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STATEMENT

The future role of radiology in healthcare

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Abstract Rapidly evolving changes in the way that healthcare is administered, coupled with the amazing recent advances within imaging, has necessitated a review of the way in which radiology should be regarded. This review considers some aspects of these changes and offers some recommendations.

Keywords Radiology · Training · Subspecialisation · Teleradiology · Interventional radiology

Introduction

Radiology has been a distinct medical specialty with unique technical challenges from its inception. The origins of specialisation can be traced back to the technical nature of X-ray image capture and perhaps more significantly the difficulty of exposing, transporting and developing images on fragile glass plates for subsequent interpretation. Despite pressure in the early 1900s to define radiology as a technical service, radiographic image interpretation and reporting required medically trained specialists. Therefore, radiologists have been clinical specialists, who have been obliged to also become experts in image capture technology, broad-based advances in engineering and, more recently, applications of information technology for healthcare, which continue to drive and be driven by radiology.

Radiology is now the key diagnostic tool for many diseases and has an important role in monitoring treatment and predicting outcome. It has a number of imaging modalities in its armamentarium which have differing physical principles of varying complexity. The anatomical detail and sensitivity of these techniques is now of a high order and the use of imaging for ultrastructural diagnostics, nanotechnology, functional and quantitative diagnostics and molecular medicine is steadily increasing. Technological advances in digital imaging have also enabled the images produced to be post-processed, manipulated and also transmitted rapidly all over the world to be viewed simultaneously with the transmitting centre.

Radiologists have been strongly involved in these technological developments and have been responsible for much of the evaluation of the strengths and weaknesses of different investigations. Radiologists have developed the knowledge of the appropriate integrated imaging algorithms to maximise clinical effectiveness. They have also been responsible for the implementation of these developments into the clinical setting and for ensuring the best use of assets and healthcare resources.

The improved image clarity and tissue differentiation in a number of situations has dramatically increased the range of diagnostic information and in many cases the demonstration of pathology without the requirement of invasive tissue sampling (histology). This increased information also requires careful interpretation without preconception to avoid prejudging the findings. The use of imaging for functional evaluation and cellular activity has created a new challenge for radiologists whose training has predominantly been based on the anatomical and pathological model with limited experience in physiology and cell function. It has therefore been the case that in some super specialist areas of work, clinician specialists may believe that radiologists have not contributed sufficiently to the care of patients [1]. It is therefore incumbent on radiologists to mobilise their skills to utilise these new approaches to evaluate clinical

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questions in the most effective way. For this reason the radiological training programme for Europe is now mainly system- and disease-focussed to ensure that radiologists can respond to the multiple interactions of patient care.

Although the training programmes are repositioning radiology in this way, these developments are now occurring and are affecting all radiologists who in general, at present, are satisfied with their overall position within the respective health care system in most European countries. Radiologists have no difficulties in finding professionally fulfilling and well-paid employment. Indeed the rapid rise in workload and complexity of examinations have resulted in a shortage of radiologists in most countries which may reduce the opportunity or desire to move and up-date sufficiently with these advances. The availability of high-speed internet transfer of images may affect the requirement and role of local radiologists by transferring images to major centres for rapid specialist interpretation. Thus the rapidly developing and expanding field of imaging becomes a challenge to our specialty, especially as it has also become so attractive to others. We should therefore be concerned to ensure the future of radiology as a medical specialty and take into consideration the forces and the dynamics surrounding our profession by meeting them with foresight and flexibility.

Although as a specialty we must embrace the opportunities that these developments create, the requirements to embrace all aspects of the speciality are now considered unattainable for any individual, especially in an environment where the clinicians themselves are focussed on specific anatomical or disease-related areas as specialists. Therefore the dilemma for radiology and radiologists is how to achieve the objectives of the specialty and still provide a comprehensive service within the confines of a radiology department where so many of the tasks previously undertaken by clinicians are now the province of radiology.

The need for change

Numerous facilities in clinical services are collectively used by different specialties: operating rooms are not owned by surgeons anymore, ICUs have become independent of departments of cardiology, internal medicine, or neurology, while emergency rooms are not part of traumatology departments. Hospital beds are no longer dedicated to individual specialists or specialties and are available for radiologists for one or two nights following interventional procedures in some hospitals. At present the radiology department remains predominantly the domain of the radiologist, but this is changing and there is no specific reason why imaging facilities should not be used by other clinical specialists trained in imaging, and images produced in these departments may also be reported remotely.

