BUSINESS MODEL AND STRATEGY ANALYSIS FOR RADIOLOGISTS TO USE ELECTRONIC HEALTH RECORDS (EHR)
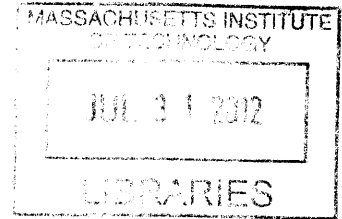
by

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Submitted to the System Design and Management program in partial fulfillment of the requirements for the degree of

Master of Science in Engineering and Management
at the
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ABSTRACT

Radiology is a medical specialty that employs imaging to diagnose and treat disease. It has long been an advance user of technology to capture, store, share, and use images electronically. In 2009, President Obama signed into law a measure, the HITECH Act (part of the stimulus package), that incentivizes healthcare providers to use electronic health records (EHR) in care delivery to improve quality, efficiency, safety, and reduce cost.

The meaningful use (MU) program's Stage 1 requirements (part of HITECH Act) did not include imaging requirements, leading to confusion among radiologists and other specialties with regard to what MU offers to and requires of them. This thesis attempts to clarify the contribution radiology can make to MU by understanding radiology as a system, including its surrounding issues and its drivers, using Stage 1 MU requirements, data from qualitative research, and results from analysis. It answers the following question:

Should Radiologists be considered part of the care team, leveraging EHR for meaningful use and hence eligible for incentive payments?

It does so via the following methods:

a) Discussing in detail current issues surrounding radiology systems from quality, safety, efficiency, and cost perspectives;

b) Discussing MU in the context of radiology and reviewing what is missing in it for radiologists;

c) Providing deeper systems analysis of current behaviors and why they have this form at this time; and

d) Explaining how MU objectives can help to overcome many current issues and ultimately help to improve health outcomes. Specific changes to MU criteria to achieve these benefits are recommended.

This thesis employs systems concepts and tools including system architecture and system dynamics for research and analysis to understand the system and derive hypotheses. A system dynamics model is used to analyze current drivers in imaging and to clarify the impact MU can have on these drivers. Thesis conclusions are supported by the analysis performed using the model as well as information gathered

through industry interviews, online articles, academic and industry journals, and blogs.

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1. INTRODUCTION

1.1. Healthcare in the US

The United States spends more per capita on healthcare than any other industrialized nation, but lags most other countries in outcome and healthcare coverage. Government and private payers reimburse for quantity, not quality, of healthcare. There is little coordination among providers in care delivery, and data are siloed in hospitals, clinics, labs, and pharmacies, locked away in proprietary systems.

Since its inception, radiology has gone through dramatic technological advances that have significantly improved the physician's capability to diagnose disease conditions earlier and more accurately, and in some cases treat them radiologically, saving thousands of lives. Radiology services are utilized for diagnosis and treatment across multiple specialty areas, including orthopedics, cardiology, cancer treatment, and many others. This tremendous growth has also brought unintended changes in physician and vendor behavior, leading to increased inappropriate utilization of imaging services. The effects range from increased healthcare spending to patients getting exposed to unnecessary radiation. In 2006, 13.3% of diagnostic imaging tests conducted in US was redundant or unnecessary [46]. Thus, both quality and safety issues plague the system.

On February 17, 2009, President Obama signed the American Recovery and Reinvestment Act of 2009 (a.k.a. "the Stimulus Bill") into law. This includes a provision to spend up to $19.2 billion to increase use of electronic health records (EHR) to increase healthcare quality and reduce cost. This part of the Act, referred as the HITECH (Health Information Technology for Economic and Clinical Health) Act, provides guidelines on EHR standards and certifications as well as incentives for healthcare players to adopt certified EHR technology. The government strongly believes that use of EHR will lead to several benefits, and accordingly there is an unprecedented drive to adopt EHR across the US.

As specified by the HITECH Act, the Center for Medicare and Medicaid Services (CMS) manages the Meaningful Use incentive program, whose current Stage 1 requirements focus on primary care. This has created confusion among radiologists (and other

specialties within medicine) about whether they are eligible for the incentive payments or will be penalized later for not meeting Stage 1 requirements. Also, it is questionable whether MU program's primary objective of improving quality, safety, and efficiency is achievable in current form, i.e., as part of the healthcare delivery process, and thus not directly addressing radiologists' needs.

This thesis examines the dynamics of the radiology specialty, including driving factors and causal relationships of technology, business, and policy conditions at this time. The following subsection explains in detail its scope, objectives, and methods.

1.2. Thesis Scope and Objectives

First, this thesis studies the current radiology system to understand its ecosystem, stakeholders, and technological subsystems, as well as issues in the areas of behaviors (i.e., usage, environmental), how radiologists are perceived in the healthcare ecosystem, technology, and policy. A study was conducted, primarily in Beth Israel Deaconess Medical Center, to characterize the current workflow, systems in use (including information technology [IT] systems), a literature review, and interviews with industry experts.

Second, MU Stage 1 requirements are reviewed in detail in the context of radiology, with discussion of core requirements, eligibility standards, incentives, and penalties. The impact of MU Stage 1's omission of imaging and other concerns relevant to radiology is discussed.

Third, using a system dynamics model provides insight into drivers in current imaging behaviors and possible MU impact could be on those drivers.

This thesis answers the following question:

Should Radiologists be considered part of the care team, leveraging EHR for meaningful use and hence eligible for incentive payments?

It does so via the following methods:

a) Discussing in detail current issues surrounding radiology systems from quality, safety, efficiency, and cost perspectives;

b) Discussing the HITECH Act in the context of radiology and reviewing what is missing in it for radiologists;

c) Providing deeper systems analysis of current behaviors and why they have this form at this time; and

d) Explaining how MU objectives can help to overcome many current issues and ultimately help to improve health outcomes. Specific changes to MU criteria to achieve these benefits are recommended.

The scope of this thesis is limited to radiology systems within United States.

1.3. Research Methodology

To understand the current radiology system and its issues, a literature review has encompassed industry and online journals, online articles, blogs, and academic journals. In addition, extensive interviews conducted with personnel at Beth Israel and Deaconess Medical Center (BIDMC), including radiologists, the PACS administrator, the Operations Director, the Medical Director, personnel in Business Planning and Strategy, and personnel in Information Systems.

To understand MU requirements, an extensive literature study was performed on current legislation, which was discussed with select industry experts in this area. Participation in relevant conferences, interview with IT vendors, and other activities supported understanding of MU requirements.

This thesis employs systems concepts and tools such as system architecture and system dynamics models to analyze and understand the dynamics of the system under consideration and to formulate recommendations.

This thesis is primarily a qualitative study, but cites quantitative information where applicable. Recommendations are made on qualitative aspects of the radiology system, supported by (a) qualitative data collected through research as already described, (2) results from system analysis, and (3) considering the entire setup from a systems perspective.

2. RADIOLOGY ECOSYSTEM

2.1. Advances in Radiology

Medical imaging has revolutionized the practice of medicine. Medical imaging technology continues to advance rapidly, continually offering new life-saving capabilities and new hope for winning the war against many devastating diseases. The radiology field already made great leaps in using advanced information technologies, especially as compared to other medical specialties.

Technologies such as computed tomography (CT) revolutionized the field by enabling physicians to look inside people without having to subject them to anesthesia and sharp blades. Imaging has enabled physicians to dissect patients without harming them. One could see things that one could not see before. The beauty of imaging is that one can visualize the anatomy before doing anything to the patient [5].

Advanced imaging such as CT and magnetic resonance imaging (MRI, which eliminates ionizing radiation exposure to patients), and, most recently, positron emission tomography (PET) scans, which have brought cancer detection and treatment to a higher level, have given doctors whole new sets of data to work with. Small tumors that were often overlooked can be seen before they become big tumors. Vascular lesions that might escape the trained eye of a surgeon can be found on a high-resolution digital image. Cardiac imaging and circulation mapping have become more precise, disease can be diagnosed long before a patient becomes terminal, and orthopedic surgeries can be avoided or at least confined in scope by using scans. In principle, costs could be controlled or even reduced because less surgery and hospital stays may be needed [5]. However, as shall be reviewed below in detail, this has not been the sole result of improvements in imaging technology.

2.2. Hospital Information System

A Hospital Information System (HIS) encompasses multiple subsystems ranging from specialty departments to administrative, financial, clinical, laboratory, and pharmaceutical departments, all networked to function as a unified system in hospital-based healthcare delivery. Before delving specifically into the radiology system, it will be helpful to understand the overall system architecture of the typical

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HIS and where radiology fits in. The overall architecture of HISs in US hospitals can be grouped into three high-level categories based on number of subcomponents and interface type. Below the details of the three prominent architectures, and advantages and disadvantages of each type, are discussed. Subsequently, radiology information systems (RISs) and other technical components of radiology are discussed. This chapter concludes with discussion of workflow, reimbursement policy, and current issues in radiology.

