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The Main and Most Important Radiological Role in the Future of the Healthcare Management: A Systematic Theoretical Review

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Abstract
This study aimed at exploring the main and most important Radiological role in the future of the healthcare management through a systematic theoretical review. As radiology plays the key role of jumping in to investigate disease diagnosing, staging, monitoring and following it over time and offering expertise and consultation on disease states. And highlighting that this discipline is now in a stage of profound metamorphosis through out of building the value of radiology and the radiologist, to empower radiologists to be larger contributors to care teams. The study concluded that the current radiology model, though useful in many respects, needs to adapt to changing economic incentives and in one way or another align itself with those of the clinicians radiologists serve.

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1.1 Introduction

Over the last two decades there have been a series of changes in medicine, technology, and national healthcare funding that have significantly changed the role that the radiologist plays in the healthcare system. Recently, the effects of these changes have become more conspicuous secondary to the increasing legislative scrutiny of diagnostic imaging and the ever increasing impact of information technology on all aspects of health care. The traditional image of the radiologist as a physician whose role is to sit in a dark room interpreting films and generating reports has become outdated, if not obsolete (Knechtges & Carlos, 2007).

Looking back, changes within radiology have largely been driven by technology changes. The digital era and new modalities are but two obvious examples. But looking ahead, we see economics and costs as driving forces for change. Radiology is a key player in achieving affordable care in this environment. Radiology, being in such a central position, has an opportunity to improve patient care throughout the healthcare chain, despite the economic pressure, but it requires change. A change in mindset and routines as well as in the imaging infrastructure and applications (Bates & Bitton, 2010).

Radiology has been a distinct medical specialty with unique technical challenges from its inception. The origins of specialization can be traced back to the technical nature of X-ray image (*see figure 1*) 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 (European Society of Radiology, 2009).

Figure (1): X-ray image

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 (*see figure 2*), 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 (Rahman, 2014).

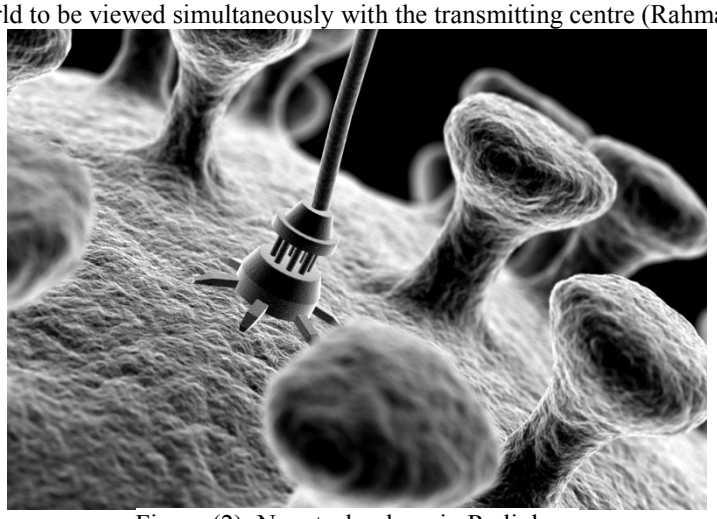

Figure (2): Nanotechnology in Radiology

It makes sense that radiologists play a larger role in patient management. Imaging is being used not just for diagnosis but to monitor the effect of therapy and to look for signs of disease recurrence. Routinely distinguishing among incidental findings, deciding which are irrelevant and which are fortuitous requires radiologists.

It is entirely possible that radiologists might recognize something other members of the patient care team might miss. Their discoveries might not even be central to the main discussion. Instead, they might pick up on something the team needs to consider early, something that could cause a big problem later on, perhaps when the issue of greatest concern is solved. This might, for example, be an orthopedic issue overlooked by specialists focused on a life-threatening cardiac condition (Perloff & Marelli, 2012).

It is in this new environment that radiologists must figure out how to remain an integral part of the healthcare delivery system. By virtue not only of the current political and economic changes in World healthcare, but also the massive technological evolution that the field has witnessed in the last decades, the traditional concept of practicing radiology in a central department needs to be reexamined closely and thoughtfully altered or perhaps done away with altogether. Furthermore, with these new incentives, the role of radiologist as thoughtful gatekeeper now merits consideration (Reinus, 2015).