New knowledge in imaging is being developed at an increasingly rapid rate. The field of radiology has expanded dramatically. The range of radiology covers diseases from the foetus through to the multi-morbid aging population, from prostate to the pituitary gland and from pancreatic neoplasia to bone dysplasia. No single person can master all the available knowledge. However, the referring physicians need a clinical interface with the imaging specialist. In order to create added value for the referring clinician, the radiologist must fully understand the clinical problem. The radiologist is expected to be able to do this at a different level and for all medical specialties. Therefore clinical experience is required before embarking training in imaging, and appropriate training in specific clinical specialties may also be needed. If not, imaging may increasingly be regarded as a sub-entity within the clinical specialty and in that setting each specialty will take care of its own specialised imaging and training, and the influence of the radiological expertise would diminish.

Public recognition of the clinical role of radiology is essential and is very much dependent on contact with the patients [2]. However, over the past years radiologists reading more and more complex examinations have become less and less visible for patients and the public. Moreover, in some health care systems the emphasis of radiology work is placed on the in-patient referrals to major general (secondary) and university (tertiary) hospitals where the role of the radiologist as part of the team is less obvious to the patient. There has been less focus on the provision of radiology services to primary care (including general practitioners and office based specialists), where the requirements are different, with a need for a more general service but still involving a range of imaging services, and where the individual role of the radiologist is more obvious to the patient.

In some countries clinical specialists may be the primary providers and interpreters of imaging in their offices. This has potential disadvantages for the patients. The self-reporting clinician may focus on the images to confirm or refute a preconceived clinical diagnosis whereas the interface of a radiologist, reporting the images, provides an independent opinion. It is also suboptimal for funding healthcare, as self-referral has been shown to increase numbers of radiological procedures and consequently costs. Moreover, radiologists will ensure the appropriate use of equipment and quality control, and apply radiation protection principles which are particularly pertinent with the massive increase in the use of multi-detector CT [3].

Radiology has prospered by staying ahead of the wave of progress. But radiologists will have to change many of their attitudes and rethink their professional training to

accommodate to the dramatic revolution and evolution of radiology [4]. Radiologists need to adapt to the changes in technology in order for the profession to deliver the service that patients expect and medical progress requires.

Specialisation in radiology

One solution has been a gradual increase in the degree of specialisation of radiologists along systems and disease-related specialties, which has been strongly advocated by the ESR in its curriculum. Some radiologists have focussed on particular imaging modalities which may have assisted the development of these modalities, but the range of imaging techniques to evaluate particular clinical scenarios is such that this approach is not appropriate when dealing with clinicians who have all specialised along systems and disease-based pathways. The current curriculum for training has been adapted to take this process into account. It now separates radiologists, following training to a core level in all aspects of radiology including all techniques, into two main categories:

1. Radiologists who have additional dedicated training to provide special interests in two or possibly three system-based specialties. These radiologists work in teams to provide a 24/7 comprehensive radiological service and at present represent the largest radiological community.
2. Radiologists who have subsequently focussed on one field of radiology which parallels a medical or surgical specialty and who work primarily in that subspecialty in secondary or tertiary referral centres.

It is however still debated how far subspecialisation should proceed and how enthusiastically it should be promoted. It is also unclear how the process should be managed in order to provide an integrated cohesive imaging service to the patients and their clinicians.

Reasons for subspecialisation

The argument for subspecialisation is strong and a number of factors should be taken into account.

1. Information overload:

Our field has become so complex that no individual can maintain the level of expertise needed to practice the entire field of radiology. At present we insist that radiologists become at least minimally competent in the entire field although it is virtually impossible today to remain a radiologist with competence in all areas of our specialty [5]. However, in interventional radiology, for example, sub-specialist training is needed to gain deeper knowledge, new techniques and practical experience to provide a high level of clinical service. The technical demands for procedural skills and familiarity with new devices mean that only a few members of a group can develop the expertise to practice interventional radiology. Mammography quality standards require that physicians practising mammography interpret a minimum number of cases and attain specific breast-related continuing medical education to continue the practice.