2.2.1. Single-Vendor Enterprise System

A single-vendor system is a large-scale HIS that integrates core clinical functions and operations in a hospital environment. The HIS stores all patient data, treatment information, and other related data in a common database that is accessed by internal personnel directly. Information is (ideally) always consistent and up-to-date. Figure 1 represents a typical architecture in which the HIS comprises subsystems to manage primary care, intensive care unit, emergency department, pharmacy, radiology, pathology, etc. A few external systems are interfaced with the HIS for specialized functions, such as a PACS (Picture Archive Communication System), laboratory systems, operation theater, and Enterprise Resource Planning (ERP) for financial/ human-resources/administration support services. HL7 is the global industry-standard protocol used to integrate software systems in healthcare informatics.
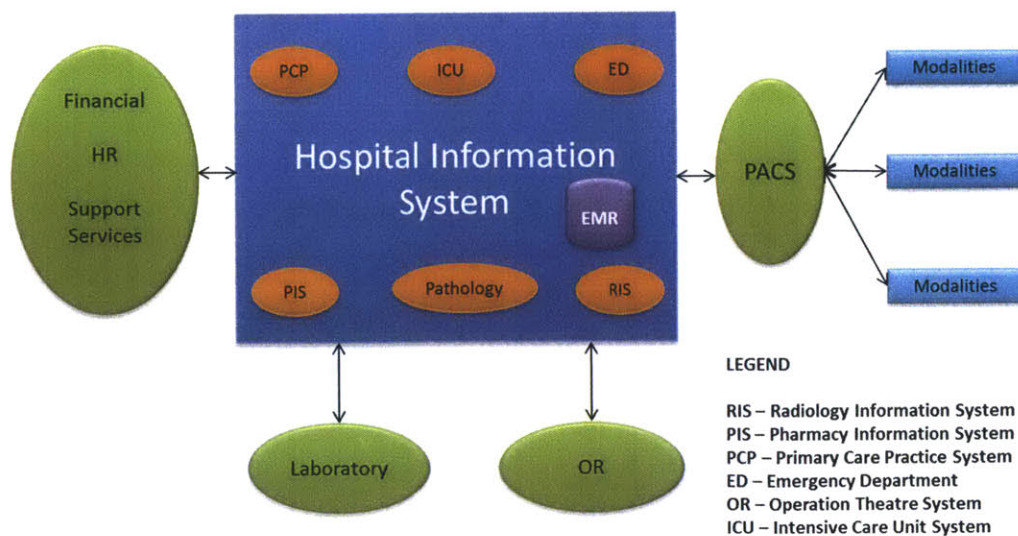
Figure 1. HIS Architecture: single-vendor enterprise system.

Some advantages of this type of HIS are:

- Clinical systems are integrated closely within the context of a single HIS system, enabling consistent user interfaces across subsystems and an easier learning curve.

- Common data model: data and processes are integrated together, ensuring data integrity, consistency. Data are updated in real time from all integrated systems.

- Fewer interface points: fewer integration issues, lower integration and operating costs.

- One vendor, one contract for most applications, thus fewer operational issues.

Some disadvantages of this type of HIS are:

- Higher implementation cost at the beginning due to larger scope and complexity; higher cost to get organizational consensus to re-engineer internal processes, which is often required for implementation.

- Risks of single-vendor lock-in (e.g., higher maintenance/update charges during life time of usage) [16].

- High switching cost to change to different vendor or architecture.

- Some of vendor subsystems within HIS are top quality; others are average or below-average quality.

Major vendors in this space are Epic, Cerner, and Meditech.

2.2.2. Best-Of-Breed Architecture

Best-of-breed (BOB) HIS architecture seeks to employ the best products in each application specialty typically needed in a clinical environment for improved clinical and business performance. Figure 2 is an example where applications from multiple vendors are interfaced together in hub-and-spoke model using an Enterprise Application Integration Engine (EAI) to connect them together. The role of an EAI is to simplify and automate business processes to the greatest extent possible [17] within an organization by enabling unrestricted sharing of data and business processes

among connected applications or data sources. Some characteristics of the BOB model are a proprietary data model, owned by each application; a highly encapsulated system boundary, limiting exposure to outside world know-how; lack of direct communication between applications; and a significantly larger number of interface points. An EAI controls the number of interface points required, thus reducing complexity of integrating subsystems; keeps information consistent across subsystems; and provides a common façade interface to end-users.
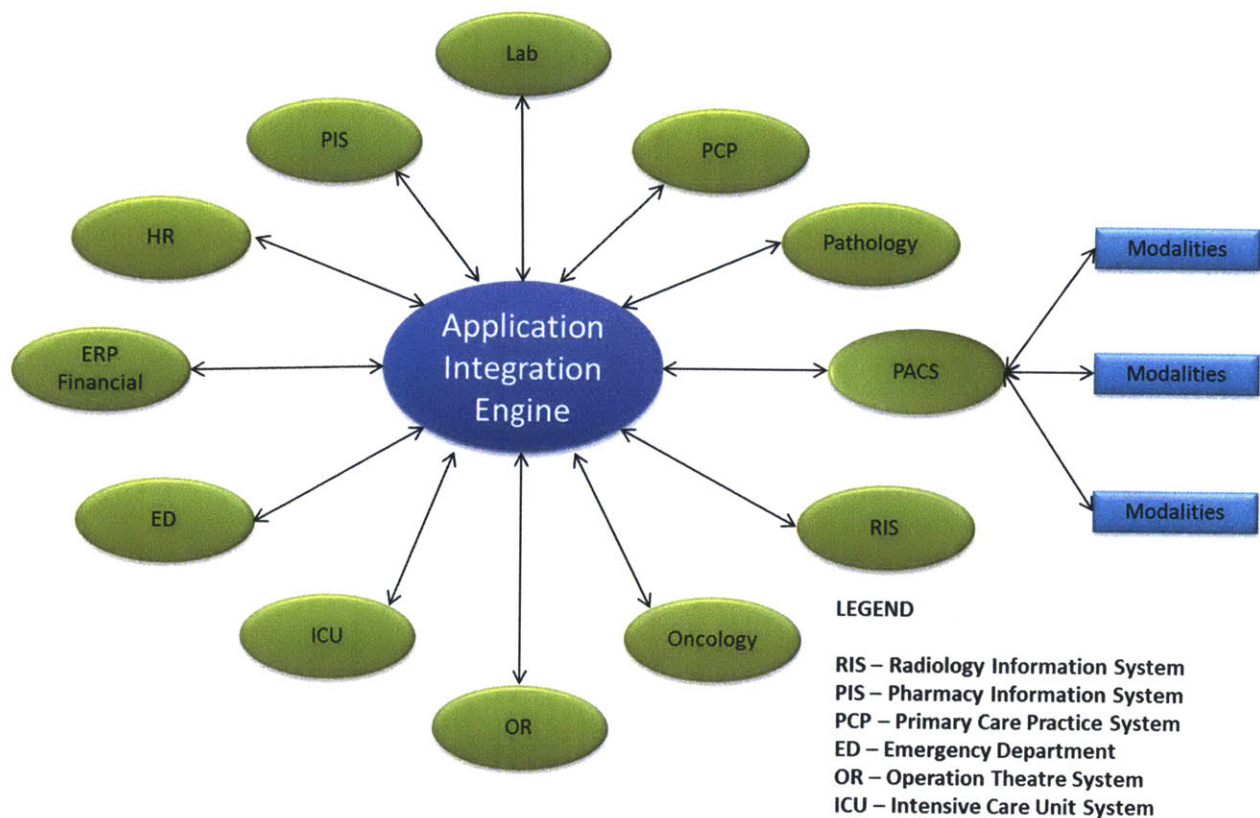
Figure 2. HIS architecture: best-of-breed.

Advantages of BOB systems include:

- Providers get best-in-class clinical applications, which often improve clinical performance, safety, and quality.

- Multi-vendor modularity of subsystems allows flexibility in business-process redesign to suit organizational requirements (unlike in single-vendor systems)

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- Risks associated with long-term support for the system are distributed across multiple vendors; i.e., if a particular vendor falls out of the market, the whole system is not necessarily affected.

Disadvantages of BOB systems include:

- The higher number of interface points entails extensive integration costs, resources, and time. With constant changes in the business environment, it is a challenge to keep the system updated.

- It is difficult to manage system integration of this complexity due to a shortage of EAI experts; the dynamic nature of an EAI requires a special skill set to manage such implementations. In 2003, it was reported that 80% of all EAI projects failed, primarily due to management issues [17].

- Significant integration issues arise from the complexity involved. Non-standard applications may lead to loss of productivity and to inefficiencies, hence to increased operational cost. Access to information is crucial at critical times in healthcare, and an inefficient operational environment poses a challenge to cost-effective management.

There are many EAI vendors; a few are Intersystems Ensemble, Microsoft BizTalk, and IBM Web Sphere.

2.2.3. Hybrid Homegrown System

This HIS type, essentially a combination of single-vendor and BOB system Figure 3, is prevalent in hospitals that originally developed home-grown EHR systems over the years. Third-party vendor applications usually outnumber single-vendor systems in this architecture, but are not as numerous as in the BOB model. This architecture primarily relies on a single-vendor model and there is no EAI. The goal is to use the fewest vendors to get the job well done; its complexity resides in integrating third-party systems using internal IT-department resources. Resources are always limited and priority is given to crucial tasks that directly affect or benefit day-to-day clinical operations. System integration issues are prevalent in this environment for the reasons mentioned earlier, but complexity and frequency of issues are lower than is typical with BOB systems.
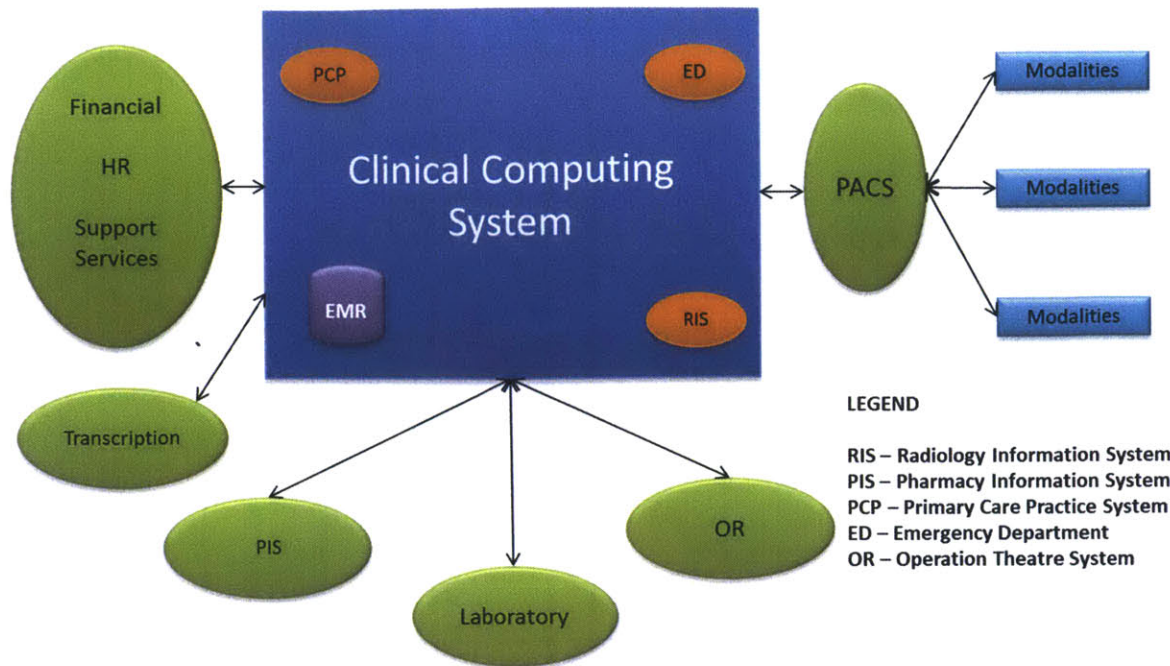
Figure 3. HIS architecture: hybrid system.

