion of compulsory courses, residency training, different scientific activities and thesis defence. These assessments are considered when the candidate is considered for promotion from a resident to assistant lecturer or from assistant lecturer to lecturer upon obtaining M.Sc. or M.D. degrees, respectively.

11.5.2 Objective Evaluation

Trainees at Radiology Department are assessed objectively by daily, weekly and biannual evaluations as well as by a thesis defence to determine whether or not the goals of the education program have been achieved.

11.5.2.1 Daily Assessment

This is done during film reporting sessions where daily clinical cases are discussed between staff members and the trainees in each subspecialty unit. On these sessions, technical skills of trainees are assessed.

11.5.2.2 Weekly Assessment

Daily ongoing assessment is done during the weekly scientific conference of the department. On weekly basis, each subspecialty unit presents clinical cases with relevant educational merits. Residents and assistant lecturers participate in presenting the cases and discussing the imaging findings and diagnoses. Short reviews of literature are presented digitally by the trainees during the conference and are assessed by the attending staff members for the following:

- Fulfilment of the assigned goal of the lecture
- Methodology of the presentation
- Clarity of the images and slides

11.5.2.3 Biannual Assessment

Examinations for M.Sc. and M.D. are carried out in May and November every year. Certain credit hours should be fulfilled as a requirement to attend the exams. A mock exam is given for the trainees 1 month before the exam to evaluate their general standard before proposing for exams. The exams are comprised of written and oral, as well as spotting and reporting tests (Table 11.4).

Table 11.4 Examinations schedule for M.Sc. (part II) and M.D. degrees in Radiology in Kasr Al-Ainy

Written exams (4 days)	(a) Multiple choice radiology exam (3 h) (b) Short questions radiology exam (3 h) (c) Pathology (2 h) (d) Internal medicine and surgery (1 h each)
Oral and practical exams (6 days)	(a) Oral radiology exam (1 day): (i) M.Sc. degree in radiology: examined by 4–5 examiners (ii) M.D. degree in Radiology: examined by 7–10 examiners (b) Practical radiology exam (2 days) (i) Ten short cases spotting and three long cases reporting (ii) Practical ultrasonography examination (for M.Sc. candidates) (c) Surgery (oral and practical exams) (1 day) (d) Internal medicine (oral and practical exams) (1 day) (e) Pathology (oral and practical exams) (1 day)

In the *spotting test*, cases from different radiological subspecialties are meticulously chosen to cover the different imaging modalities and techniques. Candidates for Part I M.Sc., are assessed for knowledge of performing the radiological techniques and radiological anatomy. Candidates for Part II M.Sc. and M.D. are assessed for knowledge of pathological basis of abnormalities detected in diagnostic imaging modalities.

In *oral exams*, candidates for M.Sc. or M.D. are examined by several examiners in different subspecialties; candidates spend about 15–20 min with each examiner (Fig. 11.1). During oral exams, the candidate's knowledge, way of thinking and approach to diagnose clinical cases are tested.

In *reporting exams*, candidates for M.Sc. or M.D. are tested on three imaging cases; they are given 20 min to report on each case. Candidates are assessed for how they approach the case, describe the findings, suggest differential diagnoses and conclude with a logical diagnosis.

In *written assessments*, candidates of M.Sc. and M.D. degrees in Radiology are assessed by written tests in the form of MCQ and short questions that are held on two consecutive days for 3 h each. The questions are selected to cover the different subspecialties in radiology. In short questions exams, a candidate is tested for his/her ability to solve a clinical case, to describe the imaging appearances of a certain pathological entity, to include the differential diagnosis of a certain pathological picture or clinical presentation and to mention a possible radiological algorithm when dealing with certain clinical situations.

11.5.2.4 Thesis Defence

According to the Faculty of Medicine, Cairo University Bylaws for Post Graduate Programs (2009), candidates for M.Sc. and M.D. in Radiology have to fulfil assigned

Fig. 11.1 Oral examination for M.D. degree in Radiology held in Cairo University. The candidate typically spends about 15 min with each of the *seven* examiners

research during her/his training period under the supervision of two or three senior staff members of Radiology Department as well as senior member of a clinical department in Faculty of Medicine at Cairo University.

The research project should be formulated in the form of a thesis. A candidate then has to defend the thesis in an open session in front of a committee of three examiners: an internal examiner (a senior member of Radiology Department at Cairo University) and the senior supervisor of the thesis, as well as an external examiner (a senior member of a university other than Cairo University) that meets the faculty standards. The candidate is asked to prepare a 20-min digital presentation to show his/her work (Fig. 11.2). The discussion assesses the candidate's knowledge of the research topic, methodology, results and conclusions of the work. A decision of acceptance or refusal of the thesis is based on the competence of the candidate in performing her/his research.

11.6 Assessment and Evaluation of Education Programs in Radiology Department at Kasr Al-Ainy

11.6.1 Radiology Academic Programs Design and Follow-Up

Specifications for the academic programs for master's (M.Sc.) and doctorate (M.D.) degrees in radiology are designed, evaluated and followed up by directors from Faculty of Medicine according to Cairo University's perspectives. The training programs are designed with the aim that candidates achieve satisfactory levels in knowledge of radiology and its subspecialities, gain practical skills, engage in continuing medical education, and get introduced to the basics of scientific medical

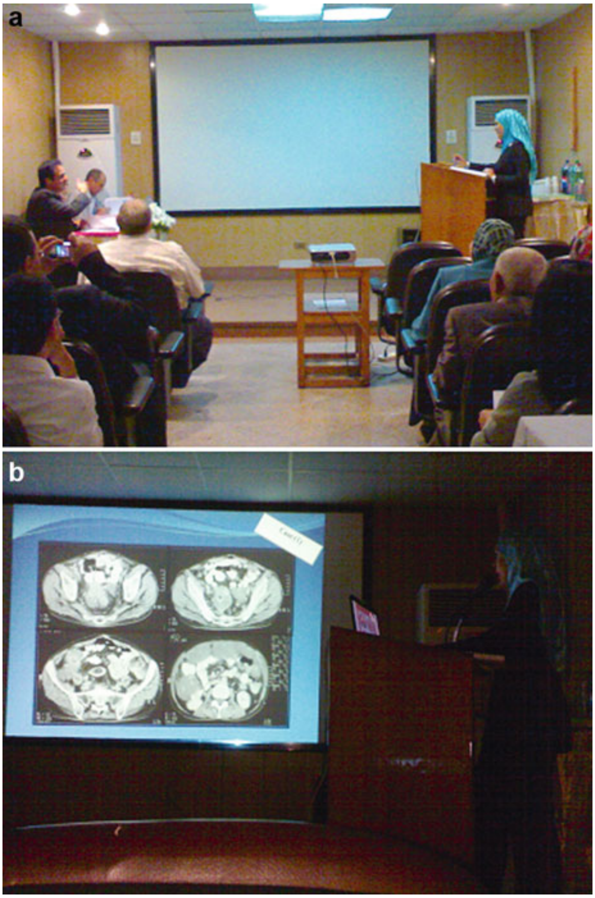

Fig. 11.2 Defence of Thesis for Master (M.Sc.) degree in Radiology in Radiology Department at Cairo University. (**a**) The candidate defends her thesis in front of three examiners (a supervisor of the thesis, an internal examiner from Cairo University, and an external examiner from another university). (**b**) A candidate typically uses digital presentations

research. Radiology training programs are also designed in respect to the ethical values of the community and culture and prepare trainees to interact positively with community's clinical problems.

11.6.2 Evaluation of Radiology Academic Programs by Accreditation Bodies

Radiology academic programs in Kasr Al-Ainy are measured for professional performance by accreditation bodies of different levels: self-assessment by Cairo University, national and international bodies.

11.6.2.1 Self-Assessment Through Medical Education Development Center (MEDC) at Cairo University

As an initial step of accreditation, Cairo University assigned the Medical Education Development Center (MEDC) in the university in 2003 to prepare a self-study for the Faculty of Medicine. The MEDC team is composed of staff members of the Faculty of Medicine who are assigned to collect information, analyze data and write reports to be used for the self-study of the faculty. MDEC prepared two self-studies for Faculty of Medicine, one in 2004 and another in 2009. Continuous measuring of professional performance of all hospital departments at Kasr Al Ainy Hospital, including the Radiology Department, has been carried out regularly by MEDC since 2004.

In each department of Kasr Al-Ainy Hospital, including the Radiology Department, an internal audit is assigned to observe, measure and follow-up the professional performance at the departments. Checklists are often used, and a feedback is presented regularly to MEDC. Since 2008, the system of academic mentor is applied in the Radiology Department as suggested by self-study of 2004 as well as by other academic researches that followed it concerning the medical education process in the Faculty (Seleem 2007; Selim 2008). Each senior staff member is assigned to mentor the academic progress of few (from 1 to 3) radiology trainees.

Continuous upgrading and renewal of teaching facilities in Radiology Department are pre-requisite for accreditation. Educational facilities include up-to-date data show machines, digital library facilities, computers and fast internet connections, as well as a supply of latest periodicals and textbooks of radiology.

11.6.2.2 National Assessment Through National Authority for Quality Assurance and Accreditation in Education (NAQAAE), Egypt

NAQAAE, established in 2007, is the accrediting body for all Egyptian educational institutions (about 55,000 institutions).The board is formed of a President, 3 vice-presidents and 11 board members selected mainly from educational experts. The main goal of NAQAAE is to support Egyptian educational institutes by fostering their quality assurance practices (NAQAAE 2011).

NAQAAE aims at raising awareness of educational quality assurance in the Faculty of Medicine of Cairo University through helping the faculty to establish an integrated system for accreditation, to set up educational standards and performance assessment indicators and to assert confidence and establish accountability in the educational outcome.

The intended learning outcomes (ILOs) of radiology education programs are developed according to the general guidelines of National Academic Reference Standards (NARS) for medical education by NAQAAE (Medicine Cairo University 2011).

Continuous measuring of professional performance of all hospital departments at Kasr Al-Ainy Hospital, including the Radiology Department, is carried out regularly by NAQAAE since 2007; the last inspection was in May 2011.

Evaluation of the radiology academic programs' ILOs are carried out during biannual meetings of the Radiology Department. However, more subjective evaluation of ILOs is currently under construction and includes the following:

1. Questionnaire to be answered by the candidate at the end of the program
2. Alumni office for postgraduates: to supervise the academic programs, to solve problems and to supply CME facilities

3. Stakeholders: representatives from different medical authorities in Egypt including army hospitals, National Medical Insurance, Medical Syndicate and Ministry of Health
4. External evaluators from national universities other than Cairo University to review the academic programs and participates in the biannual examinations to provide biannual reports
5. Quality assurance unit: a specialized unit to monitor the level of the education process and provide annual report

11.6.2.3 International Assessment Through the World Federation for Medical Education (WFME)

WFME is a global organization concerned with medical education and training of medical doctors as well as undergraduate medical students. A central part of the WFME strategy is to give priority to specification of international standards and guidelines for medical education, comprising both institutions and their educational programs (WFME 2012). In December 2004, WFME visited and inspected the Faculty of Medicine of Kasr Al-Ainy. Evaluation of WFME is based on generally accepted standards.

11.7 What Do We Know from Experience That We Can Learn From?

The self-studies that were carried in 2004 and 2009 introduced the concepts of quality assurance and self-review as well as the global standards of medical education to the authorities, administration, faculty members and students. The studies followed the basic standards of medical education from the WFME global standards. These self-studies systematically evaluated the institution's objectives, development and implementation procedures to evaluate the extent to which it achieves its goals. Data collected through interviews, documents, questionnaires and focus group discussions helped to identify points of strength and weakness of the medical education programs. These studies also suggested corrective measures to each standard to comply for WFME accepted standards and measures. These researches and analyses helped medical programs improvement.

Learning, teaching and scholarship in radiology are dynamic progressive processes, with experience gained and shared in every step. Successful medical education programs lead to better tutors, education strategies, training programs and eventually better trainee outcomes (Seleem 2007; Selim 2008).

One of the most important recommendations in this accreditation is how staff members themselves are trained to teach the academic programs. For this purpose, the Faculty of Medicine has designed training programs and workshops for its staff members. Attendance of faculty members in skill workshops is an essential requirement for each promotion and every 5 years at maximum.

In the Radiology Department at Cairo University, we aim to prepare radiologists to master their skills and knowledge through continuous measurement, assessment and evaluation of ourselves (as tutors), our academic programs, our facilities and our trainees.

Evaluation of the radiological educational programs based on accepted standards is an important incentive for improvement and for raising the quality of medical education. We believe that adoption of internationally accepted standards provides a basis for national evaluation of radiology education and facilitates mobility of trainees as well as ease acceptance of radiologists in countries other than those in which they are trained. Finally, improvement of evaluation and accreditation enhances the quality of health care both nationally and globally.

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12 Assessing Residents in a Nuclear Medicine Physician Training Program: The Philippine Experience

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12.1 Introduction

There has been a shift in medical education from structure- and process-based to competency-based education (Carraccio et al. 2002). This paradigm shift can also be observed in the context of assessment in postgraduate medical training. Several models such as the ACGME Competency-Based and CanMEDS Models have emerged and are enforced by national medical education councils responsible for postgraduate medical education in the context of medical specialty training (Epstein 2007; Frank et al. 2005). These models are essential and prescriptive within the jurisdiction of the respective councils, but postgraduate medical education councils or specialty program directors in other countries can, as a whole or in

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parts, benchmark these models in order to enhance the assessment component of their training program without sacrificing contextual integrity. This chapter demonstrates theory into practice as it highlights the common assessment tools used in several nuclear medicine physician (i.e., residency) training programs in the Philippines and how select competencies of the ACGME models are demonstrated and issues encountered.