1.2 Problem Statement

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 maximize 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 (European Society of Radiology, 2010).

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 (Margulis & Sunshine, 2000).

It is therefore incumbent on radiologists to mobilize their skills to utilize these new approaches to evaluate clinical questions in the most effective way. And therefore, the problem of this study lies in its attempt to highlight the main and most important Radiological role in the future of the healthcare management in a systematic theoretical review.

1.3 Importance of the study

Radiology plays the key role of jumping in to investigate disease diagnosing, staging, monitoring and following it over time and offering expertise and consultation on disease states. This discipline is now in a stage of profound metamorphosis. Therefore the importance of this study stems out of building the value of radiology and the radiologist, to empower radiologists to be larger contributors to care teams.

1.4 The need for change

Medical imaging and interventional radiology have been undergoing rapid advances in recent years. Patients now enjoy the benefits of earlier diagnosis and less invasive treatment alternatives with lower morbidity and mortality. The volume and complexity of work are steadily increasing but the supply of the professional workforce is not growing sufficiently to meet this increasing demand. From this perspective, modern radiologists are the victims of their success. This workload/workforce imbalance is one of the factors, which could potentially threaten the quality of care and patient safety.

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 (*see figure 3*), 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.

Figure (3): The epidemiology of aging

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 specialized imaging and training, and the influence of the radiological expertise would diminish.

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. 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 (Dalla, 2006).

1.5 The new Gatekeeper

One of the methods that radiologists can use to facilitate the appropriate allocation of resources is clinician education. Performing the appropriate exam can save the patient both the cost and the ionizing radiation associated with unnecessary/unindicated exams. Considering the rapid technological advances in radiology, regular clinic radiographic meetings/lectures could greatly enhance the clinicians' ability to order the appropriate studies. While the majority of studies ordered by clinicians are appropriate, occasionally the radiologist may feel that there is a more suitable investigation for the clinical question. Communicating this concern to the ordering clinician can result in the collaborative selection of the appropriate study and a learning opportunity for both parties. This type of collaboration between radiologists and clinicians can be taken a step further by jointly developing clinical decision rules or guidelines for imaging.

The gate keeping strategies outlined in the previous paragraph are, unfortunately, time intensive and, in the case of contacting a clinician regarding the ordering of an inappropriate study, not proactive. Improving the process by which studies are ordered and interpretations are rendered has the potential to significantly improve resource utilization without ongoing radiologist input. To this end, increased utilization of information technology holds promise for reducing the overall cost of imaging in the integrated health care system. Simply by having reports easily available, clinicians can know which exams have already been done and unnecessary repeat examinations can be avoided (Hillman, Olson & Griffith, 1992).

Implementation of a computerized order entry system could assist clinicians to order the appropriate studies. For example, integrating a decision support program, that would allow clinicians to enter a diagnosis or keyword and generate a list of appropriate imaging studies, could not only improve utilization but also decrease the amount of time spent contacting clinicians regarding inappropriate studies.

1.6 The Radiologist as Public Health Provider

Generally considered the domain of the primary care provider, public health encompasses a range of topics including immunizations, cancer screening, and other key health care services for reducing morbidity and mortality in the population. While radiologists are certainly involved in public health/ preventative medicine (e.g. breast and colon cancer screening), it is not immediately obvious that the radiologists' practice can be used as a vehicle to encourage increased adherence to cancer screening. Admittedly, radiologists do not have the longitudinal patient-physician relationships that give primary care physicians the opportunity to foster preventative health behaviors in their patients. Fortunately, there are naturally occurring life transitions or health events that are believed to motivate individuals to adopt risk-reducing health behaviors. These events have been termed "teachable moments" (McBride, Emmons & Lipkus, 2003).

The concept of the "teachable moment" can be applied to the radiologist's practice and may directly or indirectly serve as a method to improve quality of care by enhancing healthy lifestyles or by improving adherence to other screening tests. For example, mammography could be considered a "teachable moment" for educating patients about the risk of colon cancer and encouraging colorectal cancer screening (Carlos & Fendrick, 2005).

In addition, utilization of information technology could also increase the efficacy of such imaging cores without requiring significant additional costs in labor or infra-structure. Software could be adapted to detect nonadherence with health screening and subsequently electronically notify the primary care clinician. Other ways to use information technology include pop-up displays of needed services at the patient's next appointment or automated generation of patient reminders similar to screening mammography.