2.2.4. HIS at BIDMC

The current information system at BIDMC is an example of the hybrid homegrown HIS. It is the backbone of operations support; in particular, every step of the radiology workflow relies on it extensively. Figure 4 represents the current high-level IT systems that support radiology practice in the BIDMC HIS, primarily for the outpatient setting. The radiology system as a whole includes various stakeholders, beneficiaries (primary and indirect), and the Information systems that support its functions. Stakeholders are individuals or groups who may be affected by decisions or actions taken in the radiology system in any setting. The stakeholders in the radiology system at BIDMC are as follows:

- Physician community

- Radiologists

- Information Systems division

- Patients (customers)

- Regulators

- BIDMC (business)

- Software vendors

- Device (modality) vendors

- Employees (non-physicians)
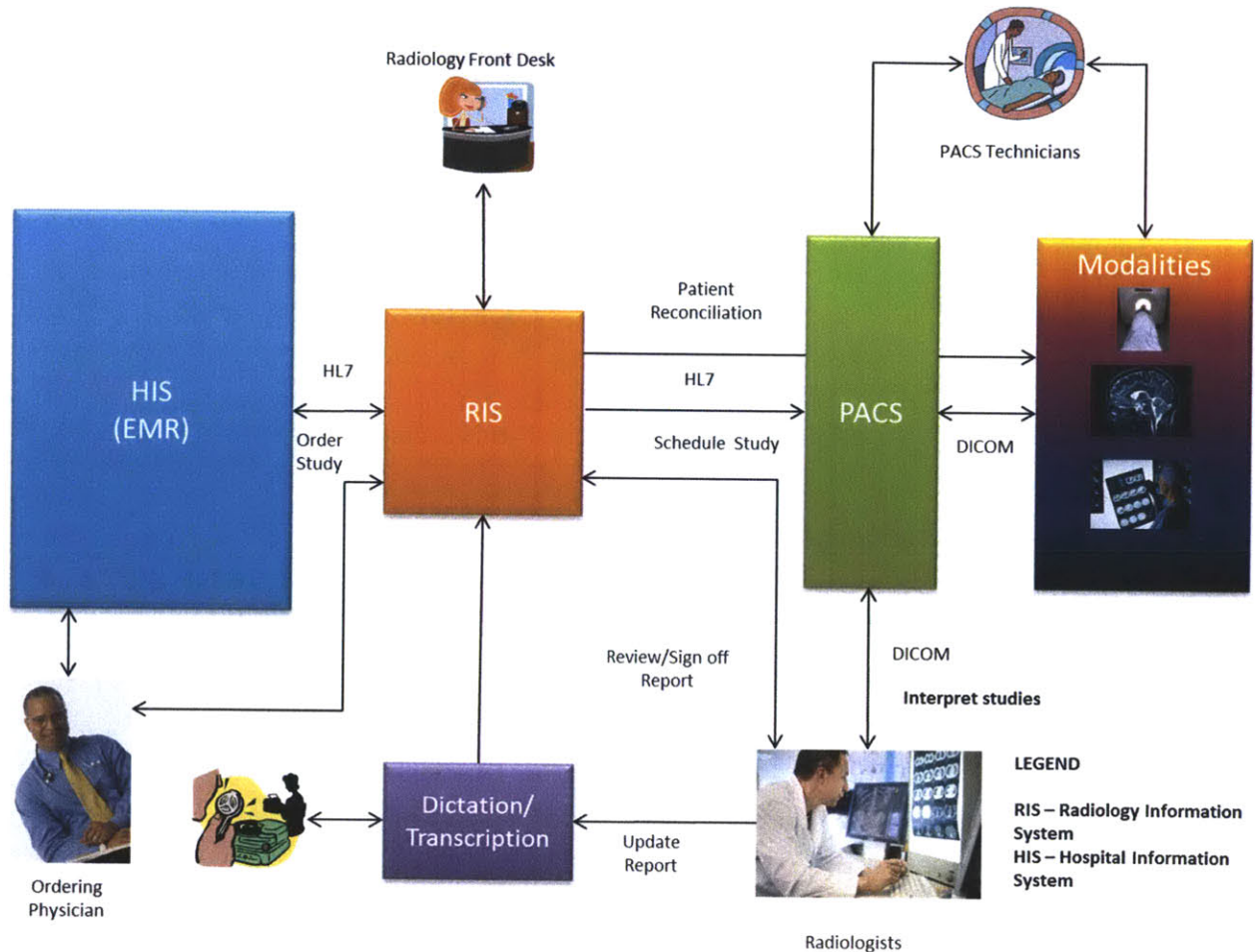
Figure 4. HIS system at BIDMC.

The primary beneficiaries (utilizers) of the radiology system are the "ordering physicians," doctors who seek to diagnose and/or treat their patient's conditions by leveraging imaging and other radiology services. Patients are indirect beneficiaries in this sense, in those cases where the imaging studies are of help to them. All other stakeholders also have vested interests in the system of one type or another.

2.3. Radiology System Components

The radiology system consists, from an IT perspective, of several subsystems, as reviewed below. HL7 governs subsystem interfaces—for example, data interchange between RIS and HIS, between RIS and PACS, etc.—to assure successful functioning of entire system.

2.3.1. Radiology Information System

A Radiology Information System (RIS) is a complete IT system supporting operation of radiology practice either within a hospital or private group-practice setting. The RIS is the primary system used by everyone in a radiology department for performing their day-to-day jobs. The primary functions of RIS are as follows:

- Scheduling

- Billing (at BIDMC, RIS sends information to billing system in HIS, which forwards billing to relevant payers)

- Coding

- Front Desk (check-in, demographics, etc.)

- Dictation

- Transcription

- Reporting (both study-related and for executive reporting)

2.3.2. Modalities

Each imaging technology used to conduct a study is referred as an imaging "modality" in medical terminology. This merely indicates the type of device involved, such as X-ray, CT, MRI, PET, or other. Section 0 covers this subject in more detail.

2.3.3. DICOM

Digital Imaging and Communications in Medicine (DICOM) is a standard developed by the American College of Radiology (ACR) and National Electrical Manufacturers Association to promote standardized communication of medical across devices (both diagnostic and therapeutic) manufactured by various vendors in a standardized

manner. Other goals are to facilitate the development and expansion of picture archiving and communication systems (PACs) that can also interface with other hospital information systems [34] and allow creation of diagnostic information databases that can be interrogated by a wide variety of devices distributed geographically.

The DICOM standard in its current version (3.0, evolved from version 1.0 [1985] and 2.0 [1988]) is structured as a multi-part document to facilitate evolution of the standard in a rapidly changing technological environment. The DICOM standard facilitates interoperability of medical imaging equipment for networked communication and off-line media communication and spells out conformance requirements, syntax/semantics of commands, and associated information (e.g., patient information, reports, study information) that can be exchanged using the protocols.

DICOM automatically associates image with metadata, demographic information, and other contextual data [39], but is primarily about study rather than patient. Also, DICOM provides flexibility to vendors to include both optional and proprietary information through use of these tags. Ideally, all vendors would store content in optional and private tags in consistent format, using the same tag (or attribute) key names so that images generated in one vendor's PACS system can be transferred to another without loss of information. Private tags can be used to store vendor-specific information which may be used for diagnosis, product development, or research.

Today the standard has expanded to support various fields such as radiology, cardiology, dentistry, ophthalmology, and others, and many vendors provide devices conforming to this standard. Interchange of images between devices and PACS systems are typically seamless thanks to the DICOM standard. In addition to the PACS, modalities workstations are equipped with software which conforms to DICOM. This has made possible an entire field of "tele-radiology" where geographically independent devices communicate using this standard. Such connectivity is necessary for cost effectiveness in today's integrated healthcare system.

The standard has also been continually developed to match technological advances. For example, the most recent version of standard specifies media formats for Blu-ray,

dose information summaries in radiology reports, and WADO (Web Access to DICOM persistent Objects) via web services.

2.3.4. PACS

A PACS (Picture Archive Communication System) is a client server system for centrally storing and retrieving images generated by various imaging modalities, allowing clients pull the images for the clinical use. In a hospital setting (or in a group of hospitals) a single PACS is deployed with connectivity to multiple sites. At each site all modalities link to the PACS, which maintain a "work list" or list of imaging studies at various stages. A PACS exposes a native application interface that is primarily used by technicians and radiologists to perform their primary functions (e.g., conduct studies, review/validate images, interpret and dictate reports for studies). Most PACS vendors also provide a web interface for accessing images remotely, eliminating the need for expensive PACS client workstation software.