12.2 Nuclear Medicine in the Philippines: Brief Overview

The late 1950s saw the birth of nuclear medicine in the Philippines, beginning with rudimentary in vitro equipment, followed in the succeeding decades by installation of imaging facilities. The physicians involved in early nuclear medicine practice had joined other scientists in the Radioisotope Society of the Philippines (RSP); thereafter, they formed the Philippine Society of Nuclear Medicine (PSNM), with a few of them board certified by the American Society of Nuclear Medicine.

More and more tertiary hospitals started opening nuclear medicine facilities in the 1980s and 1990s to provide imaging and nonimaging services to patients. A few major hospitals procured dual-headed gamma cameras with SPECT imaging. However, it was only in 2002 when PET scanning became available at the St Luke's Medical Center, and its PET/CT services offered in 2008.

12.3 Nuclear Medicine Physician Training in the Philippines

Because of the spread and the increasing sophistication of the specialty in the succeeding decades, there was a need to establish formal training programs to equip physicians with the skills to practice nuclear medicine in the country.

The physicians who first practiced nuclear medicine in the Philippines were all trained overseas, mostly in the USA and Europe where structured training for nuclear medicine as a specialty started in 1971 (Graham and Metter 2007). It is therefore not surprising that the first structured training programs implemented in the 1970s were patterned after those in the USA. Similar to those in the USA, Philippine programs in nuclear medicine initially required prior training in internal medicine, radiology, or pathology. This stems from the original specialty groups who founded the American Board of Nuclear Medicine. Eventually, the acceptable prerequisite residency programs in the Philippines were widened to include family medicine and pediatrics. Graduates of residency training in these fields can undergo a 2-year fellowship program, as it is referred to, to qualify for the nuclear medicine certification examination.

By the early 1980s, the two-track approach was being implemented. Aside from the fellowship program mentioned above, a second training track through a straight residency program was made available. Basic medical education in the Philippines generally consists of a 4-year premedical course, a 4-year medical course, and a 1-year rotating internship. Physician licensure examination is administered after all

Table 12.1 Hospitals offering postgraduate nuclear medicine physician training[a] in the Philippines

PSNM-accredited institution with nuclear medicine training	Year started	Average number of intake and graduate(s) per year
Cardinal Santos Memorial Medical Center	1998	1
Jose Reyes Memorial Medical Center	Late 1980s	1
Makati Medical Center	1996	One every 5 years
Philippine Heart Center	Late 1970s	Late 1970s to early 1990s – 1 graduate every 4 years
		Early 1990s to the present – 1 graduate every year
St Luke's Medical Center	2001	2
University of Santo Tomas Hospital	1996	1–2

All are located within the National Capital Region (NCR). Average intake and graduates in most centers is between one and two trainees per year

[a]Training programs listed are under various states of accreditation level by the Philippine Society of Nuclear Medicine as of 2011

prerequisites are met. Licensed graduates of a basic medical education were allowed to undergo a 3-year residency in nuclear medicine, without any prerequisite training necessary. In most of the 3-year nuclear medicine programs, the first-year resident rotates in clinical and imaging specialties for periods ranging from 2 to 8 months.

There are currently six institutions offering accredited nuclear medicine physician training, each center equipped with gamma cameras (with SPECT and/or SPECT/CT) and adequate patient workload to carry out a training program (Table 12.1). As of 2011, St Luke's Medical Center is the only hospital with PET/CT facility. Only two hospitals are attached to a medical school. The curriculum has been reengineered to reflect the multimodality imaging such as PET/CT and aspects of molecular imaging (Pascual et al. 2007) which follows a trend in the increased demand in learning PET imaging (Silberstein 2000). Trainees also rotate for varying periods of time in the radiological sciences for correlative imaging in CT, MRI, ultrasound, and interventional angiography. Through cooperative learning, nuclear medicine residents who do not have PET/CT facilities in their host institute are given the opportunity to visit the institution offering such service in order to keep them updated in emerging technologies (Pascual and Santiago 2007). The PSNM accredits the training programs at the national level with specific criteria such as patient workload, staff qualifications, nuclear medicine facility, and curriculum design among other things. They started the certifying examinations for nuclear medicine trainees in 1982. Graduate residents and fellows of these 3-year training programs had to take the board examination given by the PSNM annually. The average number of examinees was about five/year. Table 12.1 shows the physician training programs in nuclear medicine listed under the Philippine Society of Nuclear Medicine.

In addition, Philippine government regulations require all nuclear medicine workers to attend the "Radioisotope Techniques Training Course," or an equivalent to allow the resident to handle radionuclides. This is a 4-week course consisting of basic science, regulatory, and safety subjects. As a critical requirement for this certification, students are required to fulfill logbooks with feedback and to pass the written examination consisting mainly of multiple choice and essay responses.

12.4 Focus on Assessment

Like any postgraduate physician training program in nuclear medicine, the objective of training in the Philippines is to provide excellent opportunities for qualified physicians to achieve the core competencies in image interpretation, therapy procedures, molecular imaging research, and clinical experience needed to practice clinical nuclear medicine as well to meet the eligibility requirements for board certification required by the Philippine Specialty Board of Nuclear Medicine (PSBNM), the accrediting body for nuclear medicine physicians in the Philippines. Trainees need to determine if they were able to attain the objectives of the program through a series of formative and summative assessment measurement criteria. Each accredited training institution would have their autonomous prescription governed by sound educational practices to assess students at formative and summative levels and evaluate internally if the training program still achieves its goals and objectives. Aside from this, the PSNM conducts a mandatory specialty-specific program accreditation process. Centers offering training programs in nuclear medicine undergo accreditation every 3 years. The accreditation team reviews the curriculum, visits the centers, and inspects the facilities and procedure logs for compliance with requirements. While the minimum number of required specific procedures has not been defined, the results of the inspection may lead to recommendations regarding perceived inadequacies of the training program.

12.5 Assessing Residents in the Nuclear Medicine Training Program

Trainees undergo parallel series of assessments administered by (1) the home institution and the (2) PSNM throughout the duration of their training in nuclear medicine. Epstein emphasized that “the content, format, and frequency of assessment, as well as the timing and format of feedback, should follow from the specific goals of the medical education program” (Epstein 2007). Ideally, the home institution offers a variety of assessment tools within the formative evaluation process aimed toward specific learning objectives and desired competencies carried out throughout the year of training, followed by summative assessment and evaluation at the end of each year of completion within the program. Program directors normally assess trainees on a daily, weekly, and annual basis, depending on the objective of assessment and availability of resources. This is complemented by the yearly in-service examination by the PSNM that mainly measures attainment of cognitive knowledge in the specialty. The home institution and the PSNM also require completion and presentation of research projects that would imply demonstration of competence in practice-based learning and communication skills. Successful completion of each assessment task merits promotion to the next level as described in the training program following usual evaluation parameters. Perhaps the final objective measurement of attainment of competency in nuclear medicine is passing the certifying examination or board exam given by the PSBNM that would allow the nuclear medicine physician to legally practice all aspects of clinical nuclear medicine in the Philippines. Tables 12.2 and 12.3 shows the assessment tools typically used in the residency training program by the home institute and by the PSNM leading toward eligibility to sit for the exam in specialty.

12.6 Assessment Tools

Several tools are being used by program directors depending on the objective of the assessment and contribute toward the formative and summative assessment process of the student and program evaluation. (Turnbull et al. 1998) emphasized on the utility of an array of assessment methods in evaluating essential competencies defined in the curriculum. The individual purposes, strengths, and weaknesses of these tools are explained in detail in Part 1 and 2. In the Philippine setting, most programs are not purely outcomes-based. The approach in assessment and evaluation is variable, mostly focused toward achievement of generic cognitive knowledge, psychomotor skills, and affective traits; however, careful analysis would infer demonstration of the prescribed medical competencies as prescribed by the ACGME or CanMEDS.

Typically, trainees are assessed throughout every aspect while in the program. The schedule of assessment depends on the purpose and can be done on daily, weekly, and annual basis. The most common tool still used is the written test that measures the attainment mainly of cognitive knowledge, making the program almost exam driven. Global rating scales which provide “appropriate summative measure when assessing candidates on performance-based examinations” (Regehr et al. 1998) and gaining popularity would define competency in several aspects of the profession are also utilized. As most curricula are not exclusively aimed toward a competency-based assessment model, the competencies defined by ACGME and CanMEDS are not currently strictly followed as a rule but serves more as a guide for program directors. Not all assessment tools are performed, as there might be limitation of time, resources, and necessity. Table 12.3 shows a typical schedule used by program directors for assessment of trainees in various phases and levels of the program. The schedule is flexible and not rigid, working more as a guide. Corresponding competencies as implied by ACGME are also shown. Following Malan’s (2000) observation, “Bloom’s work, particularly in the cognitive domain, remains invaluable for outcomes-based assessment.”

Table 12.2 Parallel assessment tools typically administered in the residency training program in nuclear medicine, Philippines. Assessment tools are adapted from ACGME

Timeline	Home institute		PSNM	
	Common assessment tools used	Desired demonstrated competencies (ACGME)	Common assessment tool	Desired demonstrated competencies (ACGME)
Year one Year two Year three	Written exam, MCQ	Medical knowledge; practice-based learning and improvement	Exam MCQ, yearly	Medical knowledge; practice-based learning and improvement
	Oral exam	Medical knowledge; practice-based learning and improvement	Research paper criteria	Professionalism; practice-based learning and improvement; patient care
	Procedure or case logs	Practice-based learning and improvement; patient care		
	Direct observation	All competencies in CanMEDS and ACGME		
	360 Global rating	Professionalism; practice-based learning and improvement; patient care		
	Portfolios	Practice-based learning and improvement		
	Checklist	Patient care; systems-based practice		
	Patient survey	Patient care		
	OSCE	Professionalism; Practice-based learning and improvement; patient care		
Board examination			Exam MCQ, Oral exam, OSCE	Medical knowledge; professionalism; practice-based learning and improvement; patient care

Adapted from Toolbox of Assessment Methods 2000 Accreditation Council for Graduate Medical Education (ACGME) and American Board of Medical Specialist (ABMS) Version 1

Table 12.3 Typical schedule and type of assessment that are used. Corresponding competencies as implied by ACGME are also shown. The frequency assessment would depend on the objectives and available resources

	Assessment tools	Context	Domain assessed or implied	Competency demonstrated/suggested
Daily	Oral exam, short	Daily reading sessions; formative assessment	Cognitive	Medical knowledge; practice-based learning and improvement; professionalism; patient care
	Procedure or case logs, updates	Patients encountered Reflective activity Formative assessment	Cognitive Psychomotor Affective/attitude	Practice-based learning and improvement; patient care
Weekly	Written exam, short quizzes	Weekly exams depending on rotation focus Formative assessment	Cognitive	Medical knowledge; practice-based learning and improvement; system-based practice
	Procedure or case logs, updates	Patients encountered Reflective activity Formative assessment	Cognitive Psychomotor Affective/attitude	Practice-based learning and improvement; patient care
Monthly or quarterly intervals	Written exam Oral exam	Monthly exams depending on rotation focus Formative assessment	Cognitive	Medical knowledge; practice-based learning and improvement; system-based practice; professionalism
	Procedure or case logs, updates	Patients encountered Reflective activity Formative assessment	Cognitive Psychomotor	Practice-based learning and improvement; patient care
	Checklist	Competency assessment and self-assessment of skills achieved	Cognitive Psychomotor Affective/attitude	Medical knowledge; practice-based learning and improvement; patient care; interpersonal and communication skills; professionalism; system-based practice

(continued)

Table 12.3 (continued)

	Assessment tools	Context	Domain assessed or implied	Competency demonstrated/ suggested
Yearly	As a whole or in blocks:	Yearly exam, summative assessment; in-service	Cognitive	Medical knowledge; practice-based learning and improvement; system-based practice; professionalism; basically across all competencies
	Written exam	examination	Psychomotor	
	OSCE/simulations and models		Affective/attitude	
	Standardized patient			
	Oral exam			
	360 Global rating	Performance review;	Mainly affective/ attitude	Medical knowledge; practice-based learning and improvement; patient care; interpersonal and communication skills; professionalism; system-based practice
	Checklist	evaluation by superiors, hospital staff, patients; Summative assessment	Psychomotor	
	Procedure or case logs, updates	Patients encountered	Cognitive	Practice-based learning and improvement; patient care
		Reflective activity	Psychomotor	
		Formative/summative assessment		
	Portfolios	Literature review and reflection; products of learning; written assignments on topics; video-audio recordings documenting what has been learned; formative and summative assessment	Cognitive Psychomotor Affective	Practice-based learning and improvement; professionalism; patient care; system-based practice

Adapted from Toolbox of Assessment Methods 2000 Accreditation Council for Graduate Medical Education (ACGME) and American Board of Medical Specialist (ABMS). Version 1

12.7 Case in Point: Philippine Heart Center

All training programs evaluate residents using a combination of subjective and objective methods. The Philippine Heart Center (PHC) has one of the longest-running programs in the country and is presented here as the prototype. Written examinations are conducted two times a year. The PHC hospital training department administers the written examinations, although the nuclear medicine division contributes the questions on the topic. A short examination on research methods is also included in the semiannual testing. Being a government hospital, the PHC is required to utilize a standard assessment scheme (called the Personnel Evaluation Sheet) that is used for all employees, including nonmedical government institutions and staff. This is a semiannual exercise where targets are stated at the start of the evaluation period, and performance assessed depending on how well the targets were achieved. Both quantity and quality of work are considered. The government scheme, however, was designed as a general purpose assessment tool for the typical employee and is not ideal for evaluating physicians in training.

Global assessment by the consultant staff constitutes the largest proportion of the grade of the trainee. At the Philippine Heart Center nuclear medicine program, the following parameters, with their corresponding weights, are assessed: scan reading (50%), history taking (10%), attitude and work ethic (20%), presentations (10%), and technical knowledge (10%). These parameters are gauged through daily interactions with the resident. Although a formal 360° evaluation is not done, feedback from patients, incident reports, and informal interview of technical staff for their personal assessment of resident are incorporated into the global assessment.