2. Developments too rapid:

There are many examples of the effect of rapid developments but the increase in the temporal and spatial resolution of acquisition in CT and the complexities of new software packages in MR have been paramount. The former has involved radiologists in many non-invasive vascular imaging interpretations that were previously the domain of the sub-specialist. The latter has resulted in functional imaging, spectroscopy and diffusion imaging requiring specialist knowledge to conditions which hitherto have been the responsibility of the clinical radiologist such as the early evaluation of stroke patients. The emergence of fusion imaging presents further challenges to staying abreast of this evolving technology. As the field of radiology expands, the degree of sub-specialisation requires maintaining competence increases [5]. Thus the growing array of radiological tools will require radiologists in various practice settings to make fundamental decisions about how to focus and balance their areas of expertise [6]. It is impossible for the radiologist, who is providing a busy comprehensive service, to assimilate these advances.

3. Clinicians in secondary and tertiary referral centres are all specialised:

Secondary and tertiary based clinicians have long since abandoned the concept of the generalist and focus on particular systems or disease-related areas. While the imaging of disease becomes ever more complex, the clinical conditions remain mainly unchanged although the ability of the clinical specialist to treat these conditions is advancing. This reduced pace of change enables the clinicians to assimilate and often develop new ways of addressing the diseases in their special area, thus posing a challenge to the radiologist who is not aware of these developments.

Now better and faster imaging machines enable more accurate diagnosis with less risk and at lower costs than ever before so that radiologists will not be the only specialty to be able to identify disease sites and morphology. The developments also apply to clinical sciences such as the rapid growth of anti-cancer drugs requiring a new insight by imaging of tumour response, or to developments in laparoscopic surgery which need detailed staging of disease by radiology.

4. The referring clinician's role *changed* by imaging:

The patient characteristics, clinical history and examination remain important to guide the investigative choices and

are an integral part of the clinical examination. Clinical information is important to correlate with the imaging findings, especially to avoid false positive imaging diagnoses. However, in many circumstances a long differential diagnosis may be resolved by modern objective imaging which can provide a precise diagnosis in a few minutes. The role of surgeons has also been changed by the emergence of laproscopic surgery and by image-guided endoscopic and interventional techniques. These developments require even more precise delineation of the lesion before intervention and yet even closer collaboration between radiologists and referring clinicians.

5. Patients and clinicians require comprehensive information and the most accurate diagnosis:

A reduced level of expertise of the non sub-specialised radiologists may reduce the quality of patient care, and also the respect radiologists are accorded by their colleagues in other medical disciplines. For example an experienced neurologist or orthopaedic surgeon is unlikely to rely on a diagnosis made on a MR study by a radiologist who has had only 3–4 months of training in neuroradiology or musculoskeletal imaging. This lack of confidence in radiologists would force them to rely on their own interpretations. They no longer want radiologists to report back with generalised observations about the abnormalities.

6. Teleradiology can provide instant access to sub-specialist opinion:

Teleradiology is becoming a significant component in the delivery of radiological services due to the high quality and speed of image transmission. Communication of images between radiologists, via local or distant networks is now a widely available option to solicit a specialised opinion in selected cases. This enables subspecialty opinions to be provided easily and quickly, thus undermining the role of the radiologist who does not possess a specialised knowledge. The patients and their clinicians are now rightly expecting an expert opinion and it is possible now to obtain one through teleradiology services.

7. Technological developments:

There are often short innovation cycles of radiological equipment and it is important that there are specialist radiologists who are able to assist the manufacturers with technological developments and clinical implementation. It is also important to emphasise that radiologists have special expertise in technology not possessed by other clinicians, which provide an indispensable link with other disciplines such as physicists, experts in information technology, molecular biology and engineering. It is essential that knowledge of the technology used is included in radiological core and subspecialty training.

8. Research:

It is imperative that radiologists are engaged in research in their own discipline. Research in radiology is part of the huge domain of clinical research requiring imaging and at present much of this research is undertaken through multidisciplinary protocols led by clinicians and scientists with radiologists seen as a relatively small contributor. Unless specialisation occurs, radiologists will be unable to reverse this situation and thus risk a further loss of influence in the future of imaging at a time when there is a major transformation to functional and molecular imaging. The breadth of research topics relevant to radiology is constantly expanding and includes development in technology and its applications, epidemiology, molecular biology, computer science and other basic research fields.

Reasons for maintaining radiology with special interest(s)

In most secondary care centres and large private radiological offices radiologists have developed additional expertise in two or three clinical disciplines which supplement the delivery of a general service and complement each other within the department or practice. This enables the practice and individual radiologists to add value to the clinicians and provide support to each other.