Increased involvement of the radiologist in promoting cancer prevention/early detection offers a number of potential benefits. In addition, using existing imaging tests to successfully promote cancer prevention increases the underlying value of the imaging test and may improve the cost-effectiveness of the original test. For example, successful application of the screening mammography encounter as a teachable moment for colon cancer screening may further improve the cost-effectiveness of screening mammography programs after accounting for decreased colon cancer morbidity and mortality. Finally, adoption of such preventive medicine initiatives within the radiology department can foster a more collaborative relationship with primary care physicians that will likely demonstrate an important "added value" of radiographic services.

1.7 The Future of Radiology Needs Radiation Safety Programs

As more hospitals begin to focus on patient dose they need to design and implement a process for this new data into their existing radiation safety programs. However, understanding your radiation dose data is only the beginning. The first step to improving any process is to understand what you have and where it came from. Most healthcare providers have not historically used patient radiation dose information in any meaningful way as a quality benchmarking tool. As the transition unfolds, organizations will increasingly require enhanced interoperability and IT integration of both staff and patient dose data to accurately capture, track and measure information to assess quality long term (Johnson, Krecke, Miranda, Roberts & Denham, 2009).

Swensen and Johnson described a quality (value) map for radiology that lends itself to tying all of these areas together (*see figure 4*). This map follows the path of the patient from the referring physician's office into the radiology department and the major steps required for ordering, performing, and reporting an examination. Safety is shown as the foundation for the care processes, outcome assessment as a measure of radiologist accuracy, and service as only patient satisfaction. This simple approach provides a basis for thinking about care processes and the metrics that describe them. The framework can be expanded with more detailed steps and metrics depending on the requirements of the practice.

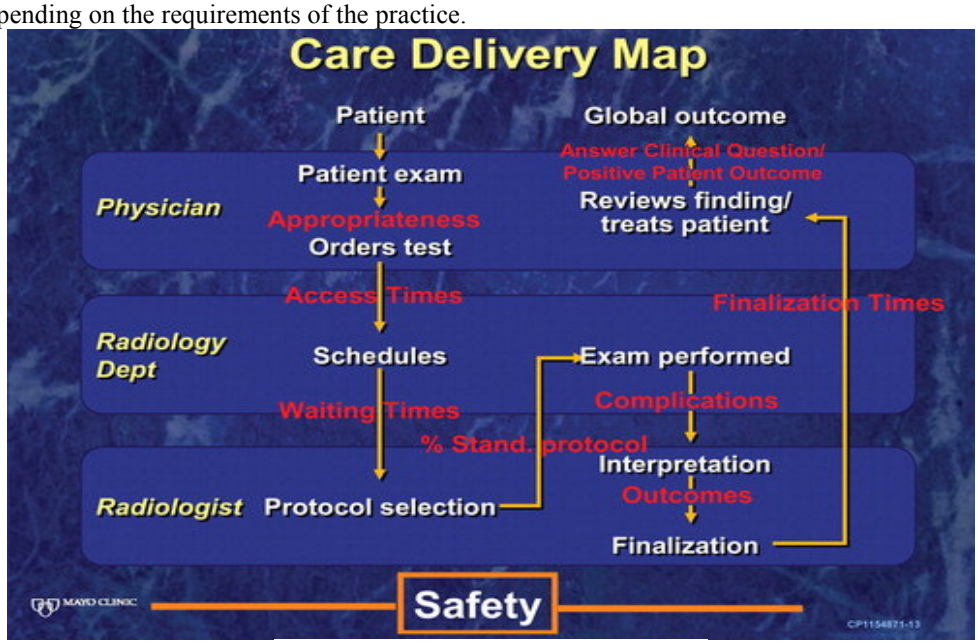

Figure (4): Defining quality in radiology

1.8 Artificial intelligence, machine learning find role in radiology

Artificial intelligence and machine learning capabilities are beginning to make an impact within radiology, as vendors start rolling out initiatives to assist professionals in making diagnoses.

The radiology profession is ripe for technology, as radiologists deal with an increasing number of images and bear more responsibility in the clinical process. For example, radiologists now are being called upon to determine what course of treatment might be less invasive, thus reducing cost, patient recovery times and the risk of complications. Or they typically are asked to assess the rate of progression of a disease such as cancer, to determine what course of treatment is most appropriate.