The assessment schemes mentioned above are used for both formative and summative assessment. The summative evaluation at the PHC includes scores from the global subjective assessment and written examinations by nuclear medicine and the research methods conducted by the training office.

12.8 In-Service Examination

In-service examination gives an opportunity for trainees to check their progress in training and for program directors to reflect and evaluate on their own program (Collins 2003). The Philippine Society of Nuclear Medicine began conducting an annual in-service written examination in 2007 to serve as a standard formative evaluation method for the residents and by extension, an assessment scheme for the training programs. The same examination is given to all trainees nationwide. Multiple choice questions are contributed and screened by members of the residency committee, which includes the training officers of all institutions with training programs. Results of the examination are made available to the trainees, training officers, and department heads, as appropriate. The examinees' scores and ranking (including mean scores, distributed by training year level) are given out. Centers, whose training programs show consistently poor outcomes in the in-service examinations, are encouraged to amend their programs. Instances of trainees not finishing a training program due to poor assessment are rare. This is because of a combination of cultural factors as well as a need to expand the specialty. It is expected that the assessment schemes being performed will identify the areas where the trainees need to improve.

12.9 Board Examination in Nuclear Medicine

Gunderman and Tarver (2004) emphasized that "the board examination plays many roles beyond certifying that successful candidates have achieved a passing score" and that "it may serve as a tool to achieve educational objectives that extend beyond the traditional focus" in a training program. The Philippine Specialty Board of Nuclear Medicine (PSBNM) is an ad hoc body tasked with conducting the board examination/certifying examination in nuclear medicine. The members are appointed by the Philippine Society of Nuclear Medicine Board and they administer the certifying examinations for graduates of training programs obtained in the country or abroad.

Satisfactory completion of an accredited training program (or expectation of completion within 3 months following the examination), as certified by training officer and head of nuclear medicine department, is necessary prior to being allowed to take the specialty board examination.

12.10 Conduct of the Examinations

The specialty board examinations have been conducted for almost three decades. During this period, incremental changes in the test format and grading methods have been incorporated in an attempt to improve the reliability of the certifying examination. Current test conduct practices are adapted while keeping a balance to maintain practicality and feasibility, particularly in view of the fairly small number of examinees seeking certification.

From the start, the certifying examinations had written and practical/oral components. Initially, the oral exams were unstructured. The first oral examination in 1982 was a one-on-one session where an examinee was assigned to just one examiner for the entire session. This format was subsequently replaced with a panel of examiners, with each examinee facing the entire panel. Often, passing or failing was decided by consensus among the examiners. It was only at the turn of the millennium when separate stations were implemented. Each examiner was assigned to one station and all examinees had to pass through each station. Until a few years ago, open-ended questions were the norm. A scintigram was usually presented, followed by questions ranging from diagnosis to therapy of the case.

In 2005, elements of the objective structured clinical examination (OSCE) began to be incorporated into the oral portions of the certification tests. Standardized questions were prepared, and the expected responses were made into a checklist to make grading more objective. Examiners each manned a separate station, which all examinees passed through.

In recent years, some examiners included formal report writing as part of the oral examination. Scintigrams of intermediate difficulty were provided and examinees were asked to write a complete nuclear medicine scan report. Examinees were assessed through a checklist of expected findings in the report. Grammar of the written report was likewise graded. This format was carried through to the January 2010 examination.

The contribution of the written and oral portions of the test to total score has been changing over the years. During the first couple of decades, oral exams were not graded but rather rated as pass or fail only. The examinees needed to pass the written and oral examinations. Graded oral examinations were introduced in 2001 and until 2003 had a similar weight with the written portion. By 2003, the written portion was given a weight of 70%, while the proportion of the oral examination was reduced to 30% in order to reduce subjectivity of the test. The subjectivity was further reduced by standardizing the questions and answers in the oral examination, similar to OSCE. The total score determined whether the examinee passed or failed.

Examiners were instructed to create an examination with an expected passing grade of 70% of the answers. The predetermined 70% passing grade was strictly followed since 2005. Previously, the passing grade ranged from 60% to 70%, with the lower limit being determined by consensus of the examiners after the examination was given, in case the number of examinees failing was deemed to be too high.

In recent years, topic group assignments were as follows, distributed equally (three topic groups each) to the three examiners:

1. Nuclear physics, instrumentation and regulations
2. Radioimmunoassay
3. Thyroid and miscellaneous endocrine
4. Musculoskeletal
5. Cardiovascular
6. Genitourinary
7. Pulmonary and CNS
8. Infection, inflammation, and miscellaneous oncology
9. Gastrointestinal and hepatobiliary

Positron emission tomography, radiopharmaceuticals, and radionuclide therapy were incorporated into the topic groups as appropriate. Through the 2010 examinations, 20 multiple choice questions were prepared for each topic group for a total of 180 questions. Three hours were allotted to the written examination portion. During the oral portion of the test, each examiner was assigned to a station. A standardized oral examination was conducted for approximately 30 min per station.

Table 12.4 Structure of the 2011 certifying examination in nuclear medicine in the Philippines. Note that several competencies are measured in different parts of the examination

	Time allotment/ examinee (h)	Assessment tool	Main competencies measured	Portion percentage (%)
Part I	2	Written exam, selected response	Medical knowledge; practice-based learning and improvement; systems-based practice	25
Part II	1	Written exam, constructed response	Medical knowledge; practice-based learning and improvement; system-based practice	25
Part III	1/2	Modified simulations and direct observation	Medical knowledge; professionalism; practice-based learning and improvement; patient care	25
Part IV	1/2	Oral exam, structured	Medical knowledge; practice-based learning and improvement; professionalism; patient care	25
Total	4			100

Starting 2011, the format of the examinations was revised to include the modified simulations and direct observation and an essay portion in addition to the multiple choice (MCQ)/true or false questions and oral practical examination traditionally being given (Table 12.4).

- Part I: Written examination, selected response – assesses the theoretical knowledge of the examinees gained from their readings and exposure to day-to-day activities in the nuclear medicine department
- Part II: Written examination, constructed response – assesses also the knowledge of the examinees and how they apply this knowledge in particular situations most frequently encountered in the department. It also assesses the written communication skills of the examinees. This portion consisted of 15 questions answerable by phrases or sentences in essay format.
- Part III: Modified simulations, direct observation – requires the examiners' presence in some of the stations where there were eight cases answerable by words, phrases, sentences, or illustrations. It requires the examinees to provide direct oral answers to the examiners as the case may be. This part evaluates how the examinees react to clinical, administrative or technical situations, or to other practical issues arising in the workplace. It assesses the examinees' capacity to analyze and handle the clinical case and the probing of the examiners.
- Part IV: Oral examination – This portion consisted of the panel of examiners to pose questions on the examinees on a certain case involving multimodality imaging. Each of the examinees was asked to describe and interpret images (correlative knowledge) and was graded on ability to correctly describe these images, make correct conclusions, and answer questions on fusion imaging, imaging protocols, radiopharmaceuticals, (comprehension, analytical skills), etc.

12.11 Issues and Challenges

Assessment is an integral part of the training program. As Epstein emphasized, "the content, format, and frequency of assessment, as well as the timing and format of feedback, should follow from the specific goals of the medical education program" (Epstein 2007). With the trend of adapting to an outcome-based curriculum, assessment and evaluation should be tailored to fit this purpose, which would be beneficial to the trainees. Like any management of change, there are many challenges that lie ahead.

In the Philippine setting wherein most programs are still exam driven, careful transition should be done to adjust the current curriculum and resources to best practices while not sacrificing student learning. Comparing with the USA wherein the roots of nuclear medicine training in the Philippines were patterned, the Accreditation Council for Graduate Medical Education (ACGME) has mandated six clinical competencies of patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and systems-based practice to be included in residency training programs regardless of specialty. At present, the Philippines does not yet have a body equivalent to the ACGME; and therefore, requirements such as the six clinical competencies listed above do not exist as policy. The most that program directors can do at the moment in the intention of adapting best practices in outcomes- or competency-based curriculum is perhaps to slowly imply in their respective curriculum the competencies achieved in their spectrum of assessment methods, on top of the usual domains of learning-based parameters while maintaining accreditation standards. In due time, with series of proper program evaluation and policy changes, the curriculum can then be reengineered to fit an outcome-based curriculum which reflects best practices adapted to the Philippine context.

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Clinical Training in Medical Physics: IAEA Perspective

13

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13.1 Introduction

Medical physics is a speciality which applies principles of physics to medicine. Medical physicists are scientists that cover a diverse range of sub-specialties including ionising and non ionising radiation and can be found in clinical settings, academic and research institutes and the commercial sector. When functioning in a clinical setting, they are considered as health professionals (International Atomic Energy Agency 2011b; Nüsslin and Smith 2011) and are often referred to as clinical medical physicists (CMP) and as such require clinical training to complement their academic education. A CMP, principally involved in ionising radiation, is an integral member of a multidisciplinary team in one or more specialisations of radiation medicine charged with the responsibility of diagnosing and/or treating patients. The primary responsibility of the CMP within this team is to optimise the use of radiation to ensure the quality and safety of a diagnostic or therapeutic procedure. This is predominantly achieved through the use of physical and technical aspects of appropriate quality assurance programmes and control of dosimetry and measurement calibration. Incorporated into these clinical duties, the CMP plays a leading role in determining the specifications, acceptance testing and commissioning of equipment. In many clinical facilities, the CMP also acts as a radiation protection officer and ensures compliance with the national regulations. The roles of educator and researcher are typical for the CMP in their interactions with clinicians, other medical physicists, dosimetrists, technicians and radiographers, nurses and other hospital staff.

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In view of the rapid developments of medical technology, it is difficult for the CMP to be competent in all specialties of medical physics (diagnostic radiology, nuclear medicine and radiation oncology); therefore, the most common practice for the CMP in advanced environments is to become qualified in only one sub-speciality. However, the education programme should be structured in such a way that would make it possible for a CMP working in one area of medical physics to move to another area with well-defined additional academic education and clinical training. This is an important consideration, particularly for CMP working in Member States of the Atomic Energy Agency (IAEA) where shortages demand that CMPs have command of multiple specialisations.

CMPs working in any specialisation or branch of medical physics are expected to have a core competency in physics at the undergraduate level and medical physics, acquired through a postgraduate education programme. A recommended syllabus for the teaching in the speciality of radiation oncology has been provided by the IAEA (International Atomic Energy Agency 2005) with companion publications in the other two specialisations soon to be available. In addition, a clinical competence, acquired through a structured clinical training programme or residency within a clinical department, is also required. However, few hospital departments offer a structured clinical training programme, especially in low- and middle-income countries. The shortage of qualified CMPs, coupled with the lack of structured clinical training in many countries, has led some hospitals to recruit medical physics graduates with inadequate or no clinical training. It is important, however, to highlight that a transition from a university education to clinical practice cannot be achieved in a safe and timely manner without undergoing a structured clinical training programme. The IAEA has emphasised the inadequacy of this approach and has published guidance documents (International Atomic Energy Agency 2009, 2010a, 2011a) highlighting this.

13.2 Establishing a Structured Clinical Training Programme

In order for a country, region or subregion to introduce a harmonised medical physics clinical training programme, a key decision needs to be made, based on the most pressing needs for and the long-term sustainability of producing CMPs. The World Health Organisation promotes access to quality, equitable, relevant and effective health care (Boelen and Heck 1995), and educational institutions similarly should adapt their strategies, standards and norms to reflect this social accountability (Boelen and Woollard 2009). Therefore, institutions offering training in CMP should ‘direct their education, research and service activities towards addressing the priority health concerns of the community, region or nation that they have a mandate to serve’.

CMPs can have a single specialty (as mentioned above for advanced settings) or be broadly educated generalists with the ability to be competent in a number of specialities of medical physics. Countries in which radiation medicine resources are geographically far apart and skilled human capacity is scarce will benefit from programmes that produce broadly educated medical physicists who are therefore able to support all existing clinical radiation medicine specialties in their environment. Other permutations of specialty training are also possible and are subject to the expertise, faculty, infrastructure and clinical services available to support the programme, for instance, the coupling of radiation oncology and diagnostic radiology medical physics.

An appropriate national responsible authority (NRA) should be constituted that will endorse the recognition of the qualified CMP who has the required educational background and successfully undergoes an accredited clinical training programme and then license them to practise independently as a professional in the hospital environment. A register of such professionals should be preserved by this authority. This authority should be autonomous and be responsible for defining the core syllabus of all the professionals it licenses. Such authorities might also license other health professionals, like clinicians and nurses, and their overarching primary mission is to protect patients.

CMP training programmes should formally accept residents (or interns) who have completed a recognised postgraduate academic education qualification in medical physics (International Atomic Energy 2010b). The minimum duration of clinical training should be defined in accordance with the content of the programme. In the IAEA programmes mentioned above, a minimum of 2 years is required for clinical training in the first speciality. Further clinical training in any other specialty requires a lesser time of at least another year for each additional specialty because there are skills which are similar to all fields. On the other hand in South Africa, for instance, where the programmes are expected to produce clinical medical physicists who are competent to practise in all fields of radiation medicine, a minimum period of internship of 2 years is the current requirement, and there is no provision for a specialist register in any one discipline (Health Professions Council of South Africa 2009, 2011).

Institutions who intend to coordinate CMP training programmes should be subject to formal minimum criteria to ensure quality. These criteria should include but may not be limited to the provision of suitable internal infrastructure to capacitate the learning environment, e.g. computer facilities, classrooms and library access, and have sufficient numbers of experienced, qualified and fulltime-equivalent CMPs to supervise the prospective learners. The existences of national and/or regional professional societies, which provide and promote lifelong learning opportunities and continuing education for CMPs, are an advantage. Ongoing reaccreditation, licensing or credentialing of individual professionals to practise is also often linked to compulsory, structured continuing education, which is regulated by the authorised professional body or a health authority. In addition, clinical practices, which are subject to rigorous routine peer review and which operate under comprehensive quality management systems, are generally better suited to manage clinical training programmes as is seen in the various branches of medicine and nursing, etc.