PACS is well matured now in industry, and PACS systems provided by many vendors are able to communicate with each other using the DICOM message format. A PACS communicates with each modality following DICOM standards; indeed, any exchange of images between two radiology systems, either in software or hardware, obeys DICOM.

Most device manufacturers have their own PACS system, which is integrated particularly well with their modalities and devices. In addition there is a large selection of PACS/RIS systems from IT vendors that also work with all radiology devices from major device manufactures, including GE Healthcare, Siemens, Philips, and Fujitsu. Radiologists derive big value from the system because they can be much more productive reading digitized images via a PACS rather than putting hardcopy film onto a light board: PACS-enabled capabilities include remote instant access, viewing large set of images in a single screen, and annotation.

2.3.5. Dictation and Transcription

Dictation is a primary method for radiologists to record their reports about studies they have interpreted. Dictation is transcribed offline into a text report which is stored in an RIS. There are many ways to generate radiology reports, including conventional

typing, offline transcription systems, and on-demand systems. Each has its pros and cons; these revolve mostly around cost, quality, and speed. Given number of cases a radiology department deals with day to day in a hospital setting, high-accuracy, on-demand, near-real-time transcription is needed necessary for operational efficiency. BIDMC has been using eScription, an industry leading medical transcription system, and is now moving to Mmodal, a more real-time transcription system specifically targeted for radiology dictation and reporting.

2.3.6. Users and Needs

Table 1 provides a summary of needs of primary users in the radiology system.

User	System Needs
Ordering physician	Request for imaging study Review study/images (access images) Review report for diagnosis/treatment
Technician	Administrative tasks to set up, maintain, and operate PACS and modalities Administer a study Verify images and approve for interpretation Address issues rise with missing images, incorrectly linked images
Billing specialists	Pre-Authorization Billing
Radiology front desk	Scheduling Check-in
Radiologists	Protocol a pending study Review Images; utilize various system tools, annotate images Dictate report Optionally provide a recommendation(s) on study to ordering physicians Retrieve earlier studies for comparison, changes in patient disease condition over period of time
Transcriptionists	Transcribe a dictation into report
Residents	Research
Researcher	Academic and Research use of past studies

Table 1. Radiology system stakeholders and needs.

2.4. Modalities

2.4.1. X-Ray

X-ray technology enables doctors to see through human tissue to examine broken bones, cavities, and swallowed objects. Modified X-ray procedures can be used to examine softer tissues, such as the lungs, blood vessels, or

Figure 5 Modality: X-ray.

intestines. An X-ray machine uses the same film technology as an ordinary camera, but X-ray light sets off the chemical reaction instead of visible light [44]. It is increasingly common to acquire X-ray images digitally, without film.

2.4.2. Ultrasound

Diagnostic ultrasound, also known as medical sonography or ultrasonography, uses high-frequency sound waves to create images of structures inside the body. By directing sound waves into the body and measuring their echoes, the ultrasound machine is
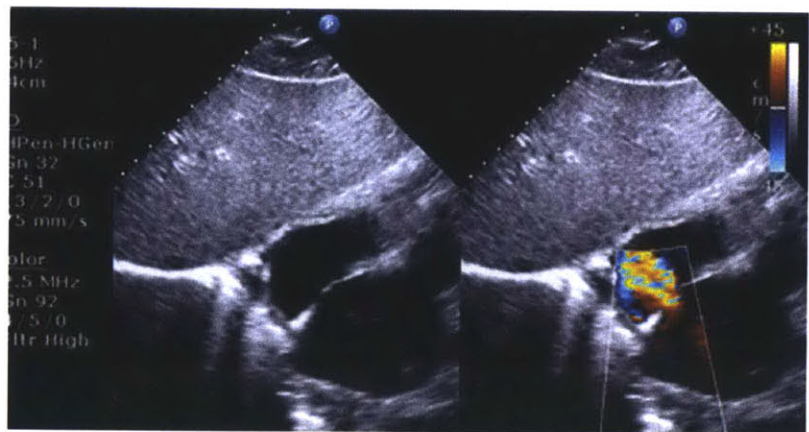
Figure 6 Modality: ultrasound

able to build up a picture in a manner closely analogous to radar. In addition to producing an image, ultrasound can also produce audible sounds of blood flow, enabling medical professionals to use both sound and visuals to assess health.

While most commonly identified with use during pregnancy, ultrasound is also used widely by virtually all medical specialties, including cardiology and surgery, to visualize muscles, tendons, and other structures. Ultrasound is now established as a critical tool both for routine and urgent-care diagnostics [44].

2.4.3. Computed Tomography

Computed [axial] tomography (CT), also commonly referred to as CAT scanning, is an imaging technique that provides detailed 3-D images of volumes inside the body. CT uses a thin beam of X-rays to take a series of cross-sectional pictures of specific organs or areas inside the body from multiple different angles. The CT's computer then analyzes the pictures and constructs a three dimensional image of the area of interest. During some CT scans, a contrast medium or "dye" is used to outline blood vessels or highlight organs of the body so

Figure 7 Modality: computed tomography.
Source [49]

that they can be seen more easily [44].

2.4.4. Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) is a medical imaging technology that uses radio waves and a powerful magnet linked to a computer to create detailed pictures of internal
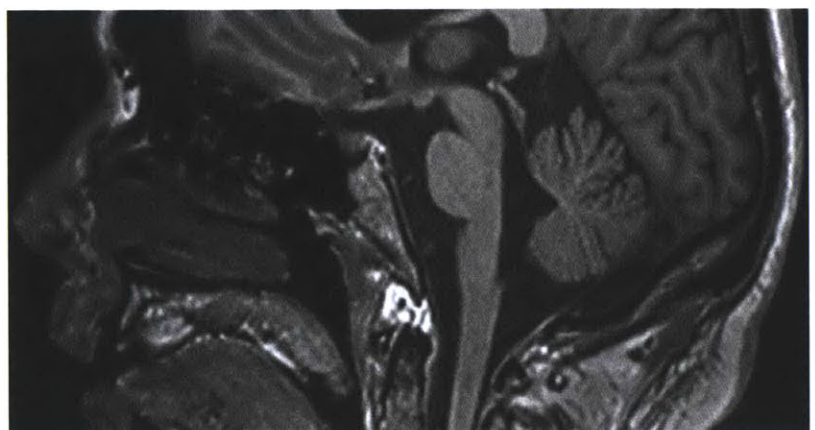
Figure 8 Modality: magnetic resonance imaging.

organs, blood vessels, muscles, joints, tumors, areas of infection, and more. These very high quality pictures can show the difference between normal and diseased soft tissues of the body, making MRI especially useful for a wide range of different types of imaging, including neurological and musculoskeletal. A contrast agent may be used to make the MRI image more informative [44].

2.4.5. Positron Emission Tomography

Positron emission tomography (PET) technology, often used in combination with CT, uses a scanner and a small amount of radioactive glucose (sugar) which is injected into a patient to make detailed, computerized pictures of areas inside the body where the glucose is used. A PET-CT scan consists of two parts: first, a CT scan to pinpoint the location for the PET, then the PET scan itself. During a PET scan, a ring of detectors picks up radiation signals from the patient's body coming from previously injected radiopharmaceuticals. The computer then analyzes the information and constructs an image of the targeted area. During some PET/CT scans, a contrast medium or "dye" is used to make the image more informative [44].
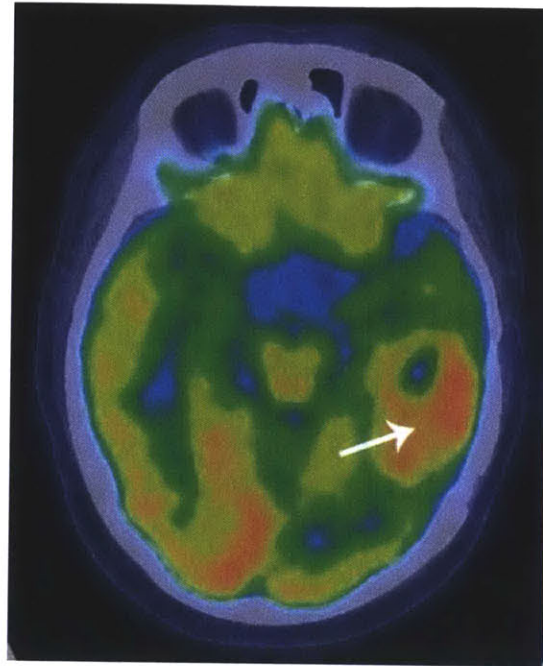
Figure 9 Modality: positron emission tomography. Source [48]

2.5. Workflow at BIDMC

Figure 10 depicts the current workflow of the BIDMC radiology department. Workflow setup plays an important role in day-to-day operations, and is crucial to the productivity and efficiency of the entire system.

Ordering Physician - HIS

Referring Physician Enters Order

Request Pre Authorization

Order Cancelled

Radiology Front Desk – RIS

Order in RIS

Schedule for Exam

Walk-in Patients

Order NOT found in RIS

Request to Create/Modify/Update Order

Radiologist Protocol Exam

Patient arrives for Exam

Technician – PACS/Modality

Technician Conducts Study

Modality Updates Image in PACS

Exam Manager Updates unlinked images

Technician Verifies Image

Radiologist RIS, PACS, Dictation

Radiologists Sign off Report in RIS

Report Updated in RIS

Results Transcribed

Radiologists Review

Radiologists Interprets Images & dictates report

- - - -> Avoidable Manual Step   — · · — · · — Missing Links   Text in Red - Inefficient part of workflow

Figure 10. Radiology workflow at BIDMC.