The use of advanced technology could be considered disruptive and perhaps threatening to some radiologists, but it will become essential for professionals to do their jobs effectively.

There's an explosion of information confronting radiologists, and there's a need for speed in processing it for patient care. With stroke, the window of opportunity to effectively treat the patient means an assessment has to be done in minutes, and radiologists need to look at images and be able to make a diagnosis instantly. That's where technology can assist (Rubin & Napel, 2010).

Radiologists are experiencing increasing demands to be more efficient with reading images, and this pressure will intensify as health care in the United States shifts to a more value-based model. Demand for image interpretation has increased to the point that a significant number of hospitals are now reportedly outsourcing their images to private firms. Some sources estimate that hospitals outsource more than 90% of their imaging, but, for the in-house radiologists at the hospital, there are still plenty of images to be read.

Radiologists want a bigger role in healthcare, one that allows them a say in patient management, ideally one that goes from diagnosis to therapy follow-up. They will get it only if they can demonstrate their involvement adds clinical value. Improving patient outcomes is one route to this goal. Artificial intelligence (AI) may be the vehicle. AI holds the potential for improved diagnosis (Wang & Summers, 2012).

The ability to mine the endless amounts of imaging data is driving AI innovation forward in radiology; however, as this disruptive technology and its data applications begin to find a more defined role, there are questions around its impact on the future of the industry. AI and deep learning have a wide range of applications and potential in radiology – spanning from improved diagnosis, enhanced workflow and inevitably, a shift in the radiologist's role. AI in radiology, for example, is designed to help tease out and prepare data for the radiologist, but as it relates to evaluating scans and diagnosis, the understanding of the interaction between the imaging physics and the disease biology is better done by the radiologist.

A merging of these two data-rich fields will allow the information specialist to understand the important data and manage the information in the clinical framework of the patient to help guide clinicians. It's a natural combination in this perspective and there are three phenomena happening now driving these compelling integrations:

- Correlation and aggregation of data.
- Emergence of computational framework.
- The digitization of pathology.

Over the foreseeable years, AI and human radiologists won't become an either-or proposition. AI applications will continue to become a primary tool of computer-aided detection, a symbiosis where AI automation empowers radiologists to focus on tasks which require the human-centric intelligence computers still won't deliver a relationship greater than the sum of its parts.

1.9 The Radiologists and Continuous Quality Improvement

The continuous quality improvement (CQI) literature emphasizes systems orientation and patient safety, but also seeks to apply lessons from operations research and industrial management to multiple other aspects of health care[30]. CQI methods have been widely adopted by administrators but are a relatively new concept within the radiology literature[30]. Although a full discussion of CQI is beyond the scope of this paper we will attempt to familiarize the reader with some of the basic concepts. If further information is desired, the article by Applegate in the references provides an excellent resource. CQI is defined as “the ongoing, organization-wide framework in which employees are committed to and involved in monitoring and evaluating all aspects of an organization’s activities (inputs and processes) and outputs to continually improve them”. The key features of CQI are customer-mindedness, data collection, experimentation, and team work. Like the systems approach to error management, CQI methods attempt to anticipate problems rather than react to them (Choksi, Marn, Piotrowski, Bell & Carlos, 2005).

The implementation of CQI methods occurs in a series of steps. The first step is to find a process to improve. The second step is to organize a team who skills are relevant to the problem (preferably an interdisciplinary team composed of people with different training and professional backgrounds). The third step is to study a process by analyzing the series of steps in that process and collecting data on each of those steps (note: this part of the CQI method is very similar to the aforementioned root cause analysis). The fourth step is to select a way to improve the process and implement that improvement. The fifth step is to repeat the entire process; hence the term continuous quality improvement.

Where CQI methods diverge from many current management decisions in health care is that the improvements made should be small and be part of an ongoing process. This is quite different from the common practice of assembling a committee to address a problem and move on to the next topic once the appropriate changes have been agreed upon. The mantra of CQI appears to be “start small, start early, and keep working on it”. Small changes instituted by interdisciplinary teams seem to better received and implemented than large changes imposed by people from a different discipline or background.