1. Diseases are not always restricted to one system:

While a number of disorders may be confined to one organ or system, such as musculoskeletal or intra-cerebral abnormalities, others may involve a number of systems such as diabetes, some neoplastic disorders or inflammatory diseases. There may also be circumstances were the initial patient imaging examination may reveal other abnormalities, which were unsuspected and potentially life-threatening. A patient, who may have a specific lesion directly related to the individual specialty, may have co-morbidity that will affect their management, while other abnormalities and disease processes can and are demonstrated incidentally by radiology, and the radiologist is essential to avoid assumptions and also false positive conclusions. In these circumstances the radiologist needs to have a broad perspective and a wide knowledge of anatomy, pathology and imaging signs. This is difficult to maintain, even when the initial training is broad-based, if the subsequent work is highly specialised. It is important that there is good joined-up thinking to avoid the patient having unnecessary examinations and being referred to a variety of physicians.

2. The majority of illness is due to a few common disorders:

Some imaging examinations are commonly performed in most hospitals and all radiologists should be sufficiently experienced to manage and interpret them.

3. A knowledge of all modalities is important:

The value of different modalities varies by disease and clinical question and some modalities have considerable limitations in some organ systems. Radiographs, ultrasound, computed tomography (CT), magnetic resonance (MR) and nuclear medicine techniques are all of value in different clinical situations in musculoskeletal radiology while in neuroradiology MR and CT are predominant.

4. Radiology is a 24/7 speciality:

If all radiologists are sub-specialists, it requires a large staff to cover all emergency work in-house. Sub-specialist staffing requirements are also increased to cover sickness and leave of absence, if continuity of service is to be achieved. Teleradiology may be of value but there is a resultant loss of contact between the radiologists and clinicians, if this is used extensively. The use of this technology is under scrutiny and is being restricted in some countries to ensure that quality issues are robust. Emergency radiology is now becoming a specialist area and the presence of radiologists on site in major accident and emergency departments is essential for the smooth running of the service and although some local emergency radiology reporting has been replaced by teleradiology.

5. Integrated nature of radiology should not be lost:

If all radiologists are sub-specialists, there may be a loss of unity in the department and a loss of interest in discussing cases. Satellite organ- or disease-based departments may become an expectation with a potential duplication and under use of expensive capital equipment and clinicians may set up their own subspecialty radiology departments in conjunction with either the sub-specialist radiologist or a clinician who has done some imaging training as part of their specialist clinical training.

6. Access to subspecialty training is limited in some parts of Europe:

In many countries in Europe sub-specialisation and access to complex equipment is limited. Therefore no opportunities are available to train or practice in a subspecialty. This situation is changing by implementing fellowship programmes and by the use of electronic teaching files and internet-accessible case collections but it may be resource-limited and the complex sub-specialisation model may not be appropriate outside the major university hospital setting.

How should sub-specialisation be implemented in radiological practice?

Subspecialisation is established in university hospital settings and large hospital-based non-academic practice groups, who are increasingly appreciating the value of having this high level of expertise within their groups, and the process towards increasing super-specialisation is already upon us and is continuing. Neuroradiologists focus on spinal, paediatric, interventional, or head and neck radiology. Interventional radiologists may concentrate on vascular procedures, non-vascular intervention, or oncologic procedures, such as percutaneous tumour ablation or chemoembolisation. Thoracic radiologists are often divided into those who provide cardiac imaging and those limiting their practice to the lungs and mediastinum.

However the primary care physician will need help from radiologists to decide which imaging procedure will most likely provide the diagnosis without having to go through the escalating sequence of imaging or other tests. Radiologists will also be expected to manage and report these examinations, many of which will cover a spectrum of common disorders which form the mainstay of any primary care service. To be able to render these consultative services, the radiologist will need to keep abreast with the new key developments in most subspecialties [1].

It is therefore likely that more than one model of practice will continue, depending on the physical circumstances of the service required, but in order to be valuable to the clinicians, the radiologists must have sufficient insight into the clinical problems being investigated and greater skills in interpreting more complex images than the clinicians themselves. In areas where there are significant ‘turf strains’, of which there are an increasing number, subspecialty qualifications may be a requirement. Radiologists should therefore have areas of subspecialty competence, even if they still provide a broad service most of the time.