The workflow begins with a physician ordering an imaging study for a patient through the ordering portion of the HIS. BIDMC has an advanced, rule-based Clinical Decision Support (CDS) system to aid the ordering process. The CDS is integrated with ACR appropriateness criteria. After patient-data inputs are taken from the ordering physician, the information is uploaded to a cloud-based web service hosted by ANVITA. The service returns best-practices information to assist in ordering the right tests for the particular case. In addition, for selective insurance providers (Blue Cross Blue Shield of Massachusetts, Tufts, and soon Harvard Pilgrim) it automatically authorizes the test as part of the initial ordering workflow. Both pre-authorization approved studies and those not requiring require pre-authorization are entered into RIS as imaging orders. The exam may be scheduled in several different ways, e.g. patient walk-in, call-in through call center to schedule in advance, or physician office calls in for appointment. At the time of patient walk-in, if the order is not in the

system—typically due to the physician office forgetting to call in while patients come directly from the office to Radiology—the front-desk assistant calls the physician office to get the order into the system (which can happen almost immediately).

Once an exam is scheduled, insurance details are verified and the order is converted into a requisition to conduct a study. At this time patient information and order data are propagated to both the PACS and the Modality (e.g., MRI, CT), where the exam is scheduled. In advance of the exam, a radiologist protocols the study to specify that the correct test is ordered and what information is requested from the study. If this results in requesting additional information, this is discussed with the physician's office. Sometimes this involves changing test type if the radiologist strongly feels that the original request is not optimal for the patient's condition. This happens very rarely in the hospital outpatient setting, where patients regularly come to same hospital. In the case of private-practice groups, there is little or no opportunity for radiologists to interact with the physician's office.

Once the protocol is complete, a technician performs the actual exam using the appropriate modality and the image is transferred to the PACS. The technician verifies the image using the PACS console and marks it as verified. However, if patient information (e.g., date of birth) is altered between when the original order is sent to Modality/PACS and the exam is conducted, the changes are propagated to the PACS server but not the Modality. The result is that images are not linked to the right patient in PACS and are left in an unlinked state. The Exam Manager periodically reviews such unlinked images and relinks them to right study request in PACS. During interviews, BIDMC personnel estimated that this happens for up to 5% of studies conducted.

Once an exam is updated, as verified in RIS by the technician, the image (or set of images) is ready for interpretation by the radiologists and appears on their list for review. A radiologist use PACS workstations to view and analyze the images and often to add annotations that get stored in the PACS along with the images. After review, the radiologist dictates results which get transcribed into the RIS. Upon receipt of the report in the RIS, the radiologist reviews the final report and signs off in the RIS. This

is the final step of the radiology workflow, after which physician gets to review the image through a web-based interface with PACS and report through HIS.

2.6. Reimbursement Model

The reimbursement component for radiology has two parts, the Professional Component (PC) and the Technical Component (TC). Payers pay for the PC of radiology services furnished by a physician to an individual patient in all settings under the fee schedule for physician services, regardless of the specialty of the physician who performs the service. The interpretation of a diagnostic procedure includes a written report. The TC is billed according to equipment, supplies, technicians, and facility, but does not include interpretation. Different rules apply whether facility is inpatient, outpatient, or a free-standing imaging center.

The payment model is based on number of studies conducted and interpreted and is thus essentially a type of Pay for Service (a.k.a. Fee for Service, FFS) , a very common payment model in US health care. The greater the number of services provided, the more providers are reimbursed (as long as there is medical necessity). This has introduced several unintended behaviors into the radiology field, driving up cost, utilization, and spending. The same behavior has led to increases in self-referral in imaging services from private-group practitioners.

Congress responded to continued increases in imaging utilization and cost by making payment cuts through several legislation channels. Summarized below are initiatives targeting radiologists in the recent past:

a) The Deficit Reduction Act (DRA) of 2005, signed into law by President Bush in 2006, included payment cuts of up to $2.8 billion for imaging services over 5 years [10]. The law equalizes Medicare reimbursement rates between outpatient imaging procedures and independent imaging centers by capping reimbursement for the TC of physician-office imaging to the lesser of the Hospital Outpatient Prospective Payment System (HOPPS) or Medicare Fee Schedule (MPFS) payment [10]. The provision also cut reimbursement for the technical portion of MR imaging, CT, and ultrasound exams on contiguous body parts by 25% in 2006 and an additional 25% in 2007.

b) The 2010 Medicare Physician Fee schedule (MPFS) changes equipment utilization rate for imaging systems priced at more than $1 million, from 50% to 90% [11]. By increasing equipment utilization, it essentially cuts per-service technical fees drastically. Many contend that a utilization rate increase to 90% is impractical and is therefore far from reality for most practices; it is also unclear whether a 8 hour work period is used for the calculation or a 24-hour period. For example, imaging centers in rural areas don't get enough patient volume to maintain a 90% utilization rate. And where an imaging modality is operating at 90% utilization, it is unable to handle urgent cases.

c) Table 2 and Table 3 outline the impact to reimbursement as result of this initiative.

Cumulative impacts of CMS's 2010 Medicare physician fee schedule Final Rule, excluding the potential change in the conversion factor of –21.2%.

Specialty	Allowed Charges (mil)	Impact of Work RVU	Impact of Practice Expense RVU	Impact of Resourced Based Malpractice (% change)	Combined Impact
Interventional radiology	$225	−1%	−9%	0%	−10%
Nuclear Medicine	$74	−5%	−15%	−2%	−23%
Radiation Oncology	$1,809	0%	−3%	−2%	−5%
radiology	$5,056	0%	−14%	−2%	−16%

Table 2. CMS 2010 Medicare physician fee schedule
Source: [10]

d) The June, 2011 MedPAC Recommendations to Congress targets three out of its four recommendations to payment adjustments related to imaging services:

- Congress should direct the Secretary to apply a multiple procedure payment reduction to the professional component of diagnostic imaging services provided by the same practitioner in the same session.

- Congress should direct the Secretary to reduce the physician work component of imaging and other diagnostic tests that are ordered and performed by the same practitioner.

- Congress should direct the Secretary to establish a prior authorization program for practitioners who order substantially more advanced diagnostic imaging services than their peers.

Modalities (Technical Component)	2009 Payment Rate	2010 Payment Rate	Fully Implemented Payment Rate	2009 vs. 2010 % Change	% Change 2009 vs. Fully Implemented
CT head/brain w/o dye	$174.92	$149.67	$90.17	−14%	−48%
CT head/brain w/dye	$224.69	$193.67	$119.02	−14%	−47%
CT head/brain w/o & w/dye	$276.99	$238.40	$145.71	−14%	−47%
Chest X-ray	$14.79	$14.07	$12.26	−5%	−17%
CT angiography, chest	$352.01	$340.47	$340.47	−3%	−3%
MIR chest w/dye	$427.39	$423.99	$323.87	−1%	−24%
CT chest spine w/o dye	$194.40	$194.04	$117.94	0%	−39%
MRI chest spine w/o dye	$348.04	$349.53	$220.72	0%	−37%
CT abdomen w/dye	$298.27	$259.31	$162.66	−13%	−45%
Echo exam of abdomen	$72.85	$71.05	$67.80	−2%	−7%
Mammogram, one breast	$49.05	$47.25	$44	−4%	−10%
Mammogram, both breasts	$63.12	$61.31	$58.07	−3%	−8%

Table 3. Code specific impacts of CMS 2010 Medicare physician fee schedule

The radiology community has raised several concerns about these payment cuts, including their possible impact on quality of care. For example, as reimbursement declines, providers have to make up for the loss in some other manner, such as reducing personnel or outsourcing administrative functions such as billing, contract renegotiation, etc. [11]. This may eventually lead to limiting the physician's ability to order the best possible test for a given patient, thus affecting the quality of diagnosis. Thus, although the initiatives may reduce utilization and curtail total spending, concern on quality of the care remains. Other concerns of the community include:

- Reduction in technical fees can have significant impact in rural areas where volume of service is low and hence it is difficult to offset equipment costs while maintaining service.
- The law does not address the self-referral issue, which many think the root cause of increased Medicare imaging expenditures [10].
- From a radiology perspective, "CMS and Congress are attacking the utilization problem in a counter-productive way where they will stifle investment, research and development and potentially force closure of a lot of centers, impairing access—especially in rural areas" (Alan Kaye, MD) [11].

On the private payer side, efforts to curtail spending range from integrated Clinical Decision Support (CDS) systems to provide relevant information to physicians when ordering and to Imaging Management programs in which the physician calls third-party administrators to get pre-authorization.

One example (obtained through personal interview) of these cost-control efforts in action is a program implemented by Blue Cross Blue Shield of Massachusetts (BCBSMA) for physicians (under their HMO) to get pre-authorization before ordering an imaging study. Unlike any other pre-auth program, this one does not deny a request, but directs the physician to consider all alternatives before submitting an order. The program focuses not on denying procedures but on "educating" physicians about trends, usage statistics, and other information relevant to making better decision *to order a right study at first time*. BCBSMA measured the progress of the program and found it has a physician acceptance rate of >90% with no measurable degradation in quality. After the program started in 2006, at which time spending on imaging was increasing by high single-digit percentages yearly basis, costs moderated, moving to <1% increase/year in 2009 and negative growth in 2010. Based on the success of this program, BCBSMA is looking to fold a similar program into their PPO program.

2.7. Trends in Radiology

Radiology has contributed valuable services over the decades, but some aspects of system setup have led to unintended behaviors that have contributed to quality and safety issues, inefficiencies, and higher spending. This section discusses key trends in radiology related to spending and utilization.