1.10 The Impact of Information Technology on Radiology Services

The more recent popularity of mobile devices combined with the exponentially growing availability of mobile applications has a significant impact on the fast development of new e-Health services. The increasing availability of mobile computing hardware and software is particularly relevant to radiology, where the day-to-day workflow is intimately intertwined with digital tools. What started in the early days of the Internet with websites, mailing lists, and newsgroups has evolved into a digital society where patients can and want to share their health information with almost whomever they want using social media and other applications. These “disruptive” innovations are progressively replacing earlier established communication tools.

An increasing number of health care professionals are also using social media for professional purposes, although most public platforms are not specifically developed and secured for such a purpose. In the recently conducted RANSOM survey, it was demonstrated that 85 percent of radiologists intensively use social media, mostly for a mixture of private and professional reasons (Ranschaert, 2016).

The professional use of social media could also be considered as a tool to optimize the perceived value and visibility of the radiologist. This idea is congruent with the ACR “Imaging 3.0” initiative, for example, in which radiologists are being called upon to make a more visible, active role in health care and to call attention to the work they do and its value to patients. Radiologists connecting with patients through social media could enable them to provide general information about radiology and to gain valuable insight in patients’ perceptions about radiological examinations and services.

It has been shown too that radiologists are using social media such as WhatsApp to discuss medical images with colleagues.

1.11 Future role of the Radiologist

Radiologists are responsible for the management of patients as well as supervision of the work performed by other members of the radiology team under their guidance. With their foundation of core clinical medical training, together with their specialist radiology training, radiologists understand the significance of a patient's medical history, examination findings and the results of investigations. The contemporary specialty of clinical radiology, including the professional care of patients by radiologists, is a process that starts at the point of referral – the commencement of handover of care to the radiologist – and continues until the care is handed back to the referrer, usually with the communication of results or upon completion of treatment. For patients being treated by radiologists, the responsibility for care may rest with the radiologist for much longer, potentially in partnership with the referring practitioner, as patients return for review or further treatment. Radiology has, and continues to be, essential to healthcare. With the rapidly developing and expanding field of radiology, the role and value of the radiologist is continuing to evolve and contribute to best practice patient care. Ongoing developments in patient care will mean an increasing role in the future for radiologists in:

- screening for disease
- early detection of disease at a more easily-treatable stage
- monitoring the response to treatment and
- treating patients and providing continuity of care

Radiologists represent one of medicine's least acknowledged but most important medical specialties in terms of the value they are able to add to patient care and health outcomes. Radiologists are often the 'behind the scenes' doctors who have a pivotal role in patient care, utilizing their general clinical and specialist radiological knowledge and skills in order to provide expert care for patients referred to them, whether it is for diagnostic tests or treatment.

This expertise is used to determine:

- which imaging techniques, if any, are most appropriate to investigate and/or treat clinical problems
- how best to use the selected imaging technique or perform a selected treatment including ensuring image quality is clinically acceptable
- the interpretation of the acquired images
- the writing of the report and
- the communication of the findings to the referrer in a time-appropriate manner and follow-up as appropriate.

Radiologists are also aware of the pitfalls of imaging and are well-trained in determining whether an imaging finding is real, significant or due to an unexpected cause.

More than other medical discipline, radiology is marked by technical innovation and continuous development, as well as the optimization of the underlying physical principles. In this respect, several trends that will crucially change and develop radiology over the next decade can be observed. Through the use of ever faster computer tomography, which also shows an ever-decreasing radiation exposure, the "workhorse" of radiology will have an even greater place and displace conventional X-ray techniques further. In addition, hybrid imaging, which is based on a combination of nuclear medicine and radiological techniques will become much more established and, in particular, will improve oncological imaging further, allowing increasingly individualized imaging for specific tracers and techniques of functional magnetic resonance imaging for a particular tumor. Future radiology will be strongly characterized by innovations in the software and Internet industry, which will enable new image viewing and processing methods and open up new possibilities in the context of the organization of radiological work (Nensa, Forsting & Wetter, 2016).

1.12 Conclusion

Radiologists, not imaging, are facing uncertain times. The Chinese ideogram for crisis is a combination of the ideograms for danger and opportunity. While there is danger in the air for radiologists, there may also be opportunity. Seizing the opportunity may take some radical thinking and a willingness to transform how radiology is practiced in the World. The current radiology model, though useful in many respects, needs to adapt to changing economic incentives and in one way or another align itself with those of the clinicians radiologists serve.

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