Clinical competence

One of the main reasons why radiologists are losing many turf issues is their inadequate clinical culture. A high level of technical training is not sufficient for dealing with clinicians and their clinical queries. Medical practice is becoming increasingly interdisciplinary due to the vastness of knowledge involved. The importance of clinical training has been emphasised previously by the ESR but it is still not a requirement for entry into radiology in a number of European countries. It is essential that, if radiologists are expected to understand the clinical features and treatment of sub-specialist areas, they have a good clinical base on which to build that knowledge. Good clinical training will enable radiologists to interact at the appropriate level with clinicians. Therefore radiologists, to be able to take part in an interdisciplinary discussion as a key player, will not only have to be specialised in the imaging of a specific organ system but also to be able to discuss complex clinical cases.

Clinicians require radiologists who understand the clinical questions, keep updated with the most recent advances in the disease processes and have knowledge of the relevant therapies.

A basic clinical experience and knowledge should be achieved prior to entering radiology. A 1–2 year programme of clinical work would ensure a sound basic knowledge and give the appropriate skills for caring for patients and interacting with clinicians. Attempting to develop a sound clinical base during radiological training may be difficult to organise and will distract and potentially dilute the radiological training programme. Further subspecialty clinical knowledge and experience may then be achieved in a number of different ways, which are not mutually exclusive, including combined clinical and radiological rounds, interdisciplinary meetings, scientific literature and research and where possible clinical secondments.

As part of this clinical knowledge and experience, radiologists in specialised situations must have a good understanding of the physiology, pathology, and up-to-date therapies applicable to their respective organ system. They must also be experts in the multiple imaging modalities applicable to the clinical problem addressed [1]. Whatever methodology is adopted to develop the necessary clinical experience, it should be focussed in the area in which a radiologist will practice, and would be more appropriately embedded in the subspecialty training.

Interventional radiology

The field of interventional radiology has moved at great speed over the last few years, and there is no evidence of a reduction in the pace. Indeed quite the opposite is true as more and more surgical procedures are performed with minimal invasion. Radiology has led the field but is being overwhelmed by the volume of work and the desire of surgeons and physicians to take over this work. In order to preserve radiology's place, it is essential that a radiologist's training in interventional radiology is structured in such a way to ensure that they not only have the core diagnostic imaging skills, knowledge and technical interventional competence, but also have sufficient clinical skills and training to care for their patients. Interventional radiologists must also be given the necessary resources of clinic time, hospital facilities and support to take and treat direct referrals. An innovative approach to training in conjunction with our surgical, cardiological and oncological colleagues is required to ensure that radiologists remain key operators in this subspecialty. Interventional radiology should also be funded and recognised for the clinical work they provide. In health economies that use Diagnostic Related Groups (DRG) for payment purposes, it is of utmost importance that patients admitted for an interventional procedure create income for the radiology department in due proportion to the gain provided to the hospital by the intervention and the hospital stay.

Training implications

The European Training Charter for Clinical Radiology [7] identifies the first 3 years devoted to developing the core skills and knowledge in all aspects of diagnostic radiology. The following 2 years may be spent either undertaking subspecialty training or gaining further experience while developing areas of special interest by focussing more time in two or three organ- or disease-related specialties.

In a report of the 2005 Intersociety Conference, Reed Dunnick et al. also advocate that the first 3 years of training in radiology could constitute a core curriculum. However, they suggest that this would be followed by a three-year focused programme. In America, this would replace their traditional fellowship and could include clinical training. During this period of training each resident would be required to focus on one or perhaps two subspecialty areas. A variety of choices would be available depending on an individual's interest.

There may be organisational challenges to obtaining subsequent clinical experience during subspecialty training although this could be on the basis of supernumerary status which would provide clinical exposure without taking clinicians resident positions, but gaining a sound clinical base prior to starting radiology is entirely possible given the acquiescence of national policies. Additional clinical experience should follow a structured curriculum individualised for each subspecialty.

There is a fundamental requirement to increase the exposure of medical students to imaging taught by radiologists. Presently, the number of radiologists involved in undergraduate training is low. As a result the potentials and excitement of radiology as a career are not transmitted and the realisation that radiologists are key players in the patient care pathway is not embedded in the medical student's psyche at an early stage. There are a number of initiatives that have been developed in Europe for increasing the teaching of radiology at undergraduate level and these should be further promoted.