2.7.1. Rising Imaging Spending

Proliferation of imaging technology has resulted in improved diagnostic capability in almost every sub-specialty of medicine, where imaging is used as an effective diagnostic tool for early detection and for treatment. Indeed, radiology workflow has been IT-enabled for a longer time now than any other specialty. At the same time, cost of imaging services has grown significantly due to capital investment in equipment and the attractiveness of the industry from a business perspective. Higher return on investment in this area has resulted in mushrooming of the number of free-standing imaging centers and in-office imaging equipment ownership by private group practice physicians. Figure 11 compares number of MRI units/million persons as of 2006 across a number of countries. Not surprisingly, the US has largest MRI units/million persons among these industrialized countries.

Moreover, total spending in US healthcare for diagnostic imaging has been steadily increasing over the years and currently is growing at twice the rate of rise in total healthcare costs. Per MedPAC's June, 2011 report [6], imaging-related expenditures are the fastest growing of all types of services in Medicare claims. From 2000 to 2009, volume of imaging services grew by over 60%. In terms of payments, imaging services makes up 19% of total Medicare payments for 2009; by volume its share is 14% [6]. The two primary reasons for this spending increase are increased cost and increasing utilization. Advances in imaging technologies such as PET and MRI greatly increased the capital investments in equipment, software, and resources required to acquire and operate them. This in turn has increased average cost per imaging study at almost twice the rate of other technologies (e.g., lab procedures, pharmaceuticals) [2].
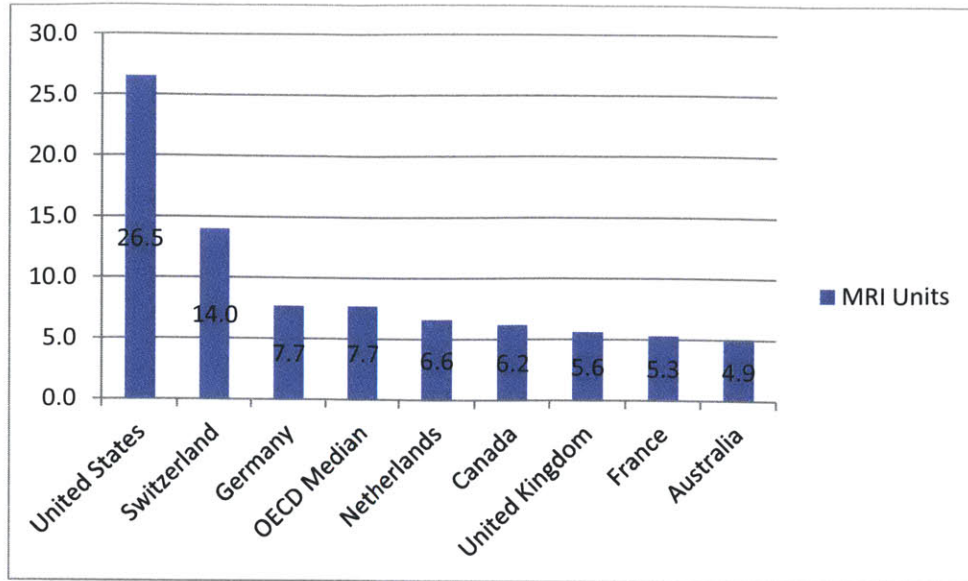
Figure 11. Number of MRI units/million persons for 2006.

Source: [8]
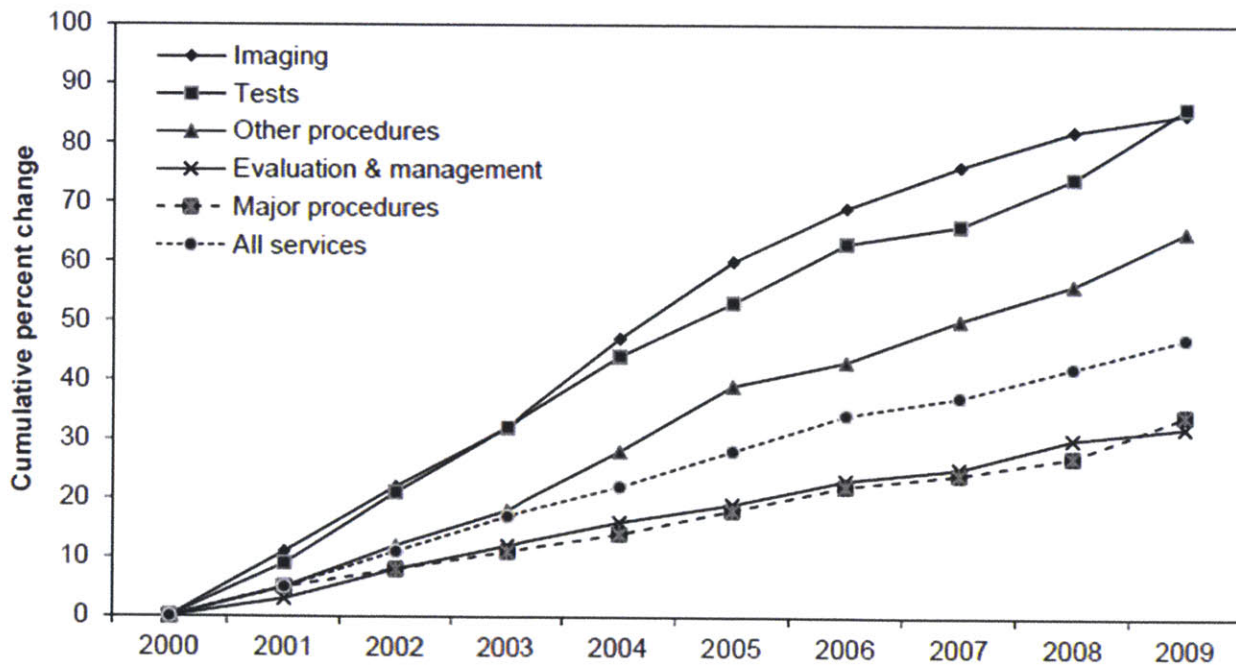
Note: Volume is units of service multiplied by relative value units from the physician fee schedule. Volume for all years is
measured on a common scale, with relative value units for 2009.

Figure 12. Spending under Medicare for different services.

2.7.2. Reasons for Growing Utilization

Growing utilization is the result of multiple factors and is a primary contributor to spending increase. Interviews and literature research reveal that several reasons are often cited for the trend of growing utilization trend in radiology. Summarized below are the most common reasons cited for growing utilization. (A detailed analysis of primary drivers in imaging and the behaviors they are causing is given in Chapter 4.)

Self Referral. Self-referral is referral for a procedure in which the referring physician is also the service provider or has an ownership interest and benefits financially by providing the service [2]. Up to 3.2 times as many scans are ordered in such cases; self-referral leads to approximately $16 billion a year in unnecessary imaging procedures [2], according to a study by Levin and Rao [3]. These behaviors, often in private group practice, are clearly profit-driven.

A study conducted by Center for Studying Health System Change, the 2008 Health Tracking Physician Survey, reveals the severity of the self-referral issue [7]. The study finds that advanced medical imaging equipment is likely to be owned by 30.3% of surgeons, 10.6% of primary care physicians treating adults, 13.5% of non-procedure-based medical specialists such as neurologists, and 15.7% of procedure-based medical specialists such as cardiologists.

Reimbursement Models. The current fee-for-service payment model is cited as a major motivator to order more imaging studies, as this directly contributes to rise in profit. This is universal problem in the US healthcare system, not just in radiology.

Ordering Physician Behavior. Each specialty has different imaging ordering behavior patterns. Non-radiologist physicians often lack knowledge of alternative options available to study a condition. For example, a PCP may take a conservative approach in most cases, trying out more basic diagnostic options before considering an imaging study, whereas specialty doctors have tended to go straight to imaging because they may assume that a patient coming to them does not require basic level of diagnosis, rather, imaging for a more precise diagnosis. However, this behavior has got better recently; today, most specialty providers know what the right study for a given condition is. Another aspect of physician ordering behavior is that higher patient volume leads to doctors spending less time in carefully evaluating conditions; some

may choose imaging as a short-cut. Also, the ordering physician's lack of knowledge regarding what study would be appropriate, and/or lack of access to such guidelines, may contribute to the ordering of more unnecessary studies.

Patient Expectations. Patient expectations are high today in terms of getting imaging done early, as patients understandably want a definite diagnosis as quickly as possible. For example, in urban areas patients are more knowledgeable than in rural areas, and demand more from providers as they actively participate in personal healthcare. Given that insured patients are not the primary payers for such services, there is little incentive to think twice before asking for an imaging study.

Defensive Medicine. Medical liability concerns drive physicians to be defensive in diagnosis. Physicians may order studies even in cases where they aren't sure whether a particular study will help, just to avoid getting sued for not following certain protocols. No law penalizes physicians for ordering wrong or irrelevant tests, only when they don't order a test per clinical guidelines for a given clinical condition. A study in Massachusetts found that 25% of high-tech imaging studies were ordered principally for defensive purposes, at a cost of $1.4 billion per year [2]. Though it is difficult to exactly quantify the contribution of defensive medicine to inappropriate use of imaging services, most professionals agree that it is at least 5% of total health costs [2].

Access to Older Studies and Medical History. Patients often see different physicians during the treatment cycle, and may not carry complete medical histories with them during such visits. In the absence of previous reports or studies, and or a complete medical history, or due to technical incompatibility between systems used by different providers, a new physician often choose to order study even if it was conducted before to diagnose the patient. Within a given hospital environment this is not typically an issue, rather, this problem arises primarily between different providers.

Lack of Care Coordination. Physicians and radiologists coordinate very little today in care delivery. This is true across most of the areas within medicine, where the patient goes through a fragmented care process and there is little exchange of information across providers treating same patient. There are two noteworthy issues here: (1) radiologists never get to know the end result of diagnosis they have provided to

patient, i.e., whether it helped to improve the health outcome or not, and (2) physicians miss an opportunity to learn and to improve, on an ongoing basis, their awareness of the appropriate use of imaging.