Clearly departments that accommodate clinical training should provide residents with access to adequate medical and scientific equipment resources in order to ensure that all core skills and competencies are achieved according to the roles and responsibilities of a CMP (International Atomic Energy Agency 2010b). For diagnostic radiology medical physics residencies, at least access to general and fluoroscopy X-ray units, CT, mammography and dental units and dosimetry equipment is necessary (International Atomic Energy Agency 2010a). For nuclear medicine medical physics residencies, a gamma camera (SPECT or SPECT/CT), dose calibrator, probes, gamma counter, phantoms, calibration sources, survey meter, contamination meter and nuclear medicine therapy services must be available (International Atomic Energy Agency 2011a). Likewise, for radiation oncology medical physics residencies, at least a teletherapy unit, a treatment planning system, a simulator (conventional or CT), dosimetry equipment including a water phantom, brachytherapy and medical imaging services must be available (International Atomic Energy Agency 2009). Clinical training sites who have a subset of these services should consider additional clinical training rotations in conjunction with sites that can complement the exposure of the residents to all facets of core competencies required. Additional equipment resources like MRI, PET/CT and particle therapy are not essential but desirable. Access to these modalities in low- and middle-income countries is often limited.

Some aspects of clinical training are common to all specialities, e.g. applications of radiation detectors, principles of radiation dosimetry, radiation biology, safe radiation practice and radiation protection frameworks (including local legislation) in radiation medicine. A working knowledge of basic anatomy and physiology and professional ethics is necessary. Skills in management, presentation, communication, research methodology and informatics are further examples of aspects of clinical training common to all specialities. The ability to provide a good basic knowledge, skill and competency in all these aspects is therefore an essential and fundamental requirement to all training programmes in all regions.

In order to accredit residency programmes, appropriate methods of assessment need to be in place to certify that the knowledge, skills and competency of the resident are indeed attained. This is preferably supported throughout the programme in the form of written assignments, presentations, projects, etc., which are all documented in a logbook, for instance. External review of residents towards the end of their training programmes is recommended.

13.3 Implementation of a Structured Clinical Training Programme

In 2003, member states in the Asia Pacific region of the IAEA within a Regional Cooperative Agreement (RCA) decided to address the problems of medical physics training in their region through the development of clinical training material under a regional project (RAS6038). This material was first developed for the specialty of radiation oncology and was informed by the work done in Australia and New Zealand which has recently been reviewed in comparison to clinical training models used in Canada (McCurdy et al. 2009). As mentioned above, this work was also extended to include the additional specialties of diagnostic radiology and nuclear medicine. In 2007, the first pilot of this material in radiation oncology was undertaken in Thailand which has subsequently begun similar pilots in each of the other two specialities. Other countries in the region, including the Philippines, Bangladesh and Malaysia, have also initiated pilot programmes to test particular speciality clinical training programmes through RAS 6038. Below, some of the processes, experiences and achievements of the piloting processes in Thailand will be highlighted.

13.3.1 Structural Matters

Initially, a senior academic medical physicist, appointed by the IAEA as the external coordinator to oversee all the piloting processes, developed a number of administrative instruments to order the processes in the clinical training pilots. The first of these, in the development of a national clinical training programme, is the application to join the pilot process. Other instruments include reporting mechanisms from the residents to the national coordinator and also for the national coordinator to the external coordinator. The application to join the pilot programme requires the identification of the NRA, its contact person and the national coordinator of the clinical training process. Each department where the residents of the programme will be trained is also required to be specified along with a profile of both the staff and equipment available within that department. In the case of Thailand, the NRA is shared between the Office for Atoms for Peace and University bodies. This authority is advised by a steering committee that is made up of members of the Thai Medical Physicist Society and the Radiation Oncology Society of Thailand who are charged with overseeing the conduct of the training programme. A separate national assessment committee has also been formed.

An important decision that needs to be made by the NRA on advice from the steering committee is the extent and depth of the training programme. When building a specific national programme, this is usually inherently written into the programme's documents. In the case of generic guidance for clinical training, such as the IAEA material, that may be implemented in differing national environments, it was believed that the final decision on the relevance of training material be made by the country concerned. For example, in the case of training for the nuclear medicine speciality, if the country did not possess a PET/CT scanner, it might not be helpful to expect full competence in all aspects of the physics needed for this modality. In this case, the NRA could simply reduce the extent of the programme and remove the need for the study of this module from the programme. Alternatively, the NRA could still include the module, however limit the depth of learning by requiring only an understanding of the technology and not a demonstrated ability in associated skills (as discussed further below under assessment).

The national clinical coordinator stands between the national authority and steering committee and the hospital departments taking part in the training and ultimately each enrolled resident in the programme (see Fig. 13.1). Each resident is

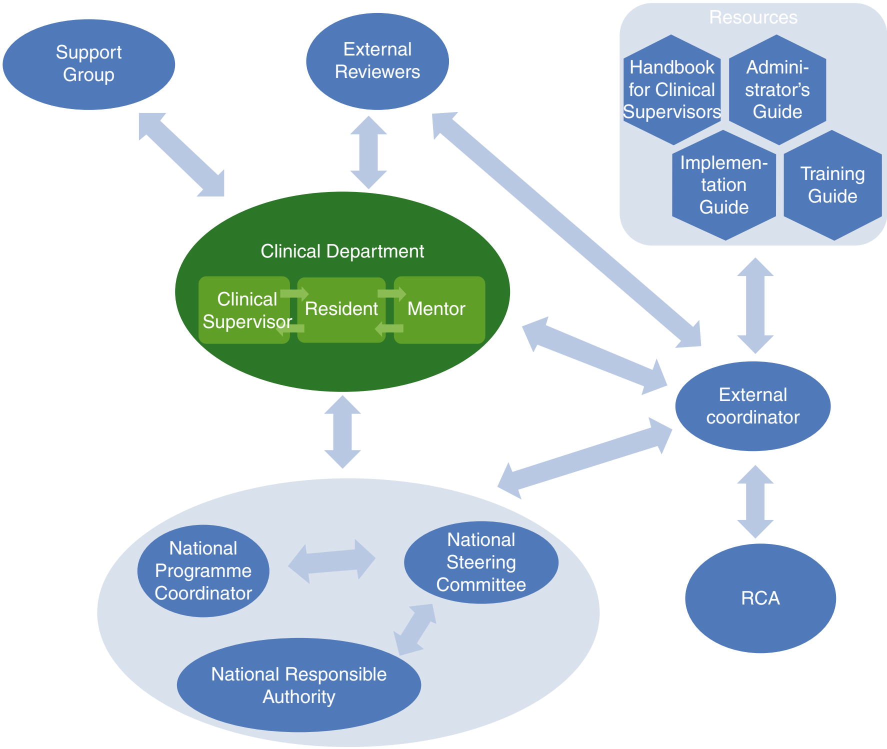

Fig. 13.1 Schematic showing the management structure and lines of communication within the RCA pilot clinical training programme. Some lines of communication (e.g. department-resident) have been omitted for simplicity

required to individually enrol in the programme which ensures compliance with the programme enrolment requirements and the support of the host medical physics or radiation oncology department. A senior medical physicist to act as a clinical supervisor needs to be identified. Depending on the number of residents in a department, there may be a central person who speaks for the department in discussions with the national coordinator; however, it needs to be recognised that the supervision of specific competencies may require a number of different professionals to ensure optimal learning.

These essential steps of the formation of the training process are overseen by the external pilot coordinator who is in the position to give advice and prevent inappropriate structures being formed. This is reinforced at the time of the programme's launch when a seminar is held for all those involved including supervisors, residents and also committee members. This launch programme may take from 3 to 5 days and includes activities to strengthen the supervisors for their role and to orientate the residents and to encourage them in determining their clinical training programmes. A detailed summary of this material training is contained in the clinical training guides for future reference for both supervisor and resident.

13.3.2 Supervision and Modular-Based Competency Instruction

In this crucial stage, it is important that those involved understand the modular nature of the competencies that are to be achieved, the assessment processes and the modes of learning to be employed. The IAEA guides have been designed to allow independent progress through modules and sub-modules that make up the content of the programme. A proposed schedule of work needs to be documented in a learning contract between the resident and the supervisor and should take into account the access to equipment and relevant expertise. This inherent flexibility, as utilised in the Australian and New Zealand programme, for example, is designed to allow the resident to personalise his/her training schedule with the work environment in mind. In the model adopted in Thailand, however, it was decided that the training would be communal in structure with a requirement that all residents in the programme work on the same competencies concurrently. In this case, the loss of flexibility has been traded for the strength that is derived from communal learning where mechanisms such as regular focussed tutorials can be employed to good effect. The Thai residents in fact meet at least fortnightly to review the material and competencies they are learning, through resident presentations that are critically discussed by supervisors and residents alike. This learning process is supplemented through regular intervention by the IAEA with the visit of experienced medical physicist experts who assist with the dual roles of teaching and demonstrating new knowledge and processes as well as observing the progress of the programme and offering advice. Importantly, the expert can assist in the assessment of residents.

13.3.3 Assessment

Perhaps the most important and distinctive part of these clinical training programmes is the assessment processes that are utilised. While traditional assessment forms, such as written exams and submitted assignments, (both formative and summative) are used in the Thailand experience, the foundational assessment tool for the resident is an assessment by the supervisor of each of the specified competencies in the programme (66 in total for the radiation oncology guide). Initially, each competency assessment was graded on a 5 points scale with 1 (the highest) indicating the resident could independently perform the competency without supervision at an acceptable standard. A resident just beginning on a competence might be assessed at the lowest level (5) as only demonstrating limited understanding of concepts and principles. An awarded competency level is simply viewed as a recorded step in a ladder of development that is completed when the highest required level (as set by the NRA) is reached. In the case of the training in Thailand, all competencies were expected at the highest level. This assessment methodology was amended in the later training guides for diagnostic radiology and nuclear medicine. In this case, competencies were typically split into knowledge-based learning (with two levels of

Sub-module 7.5: QC of PET/CT systems

Knowlege Base	**Level of Competency Achived**	
	2	1
Familiarity with routine PET/CT QC procedures.	Processes a **basic** understanding of relevent QC procedures for PET/CT systems.	Processes a **good** understanding of relevent QC procedures for PET/CT systems.
Date Achieved		
Supervisor's Initials		

Practical Skills	**Level of Competency Achived**		
	3	2	1
The ability to perform routine QC procedures on a PET/CT system and to initiate appropriate corrective action when QC results reveal problems with the PET/CT system performance.	Is capable of **assisting** with the QC program for PET/CT systems.	Is capable of **performing** most of the QC program for PET/CT systems. **Requires limited supervision.**	Is capable of **independently performing** the QC program for PET/CT systems to an **acceptable clinical standard.**
Date Achived			
Supervisor's Initials			

Date	**Supervisor's Comments**

Fig. 13.2 An example of the assessment matrix developed for the clinical training guide for medical physicists specialising in nuclear medicine (International Atomic Energy Agency 2011a)

attainment at either a basic or good level) and practical skills (with three levels of attainment ranging from limited ability to being able to independently perform the competency at an acceptable standard without supervision) (see Fig. 13.2).

13.3.4 Completion of the Training Programme

While it is not mandated in the IAEA clinical training programme, it is hoped that such training would lead to a recognition by the medical physics profession, national authorities, employers and other stake holders. Such local accreditation or certification processes may well be integrated into the final phase of a clinical training programme. This was the case in Thailand which determined that, in order to successfully conclude the programme, the resident would need to pass a practical clinical examination. In order to prepare both residents and potential national examiners, experts sent by the IAEA performed trial examinations well before the completion of the programme. The use of external examiners, apart from training local examiners, also allows benchmarking of the training programme. Under such a system, the possibility of a resident not passing at the first attempt is real, and the first cohort in Thailand of ten, only five passed at the first attempt, however, on subsequent examination, approximately 6 months later, four of the remaining five completed the programme.

In the case of Thailand, certificates were issued by the Thai Medical Physicist Society for successfully completing the programme including passing the examination. The value of such an award, however, is determined by its recognition. Steps were next taken to have this award recognised by university bodies at a level commensurate with medical specialities (e.g. radiology). This has been achieved for medical physicists specialising in radiation oncology and diagnostic radiology and is pending currently for nuclear medicine where the completed clinical training is supplemented by further written university exams. The next step is then to have this recognition extended to the workplace once the value of a professionally trained workforce is recognised.

Conclusion

Through the example of clinical training in Thailand, as the first of a number of sites, it has been demonstrated that the IAEA seeks to address the lack of adequate clinical training of medical physicists through structured clinically based training programmes (International Atomic Energy Agency 2009, 2010a, 2011a). This complements the work of the IAEA in academic institutions that are being supported by the review and strengthening of ongoing national postgraduate programmes in medical physics and through assisting in the establishment of new programmes. This support takes the form of syllabus material development and the training of academic staff. Reference material, published by the IAEA and freely downloadable, such as the Radiation Oncology Handbook (International Atomic Energy Agency 2005), is not only widely used as a core text for postgraduate students but also is the basic reference for clinical training content. The IAEA also supports numerous short training courses to develop key areas of professional knowledge and skills to strengthen national capacity in medical physics. The use of structured clinical training is a clear method of sustaining the distribution of this work.

The final steps of professional accreditation and certification have received attention with efforts by the IAEA to highlight its importance through national, regional and interregional technical cooperation programmes. As seen in Thailand, the road to agreement and recognition for clinical training is lengthy and requires a long-term strategy and patience. However, the use of a harmonised common standard for clinical training is a big step along this path. The use of a formal accreditation of clinical training institutes, as practised in a number of countries, is probably a future development for Thailand. However, the nature of the organisation and formal structure of the IAEA clinical training programme leaves less discretion in the hands of the clinical centre, allowing a less intense evaluation of training sites to be appropriate.