Teleradiology: an opportunity

Teleradiology is now an established method of providing radiological services. It is well developed in the provision of on-call emergency reporting being used by over 70% of radiological practices in the US both by groups in the US

and by Night hawk services around the world. Teleradiology is also established for the provision of radiological services to remote rural communities and for sub-specialist opinions and for specialist case transfers. In the UK it is now used to provide primary reporting services from centres both in Europe and by international providers.

With the costs of data transmission decreasing as fast as the costs of computing power, practical opportunities for global teleradiology are rapidly increasing as the cost effectiveness of PACS and digital radiology increases. In our financially constrained world, the clinical losses associated with generalised use of teleradiology may be accepted by governments and health care insurers as a means of cost containment [1].

However, exchanges of information with referring physicians in conferences or reading rooms are an integral part of delivering a clinical radiological service. It would be a great loss to the profession if radiologists were to be identified by other physicians and patients only as image readers sitting exclusively in front of workstation screens and ceasing to be clinicians [1].

The obligation or responsibility or opportunity of a radiologist to go beyond the dictated report and to offer consultant services to his or her clinical colleagues is what allows the specialty to be more than a technical service. This will be even more significant as computer-assisted diagnostic programmes extend to more body parts. If a radiologist provides nothing more than an observation of abnormal densities, radiology will be minimised or eliminated [8]. Similarly the role of laboratory medicine was minimised when chemical autoanalyzers provided results cheaply and accurately and the printed values were significant to the referring physician without any interpretation or consultation with a laboratory physician.

With so many technological advances it is not surprising that radiology utilisation of high-cost studies such as CT and MR is expanding rapidly worldwide. This has resulted in a larger and more complex workload. However the number of radiologists worldwide has not increased at the same rate as the number of examinations. Radiologists have only been able to manage this increase by improved workflow and productivity due in part to digital technology. Digital imaging, workstations, speech recognition technology, PACS and ease of communication via the internet have all facilitated workflow. Teleradiology may increase productivity in some circumstances such as night cover in smaller practices and provision of radiology reporting services to rural communities. It has also been used in some countries to compensate for manpower shortages and when used in a proactive and controlled fashion may help to avoid loosing turf to clinical colleagues. It is not however the ultimate solution to manpower problems which are better resolved by training sufficient radiologists to provide the service within the locality of the clinicians and patients. Teleradiology must not be allowed to commoditise imaging services and should only be used to support the comprehensive diagnostic service provided by radiologists within groups or local area networks.

Patient relations

Radiological societies maintain (and radiologists do not publicly disagree) that to improve the public perception of the role radiologists play in patient care, closer contact with patients is essential [9]

Radiological services are essential to the care of patients. To the patients, however, radiological services may seem somewhat inconvenient, mysterious or frightening, or may even be a painful intrusion of their privacy. The perception is further altered by the fact that patients typically do not choose their radiologist; the referring physician, the health plan or another intermediary usually makes that choice. Often patients and their diagnostic radiologist never meet. This situation substantially alters the service bond between them, actually making the relationship more demanding in a number of ways [10]. Moreover, nurses, technologists and others are increasingly participating in the performance of imaging examinations. For many patients, radiologists are identified only with the equipment used and not as physicians who play a vital role in the decisions that affect them. The use of technologists, nurses, and physician assistants for intravenous injection of contrast material makes radiologist-patient contact even less common [2]

Patients believe that the clinician who requested the examination and has received the report is actually the physician who has interpreted the study [2]. On the other hand, there is widespread agreement that patients prefer to hear the results of imaging examinations from the radiologist at the time of the procedure rather than to hear them later from the referring physician, regardless of the findings [11]. And in another study it has been shown that radiologists and referring physicians alike tend to support the proposition that, if asked, radiologists should disclose the results of imaging studies to patients [12].

It seems to be important for the future of the specialty for radiologists to have more contact with patients in the setting of high-cost, high-impact imaging procedures. The very position of radiology in a variety of hierarchies ranging from political to economic may depend on increased recognition by the public of radiologists as physicians. However, results of a survey by Margulis and Sostman [2] show that more than a half of the injections of contrast medium in radiological practices are performed by non-physicians. Radiologists are often but by no means always present in the facility during performance of the study and

radiologists rarely introduce themselves to the patient. Radiologists should always introduce themselves to patients before any interventional procedure. This is not only good manners but it also establishes the radiologist's clinical role in the whole spectrum of planning the treatment and assessing the prognosis and the response during follow-up.