Aging Patient Population. Aging of the population poses challenges to US healthcare, both from the cost perspective and as regards capacity to handle increased patient volume. Older patients having relatively higher-need medical conditions, thus requiring more testing and more expense in general.

Image Quality. Poor scan quality (e.g., from an obsolete scanner) contributes indirectly to increase in utilization, leading either to repeating of tests or wrong diagnosis with subsequent re-imaging. Some imaging centers have very old scanners not accredited by the ACR, which sets minimum standards on scanners [1]. However, this issue is almost non-existent in urban areas and is likely rare even in rural areas.

2.8. Systems Issues

Healthcare is a complex enterprise involving multiple stakeholders, users, and regulatory constraints, as well as multiple software systems and devices that require varied forms of skills to operate. Steven J. Spear, in his book *Chasing the Rabbit* (2008) notes that in "systems of work" involving many disciplines, equipment is correspondingly complex, requiring that efforts of many specialists be integrated and coordinated in a harmonious fashion. The difficulty is that the more numerous and varied the people, machines, and materials involved, the more ways they can interact with each other, often with unanticipated results [9].

After studying the current information systems and workflow of the BIDMC radiology department and its operation within the organization, and after interviewing many actors in industry, several important issues are evident across different areas of the system. These include information systems, policy, environment, and workflow. All of the issues ultimately limit the overall productivity of the Radiology group, giving rise to quality and safety issues and to inefficiencies.

Some of these issues are:

- The Radiology department seems to be set up as "function oriented," i.e., as an individual department whose members are good at what they do individually, but

where gaps exist from a system perspective: e.g., lack of communication, systems failing to talk to each other seamlessly, inefficient workflow steps involving longer process/step to complete certain tasks.

- In case of a hybrid-type system such as that employed at BIDMC, RIS enhancements have organically grown over a period of time, with incremental updates. A pending major enhancement is to transform a PACS-driven workflow into a RIS-driven workflow

2.8.1. DICOM Standards Issues

Thought at a high level images that are generated in a given modality and stored in a PACS from one vendor can be transferred to a PACS from another vendor with required data migrated, such interoperability is in practice far from seamless. Two main issues continue to hinder smooth transfers of images across multi-vendor systems. First and foremost is variations in the metadata used in DICOM format across vendors, and associated challenges to interoperability of DICOM confirming systems (PACS, Modality) with other hospital information systems (RIS, HIS). The second is the continuing proliferation of non-DICOM format based CDs having study images adapted to non-standard viewers.

Each vendor uses custom metadata attribute names in optional and private tags (or attributes), such that only their own Modality/PACS system can understand and use the data fully. As a result, images generated from modalities belonging to different vendors do not conform to DICOM identically; in fact, they differ in many ways. For example, a vendor may use a private tag to store important study information such as Annotation data which could be useful if provided in public tag. Moreover, not all systems capture exact image times, which may also store in different precisions. When such DICOM images are shared, the receiving PACS may not load all data values, as it likely to have its own custom metadata attribute format. As a result numerous interoperability issues arise in image sharing across PACS from different vendors. Though there are no data available to quantify the intensity of this issue, interviews with radiologists in industry reveals that it is a very common occurrence.

Archival storage is also affected by this issue: i.e., an image archived using one vendor's system may not store all attributes because it does not understand the entire DICOM structure in the image, which has originated with another vendor's system [40]. In addition, interoperability of PACS with HIS/EMR using HL7 is also impacted because EMR has to understand custom metadata from each vendor separately to handle various integration functions such as patient demographic updates, patient reconciliation, and patient identification [40].

The net impacts of these issues are loss of productivity, quality and safety issues from partial data or incorrect data, and resource wastage in trying to correct defective data.

Offline media communication involves writing images to disc (e.g., CD-R), which the patient can carry to the referring physician and/or other radiologists or specialists. Such communication is impacted not only by metadata mismatches but by related workflow and DICOM viewer issue afflicting the workflow. Recent data from the Mayo clinic (in RSNA 2011) reveal an up to 88% jump in the number of non-DICOM images received on CDs from patients from 2007 to 2010 [41]. Upload of such images into in-house PACS causes inefficiencies (e.g., patient ID difficulties) and there are no standardized tools to support the associated workflow steps. In most cases, every hospital uses different viewers, so a receiving provider/hospital may not be able to view images using its own house workstations/tools unless it is loaded into PACS.

Though DICOM has defined standards for media exchange (Parts 10, 11, and 12), these are not completely adhered to by vendors. Viewers are not standardized and major modality/PACS vendors neither provide standardized viewer support nor have any incentive to do so, in the absence of a legal standard for imaging systems [36]. Automatic patient access to medical records (including images) has not been customary in US healthcare system thus far, and this has also reduced demand for such support in medical community.

2.8.2. Information System (IT) Issues

Summarized below are some common IT system issues in radiology.

- In many cases, PACS-driven workflows are in use for radiologists, whereas RIS/EMR actually captures the truth of study status at any given time. PACS

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was not originally designed for use as a workflow system, as it lacks a common application framework to support authentication, notifications, automation, patient life cycle data management, etc. Issues resulting from integration issues between PACS and EMR/RIS systems include studies not picked up for review and duplicate reviews.

- Interoperability issues between RIS/HIS and Modalities/PACS lead to inconsistent patient demographic updates, patient identification issues, and similar difficulties. Though interoperability is not an issue in perfectly integrated systems, it requires reasonable cost to update such interfaces any time there is a change either on HIS side or PACS side. When this happens there is risk of images getting linked to incorrect patient records, which can cause critical safety issues.

- Though BIDMC found to have a good quality Clinical decision support system, in many cases outside referring physician doesn't have access to right set of tools, knowledgebase about ACR criteria to aid in their ordering decision. This leads to sub optimal image order which found to be inappropriate in many cases and may not answer the question, referring physician is looking for.

The issues below result from environmental factors and physician behaviors:

- Today, in most setups encountered in the course of this research, there is no fixed feedback loop between ordering physicians and radiologists. Such communications are completely voluntary today. As a result, there is no way for a radiologist to learn about the end result of a report they have provided— whether it served its intended purpose, i.e., to treat the patient. Clinically, it is valuable for a radiologist to know the end result, as this the only way to learn from experience.

- Absence of communication between radiologists and physicians severely limits physician awareness of clinical guidelines, e.g., ACR appropriateness criteria, which are can help physicians to order the right study at the right time.

- Absence of Clinical Decision Support systems in some cases (BIDMC, notably, currently has one of the best CDSs in use) results in poor-quality order

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requests containing little or no information about patient condition and context of the request for study. This requires radiologists in some cases to request data from referring physician while protocol-ing orders, which impacts productivity and gives fewer opportunities for the radiologist to recommend an appropriate study.

3. MEANINGFUL USE AND RADIOLOGY

3.1. Electronic Health Record

"Our recovery plan will invest in electronic health records and new technologies that will reduce errors, bring down costs, ensure privacy, and save lives." — President Obama, Address to Joint Session of Congress, February 2009 [18]

Certified EHR technology, used in a meaningful way, is one piece of the broader health information technology infrastructure needed to reform the health care system and improve health care quality, efficiency, and patient safety. An EHR is a longitudinal electronic record of patient health information gathered during one or more instances of care delivery. It generally includes patient demographics, patient health condition/issues, treatment information, laboratory results, medications, medical history, allergy information, immunizations, and other relevant data. An EHR makes complete and accurate information readily available, with ready sharing and improved coordination between providers (doctors, laboratories, payers), thus ultimately enabling the provision of better quality care. It empowers patients by giving them greater control over when and where information is shared. The ability of providers and patients to easily share and access information is expected to yield annual cost savings in the order of $23 billion for Medicare and $31 billion for private-sector firms (Wikipedia) through efficiency improvements, avoidance of unnecessary examinations, and provision of better care. In addition, by allowing generation of aggregate information about health statistics, medical conditions we can create value in clinical and academic research, understand pattern of disease in a geography which are not achievable with paper-based records.

3.2. HITECH Act and Meaningful Use

3.2.1. Overview

The American Recovery and Reinvestment Act of 2009 included a key feature, the Health Information Technology for Economic and Clinical Health Act (HITECH Act). The HITECH Act encourages leveraging of IT for improvements in delivery of healthcare quality, safety, and efficiency. It includes provisions for incentive payments to

providers serving Medicare and Medicaid patients for the adoption and "meaningful use" of certified EHR technology. The Centers for Medicare and Medicaid Services (CMS), part of the Department of Health and Human Services, manages the incentive programs and regulates program participants.

3.2.2. Meaningful Use

EHRs do not achieve their expected benefits if information is merely transferred from paper to digital form. They do so only when providers and hospitals use those EHR-enabled functions that deliver the most benefit: for example, ready exchange of information, computerized order entry, decision support systems, and leveraging of clinical intelligence for improved care delivery. Therefore, the "meaningful use" approach requires that providers meet specified objectives in the use of EHRs in order to qualify for incentive payments. Meaningful use (MU) criteria to qualify for incentive payments were released on July 13, 2010. Furthermore, three components of MU are specified [23]:

- Use of certified EHR technology in a *meaningful manner.*
- Use of certified EHR technology for *electronic exchange of health information* to improve quality of healthcare.
- Use of certified EHR technology to submit *clinical quality measures* and other quality measures.

The criteria for MU of EHRs to achieve improved health care quality, efficiency and patient safety are staged in three steps (Stages 1, 2, and 3) over the course of five years (2011–2016). Each stage will build on criteria and implementation experience from prior stages. The criteria specify a set of objective measures as quality measures applicable for EPs and eligible hospitals. They also specify applicable exclusions for various conditions. Table 4 lists high-level objectives for MU under each of its stages.

3.2.3. CMS Incentive Programs

3.2.3.1. Overview of the Two Programs

The Centers for Medicare and Medicaid Services (CMS) manages two incentive programs, the Medicare EHR incentive program and Medicaid EHR incentive Program.