While the processes of postgraduate academic education followed by structured clinical training appear to give the required quality of medical physicists needed in both developed and developing country scenarios, it is questionable if the required quantity of medical physicists is being addressed adequately. The solution of this problem may lie with national authorities to expend needed resources for education and training. However, unless these authorities are aware of role of medical physicists, and unless there is a combined approach to radiation medicine from both medical doctors and medical physicists, the rate of progress in the provision of appropriately qualified and trained medical physicists will remain slow.

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14 Assessing Diagnostic Radiology Training: The Singapore Journey

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14.1 Introduction

Diagnostic radiology is one of the fastest growing medical specialties in Singapore, mirroring the explosion of medical imaging in the recent decades. To respond to this growth, institutions have been increasing training capacity. The rapid expansion immediately creates challenges in maintaining standards in training. To understand

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the challenges we face in assessment, it is useful to first understand some history of diagnostic radiology training in Singapore.

14.1.1 A Brief History of Diagnostic Radiology Training in Singapore

Radiological services were available in Singapore way back in 1898, barely 3 years following Wilhelm C. Roentgen's discovery of x-rays. Dr. FY Khoo was the first local doctor to be trained in radiology. He was sent by the colonial government on scholarship to Britain for radiology training and returned to Singapore with the DMRD (Diploma in Medical Radiology) in 1949. Local doctors were sent to Britain for radiology training (Khoo 1981) until the 1980s, when training was then conducted locally but candidates would go to the United Kingdom to take the FRCR (Fellow of the Royal College of Radiologists) examination.

Formal postgraduate medical education in Singapore became organized with the founding of the Academy of Medicine of Singapore (AM) in 1957 and the establishment of the Committee of Postgraduate Medical Studies in 1961. The committee was the predecessor of the School of Postgraduate Medical Studies which is now the Division of Graduate Medical Studies (DGMS) at the National University of Singapore (NUS) (Chew and Chee 2005).

The Master of Medicine (MMed) examinations, which correspond closely to the membership and fellowship examinations of the United Kingdom and Australasian Royal Colleges, were introduced in 1971 and administered by the School of Postgraduate Medical Studies (and subsequently by DGMS at NUS). The MMed Diagnostic Radiology examination was initiated in 1998 and is held annually. The FRCR will also be held at the same time as the MMed Diagnostic Radiology in Singapore from 2011.

In 1991, the Joint Committee on Specialist Training (JCST) was formed to coordinate the training requirements and assessment for specialists. Following revision of the Medical Registration Act in 1997, the Specialists Accreditation Board (SAB) was established under the revised legislation and became the statutory body responsible to the Ministry of Health for the overall performance of the specialist training system. The JCST came under the fold of SAB to oversee the accreditation of training departments and institutions in Singapore as well as the specialist training which is administered by the 35 different Specialist Training Committees. When the SAB was formed and its Specialist Register was started, the Specialist Roll in effect became the Specialist Register (Specialists Accreditation Board, Ministry of Health Singapore 2011).

14.1.2 A Brief Overview of Diagnostic Radiology Training in Singapore

Since the establishment of the SAB, diagnostic radiology training has comprised a single national training program administered by the Diagnostic Radiology

Specialist Training Committee (DRSTC). The 5-year program is divided into 3 years of Basic Specialist Training (BST) and 2 years of Advanced Specialist Training (AST). Candidates needed to complete 1 year of housemanship (equivalent to internship in many other countries) and at least another year of clinical postings as a Medical Officer before they were eligible to apply for Diagnostic Radiology Traineeship. The DRSTC is responsible for selection of trainees subject to approval by JCST.

The BST trainees are rotated to JCST accredited radiological departments in the various public hospitals and national specialist centers every 6 months. The hosting departments are responsible for the teaching, supervision, and evaluation of the BST trainees.

In addition, the DRSTC together with the College of Radiologists, Singapore, organizes national didactic teaching programs for year 1, year 2, and year 3 trainees. All trainees in the country are released one afternoon a week to attend their respective didactic program. The BST trainees are expected to clear the FRCR or the MMed Diagnostic Radiology examination by the time they complete their sixth and final BST rotation. These two examinations are considered intermediate, and not exit examinations.

Once the trainees complete 3 years of BST and successfully clear the intermediate examination, they apply to DRSTC to commence AST, which comprises three monthly subspecialty rotations to accredited radiology departments over 2 years. The subspecialties include neuroradiology, head and neck imaging, body imaging, women's imaging, pediatric radiology, breast imaging, musculoskeletal radiology, ultrasound imaging, nuclear medicine, and vascular and interventional radiology. The hosting departments must ensure that the AST trainee gets at least four subspecialty sessions out of ten sessions per week during the 3-month rotation and are responsible for the teaching, supervision, and evaluation of the AST trainees.

Among the mandatory requirements of AST are attendance of a medical ethics, professionalism and health law course and a first authorship scientific publication. When the trainees successfully complete 2 years of AST rotations and fulfill the requirements of AST, they appear at an exit interview where their logbook is reviewed and all the exit requirements assessed. They will then be eligible for specialist registration with the SAB and exit as a specialist in diagnostic radiology.

Over the past 5 years, in order to address the shortage of diagnostic radiologists in Singapore, the annual intake of trainees has also increased significantly. This meant that training departments had to manage an increased teaching load while coping with a fast expanding clinical workload.

Further changes in diagnostic radiology training are taking place with the introduction of the American residency system for postgraduate medical training in Singapore (TODAY 2009; Tan 2009). This new residency system will tie trainees (now referred to as residents) to a specific department in one institution or program, and training will be more structured. As the first batch of diagnostic radiology residents only commence in 2011, this chapter will not describe the new assessment tools that will be introduced with this change.

14.2 Current Tools for Assessment of Trainees

The assessment of diagnostic radiology trainees has evolved through the years with formative assessments now playing a greater role than in the past. The role of summative assessment is also evolving.

Initial radiology training in Singapore was in the form of apprenticeship, and assessment was that of a general impression formed of the trainee. He/she was then signed up by the head of department (Tan LKA, 2011, Training and assessment of radiology trainees from the 1960s to 1980s, personal communication). The FRCR examination was used as a tool for summative assessment. There was no formative assessment or formal documentation. However, it has to be noted that in diagnostic radiology, trainees often worked very closely with faculty, and much of the work of the trainee was constantly being assessed on a daily basis. With only a small number of trainees in the system, this "general impression" was usually quite an accurate assessment.

After formalization of postgraduate training in Singapore and with the establishment of the DRSTC, progressive assessment of trainees was in the form of six monthly progress reports by department heads of training with no formal formative assessment (Wang 2009). The FRCR examination was used as an intermediate summative assessment tool, as well as a barrier to AST entry. The final formal summative assessment at the end of the training period is based on an interview, review of progress reports, case logbook, courses/conferences attended, examinations passed, and any abstracts presented or papers published (Wang 2009).

In the mid-2000s, the progressive, formative, and summative assessment of postgraduate radiology trainees was modified. A bidimensional five-point rating scale incorporating knowledge and competence domains and a checklist for radiological knowledge and competence was introduced. Three monthly meetings with consultant supervisors/mentors, regular logbook entries for each posting, and three monthly mini-clinical examinations (Mini-CEX), and direct observation of procedural skills (DOPS) evaluation were also added to improve the quality of formative and progressive assessment (Wang 2009). The summative assessment at the intermediate training level through the FRCR examination was retained. The final formative and summative assessment at the end of the training period was still based on an interview and review of relevant documents.

In the three and six monthly progress reports, each department has been given leeway as to how the assessment is performed. In many large departments, a meeting is held among the teaching faculty, where the performances of the trainees are discussed and a ranking exercise is performed. While this process addresses individual faculty bias, there is still subjectivity and variability in terms of which qualities of the trainees are being assessed on and the weighting of each quality. The midposting and posting assessment is then discussed by the supervisor with the trainee on an individual basis.

The Mini-CEX involves the trainee being observed in an encounter with a patient and rated by an assessor (clinical supervisor) on a number of dimensions. This is a work-based, in-training assessment which involves assessing the trainee on an activity that is performed in current training. Immediate feedback is given to the trainee

(Royal Australian and New Zealand College of Radiologists 2010a). The DOPS evaluation focuses on the core skills that trainees require when undertaking a clinical practical procedure. It is focused observation of a trainee undertaking a practical procedure (Royal Australian and New Zealand College of Radiologists 2010b).

In early 2011, the in-training examination of the American College of Radiology (ACR) was introduced as another tool for formative assessment (American College of Radiology 2011). This examination is run by the ACR for the American residents and is a series of multiple choice questions covering not only medical knowledge but also other core competencies that are felt to be important in diagnostic radiology training.

The results of this examination are released to each individual trainee with information on which answers were wrong, so as to allow the trainee to identify his/her areas of strengths and weaknesses. An analysis of how the candidates from Singapore performed as a batch, broken down by year of training, was also released to all the training departments. It is hoped that this will serve also as a feedback process for the DRSTC and the training departments to improve our training system.

14.3 Assessment of Training Departments

This section describes the process of accreditation of training departments and subsequent reaccreditation. The feedback mechanism for training departments is also discussed.

14.3.1 Accreditation and Reaccreditation of Training Departments

With the formation of the JCST, a formal process of accreditation of training departments was established. All training departments have to undergo accreditation before they are allowed to take on trainees. An accreditation application form must first be submitted. Among the detailed information required are the list of faculty within the department, the type and number of imaging equipment available, and detailed data of the workload of the preceding year. The teaching program of the department has to be detailed, together with a list of clinical-radiological conferences that are run by the department. Samples of the department's roster are also submitted.

A site visit to the department is then organized, and a three-member team comprising two DRSTC members and a representative of the JCST conducts the visit. During the visit, the head of department and the head of training are interviewed. Faculty and junior medical staff are also randomly chosen to be interviewed with regard to the teaching activities and facilities. The site visit team then verifies the information submitted during a walkabout of the department.

Based on the information provided and verified during the site visit, a recommendation on the number of BST and AST trainees that the department can take on is then made. Should there be gaps identified during the visit, the department is asked to address these gaps within a stipulated period. A formal site visit report is issued on completion of this exercise.

All training departments have to undergo a reaccreditation exercise every 5 years. Reaccreditation is felt to be important as there are dynamic changes to personnel, resources, and workload over time. While the whole process can be very time consuming, the accreditation and reaccreditation process ensures that training departments continue to place emphasis on improving their training programs.

14.3.2 Feedback on Training

There are currently several avenues for trainees to provide feedback on training. The supervisors on the ground act as the first level of feedback during their regular meetings with the trainees. In the three and six monthly progress reports submitted to the DRSTC, the trainees are also required to feedback on the training department that they have been posted to. However, for reasons discussed below, there are very few negative comments put in writing.

The Ministry of Health also requires each trainee to electronically log in an assessment of the training department at the end of each posting. As this feedback is more confidential, one can presume that this avenue of feedback is more accurate. A consistent negative feedback on a particular department can have impact on the funding disbursed by the Ministry to the parent institution. In addition, the DRSTC also organizes larger group feedback sessions. These sessions are attended by members of the DRSTC and the trainees, with the department heads of training excluded.

14.4 Cultural Differences and Challenges in Performing Assessment

Change is often painful and difficult. The majority of our current educators in diagnostic radiology went through an educational system where learning was largely by rote, high stake examinations were all in the written format, with marginal emphasis on the spoken word. It was a system that emphasized the individual with almost no emphasis on soft skills like effective communication and working in teams. Again it was a teacher-centered culture, where the dominant form of instruction was through lecture. At the same time, as our health-care system has evolved from our colonial past, departments are still organized in a hierarchical structure with trainees at the bottom of this hierarchy.

Education has seen drastic changes over the last decade, and many of these changes stem from studies and observations from the West. Learning through play, group discussions, project groups, self-learning through the internet, and observations from field trips are increasingly the norm. This "Westernized" education is what the majority of our trainees have grown accustomed to. At the same time, the current trainees in diagnostic radiology are now a much more diversified group. Due to shortages in specialists in the short and medium term in this country, there are a significant number of trainees that are graduates of medical schools overseas.

Educators in diagnostic radiology familiar with written assessments have been introduced to various new assessment tools such as the Mini-CEX and the DOP evaluation. Unlike written assessment, these often entail one-to-one contact with the learners. Cultural differences encountered by evaluators in Singapore are not only with race, ethnicity, and hierarchy but also include generational differences.

14.4.1 Age

Respect for elders is ingrained in Asian culture. While not unique to Asian culture, it is certainly more prevalent in our society. The extent of this is of course variable, but in educational circles, this invariably leads to presumptions that the older one gets, the more experienced and knowledgeable one becomes. Elders therefore are seldom questioned. There is a presumption that as the elder has learned through experience and the test of time, the way they perform procedures, for example, must unquestionably be the best and therefore must be followed. This will invariably lead to problems when trainees learn a certain technique or skill from one "elder" and then get evaluated by another. The problem can get further compounded when the trainee rotates through a different department and gets chastised for doing things differently. For the trainee to survive these evaluations, does he or she have to learn all the different ways of performing the same skill or technique and reproduce it depending on who the evaluator is? This in itself may not be a bad thing, for in future that trainee will in due course become an elder in his or her own right, having experienced various ways of performing the same procedures.

What needs to be done by the evaluators has been well described. There needs to be development of standards that can be used as references for these evaluations. To standardize, all evaluators have to agree to peg their evaluations to these standards. This, however, is easier said than done. There is a second aspect of Asian culture that often makes this step more complicated than necessary, and that is the concept of "saving face."