Involvement in primary care (general practice (GP) and office based practice)

Primary care is the point of first patient contact and offers continuous comprehensive and coordinated care to populations undifferentiated by gender, disease or organ system. In order for comprehensive care to take place in the primary care setting, the GP often requires access to a wide range of imaging services. This enables the GP to diagnose and treat the more common diseases without recourse to hospital services. It also empowers the GP to investigate the patient more fully so that, if a transfer to a hospital specialist is required, such referral can, in many cases be for therapeutic care rather than for further investigation.

A GP may wish to work up a patient more fully in conjunction with the clinical radiologist, who may be a subspecialist or a radiologist with special interests, so that the requirement for outpatient referral to specialty services may be avoided or may be a more focussed and constructive consultation. For such a means of referral to be effective, the radiologist will need to establish preferred investigation pathways with the clinicians to whom ultimately the patients may be referred. Finally, the GP may be able to treat a patient directly with the assistance of the radiologists and some image-guided therapeutic procedures can be undertaken by radiologists directly for GPs on an outpatient, day-case or short-stay basis.

In the past the workload of departments of radiology was concentrated primarily on supporting the care of hospital patients and on providing imaging services for outpatients attending consultant clinics. GPs' rights to request radiological examinations should be however similar to those enjoyed by hospital specialists. The concept that expensive investigation should be limited to clinical specialists is not sustainable. Specialists and GPs should have similar rights to request examinations. This is particularly highlighted with MRI or CT, where a single examination may avoid the need for an outpatient visit or an invasive procedure, which would cost considerably more. If GPs are undertaking primary diagnosis and management of patients, then clinical radiologists are acting as first-line clinicians and it is entirely reasonable for the radiologist to undertake the most appropriate examination. The radiologist also possesses the knowledge and competence to ensure compliance with all aspects of radiation protection and justification of investigations which is particularly relevant regarding CT. They should therefore recommend additional examinations where appropriate and manage the imaging diagnostic process in conjunction with the primary care clinician. The value of investigation which does not show an abnormality but reduces uncertainty and provides reassurance to the patient and to the GP, should also not be underestimated by the radiologist [13].

However, radiological investigations available to GPs must be determined by local radiologists in consultation with their GP colleagues as availability of new, often complex investigations may be limited in some countries and areas.

Electronic transfer has also developed rapidly over the last few years and the transmission of images and reports between radiology departments and surrounding GPs is now easily undertaken.

Closer working relationships with GPs and a stronger involvement of imaging in primary care will also increase contact of radiologists to their patients and particularly raise public awareness.

Maximising the use of resources

There has been a tendency in teaching and large regional hospitals for subspecialty services to pursue the development of satellite departments isolating radiologists from each other. While this may be essential in some clinical situations such as emergency departments, it potentially reduces the interaction between sub-specialist radiologists to the detriment of their wider knowledge and technological development. It may also reinforce the desire for clinicians to set up their own units and encourages the concept of radiologists working in clinical groups rather than providing a comprehensive imaging service. Radiologists should work towards a single strong well-staffed and funded department which is able to accommodate those clinicians who justifiably need prompt access to expert imaging [3].

Conclusion

The world of radiology is changing rapidly and radiologists have to be proactive in this process to survive. The subject is now too broad and complex for an individual to remain a comprehensive provider. As a result radiologists need to group themselves as specialists in particular systems or disease-based areas while finding a mechanism to provide a high-quality service. Radiologists must also be clinicians and understand the clinical features, natural history and treatments of the diseases that they are requested to investigate. Therefore, if radiologists want

to add value to the chain of healthcare they need to sub-specialise to a greater or lesser extent according to their working circumstances. Teleradiology services may be appropriate for small and rural practices as part of an area network especially during nights and weekends and for interaction with GPs and patients. Radiologists must also interact more directly with patients and primary care physicians to provide a comprehensive diagnostic and advisory service prior to the patient entering the secondary care service by managing the investigations of the patients themselves. This will increase efficiency, clinical effectiveness of the service and speed up the referral process. Radiologists in the teaching hospitals will also need to specialise to a higher degree in order to provide a tertiary referral service, communicate and advise clinical experts and to conduct and drive imaging research as true experts in their field.