14.4.2 "Saving Face"

The idiomatic meaning of "face" according to the Longman Dictionary of Contemporary English represents respect. "Losing face" occurs when one has to back down from one's opinions, hence losing one's dignity or prestige. "Saving face" occurs when others let one keep his or her opinions, hence enhancing one's dignity or prestige. This concept, together with that of age and experience, illustrates the difficulties that may arise when evaluators of different ages come together to decide on standards and evaluation tools. The adage "seniority has its advantages" rings ever true. Again the presumption is that through experience and the test of time, the elder's opinions and standards are unquestionably the best. Behind closed doors, it is customary to hear comments like, "It's worked for me, why do we need to change things?". Although various opinions may be voiced or raised by younger faculty, these are often stated just for the record. Ultimately, the older or more senior faculty has the final say on what these standards and tools to be employed should be used. This is not to say that "elders" are not the most experienced and knowledgeable, they often are. But in these times, the reverse may often be true that "elders" may, in various aspects and scenarios, be the least experienced.

These points raised have to be constantly borne in mind when sitting in teams and in faculty meetings. "Elders" have to be prepared to "lose face" in situations where they realize that some of the younger faculty may be more knowledgeable or even more experienced than themselves. At the same time, we have to constantly bear in mind when giving advice that others may be "giving us face" by taking our advice.

These cultural and generational differences also play an important part when garnering feedback from trainees. There is a general reluctance by trainees to feedback on negative training experiences. This is also compounded by the fact that the radiological community in Singapore is small.

14.4.3 Managing These Challenges

In Kien Lee's report "The Importance of Culture in Evaluation: A Practical Guide for Evaluators," she suggests that evaluators must be equipped with the knowledge and skills to work with people from differing cultures (Lee 2007). Evaluators can do so by having an open mind, by not making assumptions, and by asking the right questions respectfully. One can never assume that the most senior is usually right or has the best ideas. Barriers as always need to be broken down, and everyone needs to be conscious that the way others think and behave can be influenced by the culture they originate from. Evaluators need to deliberately set aside time, resources, and budget to learn about new evaluation tools and the proper way to use them. As a member of the "older" generation, this author has found that although it was painful and difficult to learn and practice new evaluation methods, actually applying them on younger trainees was relatively easy as these are already part of "their" culture.

At the same time, more emphasis should also be paid to assessment of training programs by the trainees. These assessments have to be better structured, and a level of confidentiality has to be observed to allow for constructive and honest feedback. With the backgrounds of the trainees in diagnostic radiology now more diverse, it has been encouraging that more vocal feedback has been observed, suggesting that some of our cultural barriers may be breaking down.

14.5 A Trainee's Perspective

Diagnostic radiology education in Singapore is at a crossroad. We are in the midst of a transition that sees us change our current system of BST and AST into a residency program that mirrors that of the United States. Similarly, the role of formative and summative assessment, as before, will continue to evolve to suit the new fast-paced environment that we now work in. As trainees, we love assessment but we dislike grading, there being a distinct difference between the two. By having assessments, we are able to gauge our mastery in our chosen field, allow insight into our weaknesses, and spur us to improve. In contrast, grading invariably involves comparing our competences among our peers, and this breeds competition, envy, and other vices. Such assessment will continue to play an important role in our education system, albeit far from ideal.

Formative assessment is vital and, in our view, plays a more important role than summative assessments. It uses formal and informal tools throughout the learning period to determine the educational outcomes of the learning process, thus allowing for adaptive pedagogy and personalization. Under the current training program, we have compulsory three monthly formal assessments with our supervisors which include an array of interviews, logbook entries, as well as mini-assessments targeted at assessing clinical and procedural competences. Some departments take a step further, by introducing more frequent monthly training and supervisor meetings. This allows the trainee to provide frequent feedback to the supervisor about issues pertaining to the training obtained during the review period. This will allow more responsive adaptation of the learning program to suit different grades of trainees with different levels of abilities. As we are entrenched in an Asian environment that still values a hierarchical approach, many trainees find a one-to-one supervisor-trainee interaction more useful in conveying their grouses in a less intimidating manner. Similarly, the trainee obtains feedback in a private and constructive manner.

There are several problems noticed during my training. Many supervisors are often at a loss, not knowing what their role entails, what the assessments involve, and how to maximize the supervisor-trainee relationship. Our observations seem to suggest that these supervisors are not provided with the necessary training on the processes involved, and this is further compounded by the lack of protected time for them to engage in such interactions. Further, there seems to be a strain on the current system with one supervisor having to oversee the training and welfare of several trainees. This is, of course, not ideal. Perhaps, informal daily interactions between faculty radiologists and trainees yield more valuable feedback.

Many trainees often complain about the necessity of completing increasingly onerous documentation, much of which is repetitive and requires unattainable data. For example, the department-based records overlap considerably with what the DRSTC documentation seeks. To illustrate further, some log sheets require the differentiation between trauma and nontrauma film reporting, data which cannot be easily obtained nor does one see the benefits of such delineation. There is an urgent need to streamline these documentations, making the process more efficient and beneficial.

Summative assessment, currently, is divided into an intermediate examination and an exit interview. It is, perhaps, interesting to muse that all the components shy of the final FRCR examination contain not a single image. This is contrary to what our specialty is known for: image interpretation. Be that as it may, many local teachers in diagnostic radiology are familiar with this examination, an enduring component of our training curriculum past and present. Now that the FRCR examination is conducted annually in Singapore with half of the examiners being local teachers, many trainees feel that this will be more reflective of the style and cases that one encounters in daily practice. At the end of the 5-year training period, trainees undergo an exit interview that aims to review the satisfactory progress of a trainee, determine future directions, and assess competence as a diagnostic radiologist.

What forms the best assessment tool for diagnostic radiology training? There is, perhaps, no single tool that can encompass all the requirements of assessment of the broad range of skills and competencies required of the practicing radiologist. We should strive to ensure that assessment tools will be relevant, taking into account our limited resources, Asian work ethic, and local nuances. A good training program is only as good as its teachers. As we progress, we must further engage the trainees to allow them to take up a more active role in shaping their own education.

Conclusion

In summary, the diagnostic radiology training system in Singapore has evolved from our colonial past and still mirrors that of the British system. The assessment process has been shaped by the hierarchical structure of our organizations and by our cultural background. Over the years, the training system has been incrementally improved and become more structured, and with these changes, the assessment processes have been adjusted and additional tools have been introduced. We clearly do not have a perfect system for assessment and face daily challenges as described above. Despite our deficiencies, our training system continues to produce diagnostic radiologists of a high standard, many of whom have worked in renowned institutions around the world.

There is, however, a continued need to address the gaps (cultural or otherwise) we currently have in our system, and resources will have to be invested in educating our teaching faculty in new and better assessment techniques. There is also a need to engage our trainees more and to have them contribute to the assessment process.

We are now in the midst of a significant change in postgraduate medical education with a switch to an even more structured American style residency system. This change is not unique, as many training programs worldwide are also reviewing their curriculum and are also evolving. We believe that with a better structured system in place, training assessment will become more accurate, consistent, and reproducible. We are, however, cognizant that we cannot blindly adopt a new system, without carefully considering the cultural differences that exist between our societies. As we adapt to this change, we must continue to tap on our own experience in training to blend the best of both East and West, with the view to train the best radiologist for our future needs.

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15 Assessment of Radiation Oncology Medical Physics Residents: The London, Ontario (Canada) Experience

Jacob Van Dyk and Jerry J. Battista

15.1 Introduction

Medical physics is the application of physics to medicine. *Medical physicists* tend to be clinically oriented professional scientists, most often entering the field with a graduate degree in physics or biophysics (M.Sc./Ph.D.). However, as the field has evolved rapidly with diverse technology and techniques, entry from other disciplines of science or engineering has also occurred. Medical physicists specialize in various areas of medicine, usually in radiation or imaging related fields, although they can be involved in other areas of medicine such as hyperthermia, photodynamic therapy, physiological measurements or other therapies. In terms of hospital staffing numbers, the largest single group of medical physicists are those who are working in cancer therapy centres involved with radiation treatment. Because of their direct involvement with patients, these medical physicists are often called *clinical physicists* or *clinical medical physicists or hospital physicists* (the latter designation is used especially in the UK).

Radiation oncology is a highly complex field of study where high doses of radiation are used to treat cancer patients. All modern cancer centres involved in radiation therapy have three major professional groups who work closely together as a team to deliver an appropriate and safe radiation dose to the patient such that the probability of cure is maximized and the probability of complications or morbidity is kept at acceptably low levels. These professional groups include the medical physicist working closely with the *radiation oncologist* (physician specializing

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in the treatment of disease by the application of radiation beams), the *medical dosimetrist* (who is involved in computerized treatment planning), and the *radiation therapist*[1] (who is involved in the actual treatment of the patient on the radiation treatment machines as well as interfacing with the treatment planning process).

The *radiation oncology medical physicist* is involved in all the technical and physics aspects associated with radiation treatment. This includes: (1) participating in the general design of radiation therapy facilities; (2) participating as a major partner in the purchase and acquisition of radiation treatment and related equipment; (3) having a major responsibility for the accuracy and quality of the computerized treatment planning process; (4) the development and execution of the quality assurance program including the quality control of individual technologies associated with radiation treatment as well as patient-specific treatment and dose verification; (5) all aspects of radiation safety including the design of treatment and imaging rooms, licensing applications for nuclear regulatory agencies, staff monitoring of radiation exposures to personnel, development of an incident (error) reporting system and addressing any radiation related concerns for the patient, the hospital staff, students, or the general public; (6) keeping abreast of the developments in new technologies which are evolving at a rapid rate in the early twenty-first century and providing a leadership role in the implementation of new techniques and technologies as they become available to the clinic; and (7) providing in-service education sessions for staff on topics related to treatment techniques, quality assurance programs and radiation safety procedures. For institutions having academic responsibilities associated with nearby universities, medical physicists may be involved in teaching radiation oncology medical residents, radiation therapists, medical physics students at the undergraduate and graduate studies levels, or medical physics residents – the latter being the focus of this chapter.

Medical physicists working in a radiation oncology environment require a high level of expertise and training and have highly responsible positions since the results of their work can have "life or death" consequences for patients and staff. This was emphasized recently by the articles published in the *New York Times* (Bogdanich 2010) outlining a series of treatment errors that had occurred in the state of New York, some of which resulted in severe debilitating effects of patients or even in death. Often these unfortunate incidents can be traced back to inadequate staffing levels, lack of expertise in quality assurance protocols or inappropriate implementation of new technologies. Hence, proper education and clinical training of medical physicists are crucial to the optimal and safe radiation treatment of the cancer patient.

[1] In different parts of the world, radiation therapists are also known as radiation therapy technologists (RTT) or radiographers. Medical dosimetrists are often radiation therapists who get additional special training in computerized treatment planning. Sometimes, especially in the USA, medical dosimetrists are trained in special university programs.

15.2 Career Structure of Medical Physicists in the Province of Ontario, Canada

The medical physicist career structure in the Province of Ontario is generally divided into four major phases (Cancer Care Ontario 2003): (1) medical physics resident, (2) medical physicist, (3) senior medical physicist, and (4) chief physicist.

15.2.1 Medical Physics Resident

The medical physics residency is nominally a 2-year clinical apprenticeship. Upon successful completion, the trainee should be competent to perform all routine clinical physics procedures with minimal supervision. The residency curriculum and program is described in detail in the next section. The minimum entry requirement in Ontario is an M.Sc. in physics or related science. In the past decade, the preferred and typical entry requirement has become a Ph.D. in physics or a related science. This degree generally allows medical physicists to further participate in university level teaching and to access research grants for the development of new and improved radiation therapy techniques and to financially support graduate students. This diversity of clinical, research, and educational duties adds to job satisfaction and enhances staff retention. In the London, Ontario (Canada), program, the positive reality is that we attract a significant number of applicants with Ph.D. in Medical Physics or Medical Biophysics that we generally accept only applicants with such focused degrees. Residency training culminates with the provincial Cancer Care Ontario (CCO) Review-A examination process described later in this chapter.

15.2.2 Medical Physicist

The medical physicist is a staff member who can participate in the full range of clinical service, research, and education activities of the department. Entry requirements include the successful completion of Review-A or equivalent. Equivalency is determined by the Medical Physics Credentialing Committee (PCC) of the Physics Professional Advisory Committee (PPAC) of CCO. After 2 years of employment as a CCO medical physicist, further salary progression is contingent upon election to Membership of the Canadian College of Physicists in Medicine (CCPM), the Canadian national certification body for medical physicists. Exceptions based on equivalency of credentials are assessed on an individual basis by the PCC.

15.2.3 Senior Medical Physicist

A senior medical physicist is a medical physicist with a leadership and supervisory role in the department and a demonstrated record of excellence in clinical service or research or both. Requirements include 5 years of experience as a medical physicist. Fellowship status in the CCPM is also required. Exceptions based on equivalency of credentials are assessed on an individual basis by the PCC.

15.2.4 Chief Physicist

The chief physicist role is characterized by professional, academic, and research leadership. The chief functions as a manager within the Department of Medical Physics. The chief physicist provides leadership, direction, and advice to medical physics staff and staff of related departments. Managerial responsibilities include planning, organizing, and managing departmental operations and human resources. Requirements include a minimum of 10 years of experience and expertise in clinical radiation therapy physics including demonstrated experience introducing new technology and new treatment techniques into clinical practice. Management skills, including leadership, organization, planning, and supervision of staff, are required and are often enhanced through the hospital or university continuing education programs. Fellowship in the CCPM is required with a similar consideration for equivalency as described under the senior medical physicist position. There is also an expectation that the chief physicist will have a university appointment at the associate or full professor level in Physics, Medical Biophysics, and/or (Radiation) Oncology Departments. Other academic cross-appointments to Departments of Medical Imaging or Biomedical Engineering are common for this staff category.