Recommendations

- Sufficient radiologists are in training to ensure that the workforce is large enough to undertake the workload.
- System- (or disease-) based subspecialisation or the development of system- (or disease-) based areas of special interest is essential for all radiologists to respond to the complexity and technological advances of imaging.
- Encouraging radiologists to build strong networks with clinicians. In order to achieve this, all radiologists should have sufficient clinical knowledge in order to understand the fundamentals of clinical presentations, natural history, treatment and prognosis of all common and/or severe diseases. They should also obtain a more in-depth clinical knowledge of particular diseases related to any subspecialty in which they wish to practice. This may involve a number of strategies, but subspecialty and special interest curricula should ensure that trainees participate in clinical rounds, multidisciplinary meetings and provide opportunities for interaction with relevant clinicians.
- Wide clinical experience should be obtained before entering radiology. In such circumstances further clinical experience may only be required in a chosen subspecialty and to a level dependent on previous experience.
- Expanding consulting activities of radiologists with clinical specialists in multidisciplinary conferences.
- Intensifying relations with GPs offering diagnostic management of their patients including referral to clinical specialists if needed or full work-up in conjunction with the GP.
- Communicating with the patient and discussing options particularly in cases of primary care (patient referred by GP).
- Making use of teleradiology services in a proactive way through local area networks under the control of radiologists to incorporate general and sub-specialist radiologists in a comprehensive coverage of clinical scenarios.
- Ensuring that all radiologists involved in such networks keep close contact with referring physicians through both personal interaction and video conferencing.
- Encouraging radiologists to network with interventional radiologists to learn the basic aspect of the techniques, indications and imaging follow-up in order to increase the quality of care to patients and the potential referral to both.
- Ensuring that radiologists are conversant with the technical aspects of the equipment they are utilising and that sub-specialists involve themselves where possible in the development and implementation of new innovations.
- Reinforcing the clinical role of radiologists to use resources to increase day-case work, to make decisions regarding imaging strategies, and to explain the results and further examinations to the patients.
- Reinforcing the status of the radiologist with special interests.
- Training programmes are always subject to country by country variations but should be structured with these principles in mind. Possible combinations include:
- System- or disease-oriented sub-specialisation during the last 2 years of residency training (3+2). This may be followed by an additional 1 year fellowship training where appropriate.
- Additional clinical experience fitting to the radiological sub-specialisation within the subspecialty training period and fellowship.
- System- or disease-oriented training in two areas of special interest in the final 2 years of residency. This may be followed if appropriate by an additional 1 year fellowship training gaining further experience which may include an understanding of general practice medicine.

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References

1. Margulis AR, Sunshine JH (2000) Radiology at the turn of the millennium. Radiology 214:15–23
2. Margulis AR, Sostman HD (2004) Radiologist-patient contact during the performance of cross-sectional examinations. J Am Coll Radiol 1:162–163
3. Krestin GP (2009) Maintaining identity in a changing environment: the professional and organizational future of radiology. Radiology 250:612–617

4. Dalla Palma L (2006) Tomorrow's radiologist: what future? Radiol Med 111:621–633
5. Dunnick NR, Applegate K, Arenson R et al (2006) Training for the future of radiology: a report of the 2005 Intersociety Conference. J Am Coll Radiol 3:319–324
6. Alderson PO (2000) A balanced subspecialization strategy for radiology in the new millennium. AJR Am J Roentgenol 175:7–8
7. European Training Charter for Clinical Radiology, ESR 2005. http://www.myesr.org/html/img/pool/ESR_2006_VI_Training%20Charter_Web.pdf
8. Linton O (2004) Consulting. Acad Radiol 11:602
9. Neiman H (2001) ACR Bulletin 57:3
10. Alderson PO (2000) Customer service and satisfaction in radiology. AJR Am J Roentgenol 175:319–323
11. Schreiber MH, Leonard M Jr, Rieniets CY (1995) Disclosure of imaging findings to patients directly by radiologists: survey of patients' preferences. AJR Am J Roentgenol 165:467–469
12. Schreiber MH (1996) Direct disclosure by radiologists of imaging findings to patients: a survey of radiologists and medical staff members. AJR Am J Roentgenol 167:1091–1093
13. Rogers LF, Potchen EJ, Maynard CD (1995) The radiologist as a primary care extender. Radiology 194:19–22