15.3 Description of London Residency Program in Medical Physics

The main objective of the medical physics residency program of the London Regional Cancer Program (LRCP) is to provide “on-the-job” training and clinical experience in the practice of radiation oncology physics (Karnas 2008). Upon completion of the LRCP residency program, the physicist should be capable of working safely, competently, professionally, and independently in a radiation treatment facility.

By way of background infrastructure information, the LRCP radiation therapy facilities support the treatment of 3,500 new patients per year, with a wide scope of disease sites. The equipment is state-of-the-art (eight Varian series linear accelerators (linacs), one TomoTherapy unit, two CT-simulators, and direct access to SPECT-CT, MRI, and PET-CT). These technologies are continuously updated or replaced, providing great learning opportunities, while machines are in the dismantled state and serviced by our local engineering team (we perform in-house servicing with limited external service contracts) as well as the acceptance and commissioning procedures involved in introducing the new technologies into clinical service. For technology or techniques that are not available in London (e.g., total skin electron irradiation, cranial stereotactic radiosurgery), arrangements are made for residents to gain this specialized experience in nearby affiliated centres. Hamilton, Kitchener, Windsor, and Toronto are all within a 200-km radius of London (2–3 h drive by car).

The nominal program duration of the LRCP residency program is 24 months. However, allowances are made for students entering the program from medical physics related fields (graduate degrees in medical physics) and previous work experience. Completion of the residency program is dependent on appropriate written documentation and successful completion of the CCO Review-A oral examination.

The first month of the residency program consists of a thorough orientation. The purpose of this orientation rotation is to achieve an overview of the treatment facility, patient treatment process, and to become familiar with the entire team of radiation specialists. The resident "shadows" radiation therapists for 1–2 weeks to gain insight into the radiation delivery process from the time a patient first undergoes CT-simulation to final treatment day. Half-day to full-day timeslots are typically scheduled for observing CT-simulation, mould and block room, external beam dosimetry, brachytherapy, and treatment machines commonly used for breast, prostate, head and neck, lung, and skin cancers. The resident also views morning machine "start-ups" and quality assurance (QA) procedures and participates in some of the evening quality control (QC) measurements. In addition, the resident receives training sessions in radiation and electrical safety.

After the orientation, the medical physics resident has four specific clinical rotations and performs a clinically relevant research project with a mentor. The four main clinical rotations are in (1) treatment planning (~6 months), (2) brachytherapy (~5 months), (3) external beam dosimetry/commissioning (~6 months), and (4) radiation safety (~1 month). The purpose of the research project is to provide the resident with experience in solving clinically related problems similar to ones that medical physicists need to resolve as part of their daily work. The research project is expected to take approximately 20–25% of the resident's total time or about 5–6 months in aggregated time. In addition to the research project, the resident is also involved in a number of smaller projects that relate to the application of new treatment or dosimetry techniques as are being implemented during the period of the residency.

Along with the clinical rotations, there are four core didactic courses that the residents are required to complete if they (or their equivalents) were not taken during their undergraduate or graduate studies. They are as follows:

1. Radiological Physics (University of Western Ontario (UWO), Physics 4672/9655). This is an introduction to the theory of radiation interactions with matter (or tissue) and the use of instrumentation and dosimetry techniques in radiation therapy.
2. Radiobiology with Biomedical Applications (UWO **Medical Biophysics 4467**/9567B). This introduces the nature and effects of ionizing radiation on biomolecular structures and living cells, applied radiobiology, genetic effects of ionizing radiation, theory and practice of radiation protection, and radiobiological applications to modern cancer therapy.
3. Medical Physics for the Radiation Oncologist. This is an in-house course at the LRCP primarily for the medical radiation oncology residents but shared with the medical physics residents and graduate students enrolled in a new CAMPEP-certified (Commission on Accreditation of Medical Physics Educational Programs 2011) program. The course deals with the *practical* aspects of radiation interactions with tissue; the technology associated with radiation oncology; the various methods of measurements and dose calculations used for radiation treatment planning; and radiation protection of the patient, staff, and general public.
4. Applied Physics Course. This is a case-based learning course originally designed for the medical residents in radiation oncology but now also attended by the medical physics residents.

Didactic courses (3) and (4), which are attended by both radiation oncology residents and medical physics residents, have resulted in an interesting synergy between the two professional groups. The radiation oncology residents often enhance the learning of medical physics residents by their knowledge of medically related issues (e.g., anatomy, physiology, oncology), while the physics residents provide assistance to the medical residents in radiation physics topics. Furthermore, the mutual participation in these courses has provided a social setting that enhances interactions in the context of practical clinical problems, as will be experienced in their future career. Inter-professional communication skills are honed.

In addition to these didactic courses, the medical physics residents also participate in practical physics tutorials. These are in-house sessions led by staff physicists. These weekly tutorial sessions are set-up for participation by all the residents and deal with clinical physics topics covered during their rotations. The topic of the day will have a special emphasis on the specific rotation of one of the residents. The topics are assigned to all the residents on a week-by-week basis.

Once the residents have developed a certain level of practical experience, they will also be assigned a "first call" on a linac, which entails checking that unit's patient treatment sheets, weekly QA reports and assisting with machine-related issues, be it associated with patient treatment set-up issues or machine problems and troubleshooting. The linac responsibility usually commences 9 months into the residency program, and the primary unit physicist provides the appropriate training and support. Following the training period, the unit physicist will notify the Director of the Residency Program in writing, using the delegation form, indicating that the resident has achieved a level of competency to function independently. The formal accountability remains, however, with the primary unit physicist.

The Director of the Residency Program will initially mentor the clinical research project; however, once the details of the project have been determined, a staff physicist will be assigned to be the formal mentor/supervisor for that project. Co-mentors/supervisors may also be determined depending on the nature of the project and the facilities required to complete the project.

15.4 Methods of Assessment of the Residents' Performance

There are multiple types of assessment of the residents as they progress through the residency program. These are summarized in the subsections below. One of the requirements of the residents is that they provide a one-page summary of their activities for each month during the entire residency, including the orientation (Fig. 15.1). This provides the resident and the Director of the Residency Program with a documented record of activities that have been carried out. These summaries are reviewed at 6-monthly intervals to ensure that the resident is progressing at an appropriate rate and to confirm that the entire program will be completed according to the schedule that was initially developed.

Medical Physics Residency Monthly Report
Name: ______________
Month/Year: ______________
Current Rotation: ______________

Current Responsibilities:

Rotation Specific Achievements (with reference to syllabus):

Other Clinical Activities:

Research Activities:

Seminars and Courses Attended:

Other Activities:

Fig. 15.1 Replica of medical physics monthly residency report

15.4.1 Performance in Courses

Any formal courses required by the resident must be completed with at least a grade of B+ [>77% using UWO scales (University of Western Ontario 2010)].

15.4.2 Observation of "On-the-Job" Competence

The "on-the-job" work of medical physicists can be broadly divided into three components: theoretical, experimental, and clinical competencies.

15.4.2.1 Theoretical

The theoretical competency primarily relates to the knowledge base that the resident acquires during the courses and practical rotations in the residency. The initial knowledge base is developed through didactic courses. The next level is through practical application of knowledge gained during the clinical rotations (i.e., translational). Thus, the residents learn about the technology of radiation oncology in the courses; this knowledge is then amplified by actual hands-on experience with the use of this technology either at the time when measurements are performed on the radiation apparatus or during the participation in patient procedures for treatment. This theoretical knowledge is assessed by regular interactions or tutorial sessions with the supervisor of that specific rotation. Generally, the supervisor will pose a series of leading questions which help elucidate further discussion on the theoretical aspects of the patient radiation therapy procedures.

15.4.2.2 Experimental

A significant component of a radiation oncology medical physicist's work life consists of performing radiation measurements related to radiation treatment delivery machines (acceptance testing, commissioning, and quality control) and radiation protection of the patient, staff, and general public (low dose radiation survey measurements). Experimental expertise can be assessed by the quality of the measurements and competence with measurement techniques. The experimental results are reviewed regularly by the staff physicist supervising the resident's rotation, be it during the external beam, brachytherapy, or radiation protection rotations. The resident's judgement, critical thinking, and correct interpretation of experimental results are assessed.

15.4.2.3 Clinical

A major component of the clinical work of a medical physicist relates to radiation treatment planning. The treatment planning rotation begins with a series of predetermined treatment planning exercises that are to be performed by the resident with the mentoring of a medical physicist and/or a medical dosimetrist. Upon completion, the resident then observes a medical dosimetrist perform real clinical treatment plans. This is then followed by the resident performing clinical treatment plans under close mentoring of a dosimetrist and supervision of a physicist. Assessment here consists in a review of the quality and efficiency of the resulting treatment plans and compliance with clinical goals.

After the completion of each rotation by the resident, the medical physics supervisor/mentor of that rotation discusses and reviews with the resident, the accomplishments during the rotation. As a guide for communication, an evaluation form is filled in. Sample forms are shown in Fig. 15.2a, b for *external beam dosimetry* and *treatment planning*.

a

Residency Program in Medical Physics, London Regional Cancer Program

ROTATION APPRAISAL REPORT

A. Rotation: **External Beam Dosimetry** Name: ____________________

B. Syllabus requirements:

	Score 1 to 5 (5 = the highest)	Not completed	Comments
Linac design			
Linac operation			
Beam symmetry/flatness			
Depth dose curve			
Tissue-phantom ratio			
Output/dose factors			
Wedge & tray factors			
QA checks			
QA tools			
Calibration protocols TG-51			
EPID, IMRT, OBI/CBCT, gating/RPM			

C. Professional attitude and communication skills:

	Unsatisfactory	Below average	Average (good)	Above average	Outstanding
1. Interpersonal skills					
2. Initiative					
3. Sense of responsibility					
4. Adaptability					

D. Comments by appraiser:

E. Comments by resident:

Signature of Staff Member Date Signature of Resident Date

Fig. 15.2 (**a**) Replica of medical physics rotation appraisal report for *external beam dosimetry*. (**b**) Replica of medical physics rotation appraisal report for *treatment planning*

b

Residency Program in Medical Physics, London Regional Cancer Program

ROTATION APPRAISAL REPORT

A. Rotation: **Treatment planning** Name: ______________________

B. Syllabus requirements:

	Score 1 to 5 (5 = the highest)	Not completed	Comments
Understanding TPS (algorithm, normalization, MU calculation)			
Dose constraints			
Breast plans			
Pelvis plans			
Rectum plans			
Lung plans			
Head & Neck plans			
Brain plans			
IMRT forward plans			
IMRT inverse plans			

C. Professional attitude and communication skills:

	Unsatisfactory	Below average	Average (good)	Above average	Outstanding
1. Interpersonal skills					
2. Initiative					
3. Sense of responsibility					
4. Adaptability					

D. General comments by appraiser:

____

____

____

E. Comments by resident:

____

____

____

Signature of Staff Member Date Signature of Resident Date

Fig. 15.2 (continued)

15.4.3 Performance in Regular Weekly Discussions

During each rotation, the resident communicates regularly with their supervisor for that rotation. In addition, the resident should have a weekly review with the supervisor to discuss the activities of the week. The supervisor should raise a series of questions related to the rotation regarding the theoretical, experimental, and clinical aspects of the activities of the week. The intent here is for the supervisor to push a little deeper in terms of knowledge translation gaps rather than simply assessing the performance associated with procedures that have been carried out. This then provides both an opportunity for appraisal as well as a learning opportunity for the resident.

15.4.4 Performance in Review Sessions

Every 6 months, a "formal" review is performed by the Director of the Residency Program and provides an opportunity to review the monthly reports, the end-of-rotation reports primarily to assess the overall progress of the resident and to ensure that the total program is advancing according to the schedule developed at the beginning of the residency.

15.4.5 Performance in the Research Project

Generally, a clinically relevant research proposal is developed early in the residency (within the first 6 months) including objectives and timelines. Progress of the research activities is reviewed at the half-yearly reviews. Usually the project is defined in such a way that it will result in a publication in a peer-reviewed journal (a good metric of scientific productivity). The quality of performance is reviewed by the supervisor/mentor of the project, by the journal peer-review process (assuming it gets to this stage during the residency), and finally by the Review-A presentation, which is described in the next subsection.

15.4.6 Performance in the Formal "Review-A" Exam

At the completion of the residency, there is a formal provincial credentialing process for medical physicists who would like to work in any cancer therapy centre in Ontario. The process is known as "Review-A" (as opposed to "Review-B," which assesses *excellence* in medical physics and is specific for promotion to a senior medical physicist). The Review-A is conducted by four chief physicists and one radiation oncologist. The four chief physicists are generally members of the CCO Physics Credentialing Committee. At least three of them must be from a centre other than the candidate's sponsoring centre. The Review-A consists of a brief oral presentation (15 min), usually on the topic of the candidate's clinical research project, followed by in-depth examination of that subject. In addition, there are general medical physics questions from a confidential question bank to evaluate the candidate's knowledge of the core material outlined in the residency training program syllabus (Karnas 2008). Questions are selected from this bank, which contains over 100 questions that are regularly updated. The candidate's response could lead to supplementary questions not found in the question bank or textbooks. There are also at least two questions posed by the radiation oncologist on the review committee. These questions are generally very clinical in context and assess the candidate's clinical knowledge as well as how the candidate is able to communicate in responding to clinical problems with a physician.

The candidate's interpersonal skills, clinical physics accomplishments, written communication skills, and planning and organizing ability are assessed and scored by the candidate's supervisor(s) prior to the examination.

To pass Review-A, the candidate must demonstrate a degree of competence that would indicate that the candidate is able to carry out clinical physics duties safely and effectively, with minimum supervision. If two or more reviewers fail the candidate, the candidate will receive a failing grade regardless of the other reviewers' scores. A candidate may request feedback with respect to the results from the sponsoring chief physicist. The Review-A evaluation form is shown in Fig. 15.3. Candidates that fail are generally given some feedback regarding where the weaknesses occur and then have an opportunity to repeat the Review-A process at the next sitting.

15.4.7 Performance in the CCPM Membership Exam

While the Review-A process certifies radiation oncology medical physicists to work in the Province of Ontario, for all of Canada, there is a further certification program for individual physicists through the Canadian College of Physicists in Medicine (CCPM). There is some redundancy between the Ontario Review-A process and the CCPM certification process, and this has been a subject of significant debate and discussion. Practically, CCPM only provides certifying examinations once per year, and this has been deemed to be too infrequent for Ontario. In contrast, the Ontario Review-A exams are generally held three times per year and thus improve the output efficiency of the residency program (i.e., shorter wait to access open jobs). Thus, there continues to be a requirement in the Ontario career structure that the resident initially passes the provincial Ontario Review-A process. The graduate then needs to be certified nationally as a member of the CCPM within the first 2 years of employment to assure continued career progression; after 2 years, salary increases are dependent on the completion of the CCPM Membership certification.

Provincial certification procedures are not wholly consistent in the various provinces in Canada. The Review-A process, or equivalent, is not necessarily performed outside of Ontario with some provinces only requiring the CCPM *Membership* certification as a measure of completion of a residency or for employment in a cancer centre.

15.5 Assessment of the Residency Program

15.5.1 Review by Accreditation Commission

The residency program is accredited through the Commission on Accreditation of Medical Physics Educational Programs (CAMPEP). The *mission* of CAMPEP is to

REVIEWER'S SCORING SHEET
Medical Physics Review A

Candidate:	
Reviewer:	
Date of Review:	

CATEGORY	MAXIMUM SCORE	CANDIDATE'S SCORE
1. Residency Project • Project Evaluation • Presentation • Defense	 **7** **3** **10**	**/ 20**
2. Oral Communication Skills	**10**	**/10**
3. Clinical Physics Skills • External Beam • Brachytherapy • Radiation Protection • Radiation Oncology • Radiobiology	 **15** **7** **8** **10** **10**	**/50**

The following scores to be determined by supervisor:

1. Written Communication Skills	**7**	
2. Clinical Physics Accomplishments	**20**	
3. Interpersonal Skills	**13**	
4. Planning and Organization	**5**	**/ 45**

TOTAL SCORE	**125**	

Note: To pass Review 'A', the candidate must obtain a total score of at least 85 points with a minimum requirement of half the maximum score in each category.

Pass ☐	Fail ☐
Signature of Reviewer:	

Fig. 15.3 Replica of CCO Review-A scoring sheet (dated Nov 2005)

promote consistent quality education of medical physicists by evaluating and accrediting Graduate, Residency and Continuing Education programs that meet high standards established by CAMPEP in collaboration with its sponsoring organizations. The sponsoring organizations are the American Association of Physicists in Medicine (AAPM), the American College of Medical Physics (ACMP), the American College of Radiology (ACR), and the Canadian Organization of Medical Physicists (COMP). *Accreditation* is a voluntary, non-governmental process of peer review, the objective of which is to ensure a program or institution has met a defined standard. Thus, accreditation serves as public recognition that a program provides a quality service or education (Commission on Accreditation of Medical Physics Educational Programs 2011). Accreditation is sometimes erroneously confused with certification. In general, institutions and programs are accredited, and professional individuals are certified. Some examples of types of institutions that may be accredited are health-care institutions such as hospitals and educational institutions such as colleges or universities (Commission on Accreditation of Medical Physics Educational Programs 2011).

The *process* of CAMPEP accreditation of degree granting and clinical training programs requires that the program submits a self-assessment report giving evidence of compliance with requirements. After review of this report, a survey team conducts a program site visit to validate the assessment. If successful, accreditation is granted for a maximum period of 5 years with the requirement of brief annual update submissions. Renewal requires submission of an updated self-assessment report. The *survey team* consists of senior medical physicists with experience in both clinical practice and educational programs. Generally, the survey team will also include a physician (Commission on Accreditation of Medical Physics Educational Programs 2011). Detailed guidelines for the accreditation of residency education programs in medical physics can be found on the CAMPEP website (Commission on Accreditation of Medical Physics Educational Programs 2011). The LRCP residency program was initially accredited in 2006. Recently, a specialized option within the University's graduate program in Medical Biophysics was also CAMPEP-accredited and serves as an excellent preparation for a residency in medical physics.

The CAMPEP accreditation process has homogenized the curriculum of many training programs across Canada and the USA. Furthermore, the enforced documentation of ongoing evaluation of residents' performance throughout the training period and on completion (see Fig. 15.2a, b) is providing timely feedback for progressive improvement until graduation. It should be noted that graduation from a CAMPEP-accredited residency program will become an *absolute* requirement for eligibility to sit professional certification exams of the American Board of Radiology in the United States by 2014 (American Board of Radiology 2010) and of the CCPM in Canada by 2016 (Canadian College of Physicists in Medicine 2010). Through this recent development, training programs in radiation oncology physics will become quite parallel to those developed previously for radiation oncologists.

The London residency program strengths include its long history, with informal residency training of physicists dating back as far as the 1970s. Informal training of international guests (e.g., Cuba) still occurs, and this enriches the learning environment for the residents. We host regular seminars (e.g., QA Rounds, Oncology Rounds, Physics Seminars, Journal Clubs, Webcasts) to which physics residents are invited. Our medical physics group has also hosted regional, provincial, and national conferences in medical physics (e.g., meeting funded by Ontario Research and Development Challenge Fund (ORDCF), AAPM Chapter meeting, COMP annual general meeting). There is excellent university academic support and teaching through courses offered at the University of Western Ontario within the Physics & Astronomy, Medical Biophysics, and Biomedical Engineering programs. The graduate programs (with Medical Biophysics now being CAMPEP accredited) have dovetailed with the residency program providing an excellent steady stream of local applicants in addition to external applicants for our residency program. The chairs of the University's Oncology Department (G. Bauman) and Medical Biophysics Department (J.J. Battista) have offices and research laboratories within the London Regional Cancer Program. One of the faculty members (J.J. Battista) is also the coordinator of the Ontario residency training program and is thereby in touch with province-wide workforce trends and government funding opportunities for residency positions. The teaching quality is excellent with three physics faculty members (Van Dyk, Battista, Karnas) recognized for excellence through university awards from Oncology departments. A team approach with the radiation oncologists and radiation therapists is strongly encouraged, and this provides a good learning approach and experience in a multi-disciplinary field. One of our faculty members (Van Dyk) has produced two books on the technology and techniques of radiation oncology (Van Dyk 1999, 2005), and these provide excellent background materials for our residents, in addition to desktop access to e-journals via the LRCP and the university.

15.5.2 Survey of Graduate Residents

During the last 10 years, 16 residents have completed the 2-year residency program. All residents successfully completed the Review-A certification exam and are working in a clinical radiation oncology environment in Canada today. Ten have remained in Ontario, four moved to British Columbia, and two reside in Alberta. Six of the 16 have remained at the LRCP indicating another advantage of the local residency program. The host educational and training institution is able to select some of the best residents out of its own training program, thereby providing an excellent source for recruitment and a tremendous resource for the training of future residents. Fourteen of the former residents have successfully completed the CCPM Membership Exam (two are recent graduates of the residency program and remain to sit the exam), and three of the residents have also completed the CCPM *Fellowship* exam, which assesses *excellence* in medical physics and demonstrates leadership capabilities. Ten of the 16 residents have affiliations with major universities including UWO, University of Toronto, University of British Columbia, and University of Calgary.

While there are multiple means of assessing the quality of graduates and how well they perform in their working careers, one means of such assessment is to ask the graduates themselves to see how well prepared they felt for a working career in their area of training. To this end, we performed a survey of the graduates of the medical physics residency program at the LRCP over the last decade. With 16 residents graduating during this time, enough data should be forthcoming to yield meaningful results.

Survey questions were developed that addressed the following main topics:

1. Information on number of years since graduation.
2. Current position.
3. Formal certification(s) achieved since graduation.
4. Whether the residency prepared them adequately for the certification exam(s).

7.Looking back...												Create Chart Download
	Not very '...'									Extremely '...'	Rating Average	Response Count
How 'well' did your residency prepare you for the responsibilities of a medical physicist working in a clinical environment?	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	6.3% (1)	25.0% (4)	**37.5% (6)**	31.3%(5)	8.94	16
How 'satisfied' were you with the entire training experience?	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	6.3% (1)	6.3% (1)	**50.0% (8)**	37.5%(6)	9.19	16
How 'competent' did you feel to practice medical physics in a clinical context?	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	12.5% (2)	18.8% (3)	0.0% (0)	**56.3% (9)**	12.5%(2)	8.38	16
How 'competent' do you feel now?	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	6.3% (1)	**62.5% (10)**	31.3%(5)	9.25	16
											Please add comments to explain: Show Responses	6
											answered question	16
											skipped question	0

Fig. 15.4 Results of questions related to how well the residents felt that their training prepared them for working as a medical physicist in a clinical environment

5. Information on what fraction of their time is devoted to clinical service, teaching, research, administration, and other.
6. Whether they have an academic appointment at a university.
7. How well the residency prepared them for their work, how satisfied they were with the residency training, how competent they felt to practice medical physics after graduation, and how competent they feel now.
8. Residency training can be broadly divided into the following components: (a) clinical physics knowledge and skills, (b) leadership skills, (c) ethical behaviour and professionalism, (d) communication and teaching, and (e) QA management and error management techniques. They were asked how well they felt that the residency prepared them for these different components.
9. Whether any specific topics were missed or under-emphasized during their residency.
10. Any general thoughts or comments about their residency training that may help with improvement of the program for future residents.

The survey was limited to ten questions largely to keep it brief to encourage survey compliance. The survey format was based on a web-based process through SurveyMonkey™ (SurveyMonkey 2011).

All 16 graduate residents responded to the survey yielding a 100% response rate. The results for questions 7 and 8 are shown in Figs. 15.4 and 15.5. Question 7 specifically addressed the issue of how well they felt prepared for the responsibilities of a medical physicist working in a clinical environment and received a weighted average of 8.9 out 10 indicating that they were "extremely satisfied." Satisfaction with the training experience yielded 9.2, how competent they felt after the residency to practice medical physics yielded 8.4, and how competent they feel now yielded 9.3. Clearly, overall, there was a high level of satisfaction. For question 7 (Fig. 15.4), six residents made added comments. One theme was that the practical, "hands-on"

8. Residency training can be broadly divided into following components: (a) clinical physics knowledge and skills, (b) leadership skills, (c) ethical behavior and professionalism, (d) communication and teaching, (e) QA management and error management techniques. How well do you feel that the residency prepared you for these different components? Create Chart Download

	Not very well									Very well	Rating Average	Response Count
(a) Clinical physics knowledge and skills	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	6.3% (1)	0.0% (0)	31.3% (5)	**62.5% (10)**	9.50	16
(b) Leadership skills	0.0% (0)	0.0% (0)	6.3% (1)	0.0% (0)	12.5% (2)	18.8% (3)	0.0% (0)	**25.0% (4)**	**25.0% (4)**	12.5% (2)	7.44	16
(c) Ethical behavior and professionalism	0.0% (0)	6.3% (1)	0.0% (0)	0.0% (0)	6.3% (1)	0.0% (0)	12.5% (2)	18.8% (3)	25.0% (4)	**31.3% (5)**	8.19	16
(d) Communication and teaching	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	6.3% (1)	12.5% (2)	**37.5% (6)**	18.8% (3)	25.0% (4)	8.44	16
(e) QA management and error management techniques	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	12.5% (2)	18.8% (3)	**56.3% (9)**	21.5% (2)	8.69	16
											Please add comments to explain. Show Responses	2
											answered question	**16**
											skipped question	**0**

Fig. 15.5 Responses to how well they were prepared for different topical components in their working life

component was very important and should not be decreased. One of the residents commented that while the program provided the technical skills necessary, it took some time to become comfortable with the burden of responsibility in the clinic.

When asked how well they felt that the residency prepared them for different career components (question 8, Fig. 15.5), the weighted averages were 9.5 for “clinical physics knowledge and skills,” 7.4 for “leadership skills,” 8.2 for “ethical behaviour and professionalism,” 8.4 for “communication and teaching,” and 8.7 for “QA management and error management techniques.” Perhaps in the future, more consideration should be given to specific training of “soft” skills especially as related to leadership.

There were 14 general comments about possible improvements in the program. The following summarizes some of these comments:

- Two requested more interaction with the radiation oncology medical residents and the radiation therapy students.
- More off-site training for techniques not available at the LRCP.
- More review of Task Group documents including those which do not apply to day-to-day work.
- Should not get caught up in overly strict time allotments for specific training rotations. The clinical work can be highly variable over the course of a residency, and opportunities to learn can be missed. Residents should contribute to the work of the department, doing many of the tasks they will eventually be responsible for.
- Talks at the Physics Rounds about new trends or the latest discoveries in radiation therapy (similar to Journal Club).
- Project management could use more emphasis in the context of implementation of new equipment/technologies.

The survey provided useful feedback on the effectiveness of the residency training program. While the responses were very positive and no major concerns were expressed, the results provide useful information for fine tuning the existing program to address issues and suggestions made by the respondents, especially those dealing with some of the "soft" skills such as leadership training.

15.6 Summary

Medical physicists play an important role in the health-care environment, especially in radiation medicine. Their positions entail a high level of responsibility and can involve life-or-death actions and decisions. To be safe and effective in the use of radiation, rigorous education and training programs are essential. The medical physics residency program is intended to provide such training.

While various assessment procedures were reviewed, the survey of all residents graduating during the last decade provided excellent feedback on how well they felt prepared for working in a clinical environment. Our recommendation would be that such a survey should be performed at least every 5 years.

In summary, the radiation oncology medical physics residency program in London, Ontario (Canada), has proven to be a rich source of well-trained medical physics staff to radiation oncology programs throughout Canada.

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