STAGE	TIMING	MEANINGFUL USE OBJECTIVES
1	2011	• Electronically capture health information in a structured format • Use information to track key clinical conditions • Communication of information for care coordination purposes • Initiate reporting of clinical quality measures and public health information
2	2013	• Disease management • Clinical decision support • Medication management • Patient access to health information • Quality measurement and research • Bi-directional communication with public health agencies
3	2015	• Achieve improvements in quality, safety and efficiency • Decision support for national high priority conditions • Patient access to self-management tools • Access to comprehensive patient data • Improving population health outcomes

Table 4. Three stages of Meaningful Use and its objectives.
Source: [19, 20, 21]

The Medicare EHR incentive program provides incentive payments to eligible professionals (EPs), hospitals, and critical access hospitals (CAHs) that are meaningful users of certified EHR technology. In this incentive program, an EP must be a doctor of medicine or osteopathy, doctor of oral surgery or dental medicine, doctor of podiatric medicine, doctor of optometry, or chiropractor [22].

The Medicaid EHR incentive program provides incentive payments to EPs and hospitals for efforts to adopt, implement, upgrade, or meaningfully use certified EHR technology in first year of implementation [19, 20]. This program requires successful demonstration of MU in subsequent years [20]. In this incentive program, EPs include physicians, dentists, certified nurse-midwives, nurse practitioners, and physician assistants practicing in Federally Qualified Health Center (FQHC) or a Rural Health Clinic (RHC) led by a physician assistant [24]. The program is voluntary for state Medicaid agencies; if a state decides to opt out, EPs in that state will be unable to receive incentive payments through Medicaid.

EPs who meet the eligibility requirements for both the Medicare and Medicaid EHR incentive programs must designate which program they would like to participate in (only one may be chosen). After a payment is made, EPs will be allowed to change their program selection once before 2015.

An EP who works at multiple locations, but does not have certified EHR technology available at all of them, must meet the following criteria [23]:

- Has 50% of total patient encounters at locations where certified EHR technology is available.
- Bases all MU measures reported only on encounters that occurred at locations where certified EHR technology is available.

3.2.3.2. Medicare EHR Incentive Program

Table 5 describes the Medicare EHR incentive program in detail.

MEDICARE EHR INCENTIVE PROGRAM	
Eligibility	• Medical professionals, hospitals and CAHs. • Hospital-based professionals providing less than 90% of services in inpatient services or emergency department.
Incentives	• Can receive maximum of up to $44,000 per provider in total spanning five-year period. • A qualifying EP will receive incentive payment equal to 75% of Medicare allowable charges for covered professional services furnished by EP in a payment year subject to maximum payments. • An EP who predominantly furnishes services in a geographic Health Professional Shortage Area (HPSA) is eligible for a 10% increase in the maximum incentive payment; maximum payment is thus $48,400. • Qualifying EP can receive an annual incentive payment as high as $18,000 if their first payment year is 2011 or 2012.
Timing	• Begins in 2011, ends in 2016. • First year's EHR reporting period is 90 continuous days; every year thereafter it is the entire year. • EPs who first demonstrate meaningful use in 2014 will receive payment as if they began meaningful use in 2013 • Last year an EP can begin receiving incentive payment is 2014.
Penalties	• Payment adjustments beginning in 2015 in EPs Medicare physician fee schedule starting at 1% reduction and maximum of 5% in subsequent years. • The Recovery Act allows for a hardship exception; if applicable, exempts certain EPs from the payment adjustment subject to annual renewal (max. 5 years limit).

Table 5. Medicare EHR Incentive Program details.
Source: [21, 22]

Table 6 shows maximum incentive payments based on first calendar year in which EP participates in the program.

To get the maximum incentive payment, Medicare eligible professionals must begin participation by 2012. The HPSA bonus, $4,400 for those qualified, is additional to

this payment but declines to $3,900 for those starting in 2013 and to $2,400 for those starting in 2014.

Calendar Year	First Calendar Year for Incentive Payment			
	2011	2012	2013	2014
2011	$18,000			
2012	$12,000	$18,000		
2013	$8,000	$12,000	$15,000	
2014	$4,000	$8,000	$12,000	$12,000
2015	$2,000	$4,000	$8,000	$8,000
2016		$2,000	$4,000	$4,000
Total	$44,000	$44,000	$39,000	$24,000

Table 6. Medicare incentive payment schedule based on first CY of payment.
Source: [22, 23]

3.2.3.3.   Medicaid EHR Incentive Program

Table 7 describes the Medicaid EHR incentive program in detail.

MEDICAID EHR INCENTIVE PROGRAM	
Eligibility	• An EP must meet either (1) meet certain Medicaid patient volume thresholds as given in Table 8 or (2) practice predominantly in an FQHC or RCH where 30 percent of the patient volume is derived from needy individuals[1]. • An exception is that a pediatrician may have at least 20% Medicaid patient volume and still qualify, but for a reduced incentive.
Incentives	• Up to $63,750 available for qualified EPs over a six-year period. • Pediatricians who meet 20% patient volume but fall short of 30% may receive up to $42,500 over a six-year period.
Timing	• State agencies may begin offering as early as January 2011. • Last year to begin participating is 2016. • May receive payments up to 6 years; 2021 is the final year for the payments.
Penalties	• None for non-compliance

Table 7. Medicaid Incentive Program details.
Source: [24]

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[1] Section 1903(t)(3)(F) of the Act defines needy individuals as individuals meeting any of the following three criteria: (1) they are receiving medi-cal assistance from Medicaid or the Children's Health Insurance Program (CHIP), (2) they are furnished uncompensated care by the provider, or (3) they are furnished services at either no cost or reduced cost based on a sliding scale determined by the individual's ability to pay.

Table 8 shows the above-referenced patient volume thresholds by provider type.

Entity	Min. Medicaid Patient Volume Threshold (%)	
Physician	30	Or the Medicaid EP practices predominantly in an FQHC or RHC with a 30% "needy individual" patient volume threshold.
Pediatrician	20	
Dentist	30	
Certified nurse-midwife	30	
Nurse practitioner	30	
Physician assistant when practicing in an FQHC/RHC led by a physician assistant	30	

Table 8. Medicaid patient volume thresholds by provider type.
Source: [24]

Table 9 specifies maximum incentive payments based on first calendar year in which an EP participates in the program.

Calendar Year	First Calendar Year for Incentive Payment					
	2011	2012	2013	2014	2015	2016
2011	$21,250					
2012	$8,500	$21,250				
2013	$8,500	$8,500	$21,250			
2014	$8,500	$8,500	$8,500	$21,250		
2015	$8,500	$8,500	$8,500	$8,500	$21,250	
2016	$8,500	$8,500	$8,500	$8,500	$8,500	$21,250
2017		$8,500	$8,500	$8,500	$8,500	$8,500
2018			$8,500	$8,500	$8,500	$8,500
2019				$8,500	$8,500	$8,500
2020					$8,500	$8,500
2021						$8,500
Total	$63,750	$63,750	$63,750	$63,750	$63,750	$63,750

Table 9. Medicaid EHR incentive payments by calendar year.

3.2.3.4. Differences between Medicare and Medicaid Programs

Table 10 describes notable differences between the two programs.

Medicare	Medicaid
Federal Government (CMS) manages it.	Optional for states to implement (may not be an option in every state).
Payment reductions begin in 2015 for providers who do not demonstrate MU.	No Medicaid payment reductions.
Must demonstrate MU in 1st year.	A/I/U option for 1st participation year.
Maximum incentive is $44,000 for EPs (bonus for EPs in HPSAs).	Maximum incentive is $63,750 for EPs.
MU definition is common for Medicare.	States can adopt certain additional requirements for MU.
Last year a provider may initiate program is 2014. Last year to register is 2016. Payment adjustments begin in 2015.	Last year a provider may initiate program is 2016. Last year to register is 2016.
Only physicians, subsection(d) hospitals, and CAHs.	5 types of EPs, acute care hospitals (including CAHs) and children's hospitals.

Table 10. Differences between Medicare and Medicaid her incentive programs.
Source: [23]

Below, discussion of MU is focused on EPs rather than on institutions.

3.2.4. Process Overview

The MU legislation and the CMS's EHR incentive programs present one with a massive amount of information to review, analyze: one must understand the program requirements and develop a long-term plan to meet legal obligations for radiology practice groups (as for any specialty). The information load is daunting in many cases, having wide implications across one's business, legal, finance, and IT strategy; it requires thorough review of cost to implement EHR and meet legal requirements to avoid penalties, decisions on whether to buy off-the-shelf EHR products or get an existing system certified, workflow changes, education and training—and the list goes on. Complete, detailed review of these issues is beyond scope of this research, but below is a list of steps radiologists can take to get started and what is involved in getting through the process.

1. **Determine Eligibility**

Review the eligibility requirements list in prior sections above (or on the CMS web site, http://www.cms.gov/CMSEHRIncentiveprograms/) to determine your (or your group's) eligibility.

   a. **Free RMU Practice Analyzer.** The radiology Meaningful Use Practice Analyzer is a unique application intended for all US radiologists hoping to understand, and potentially participate in, the CMS EHR Incentive Programs. The online application will guide you through the complex process of analyzing your practice for Meaningful Use. You can access the tool by visiting http://www.healthmu.org/radiology/analyze/index.php.

   b. **Program Choice.** If you are an EP eligible for both of CMS incentive program, you must choose a program to participate and follow the relevant steps below. If you are not sure about which one to choose, review section 3.2.3 above.

2. **Medicare EHR Incentive Program**

   a. **Get Registered.** You may register by going to this site: https://ehrincentives.cms.gov. You can register before you have a certified EHR. For detailed instructions on how to register, refer to the Medicare registration user guide and Registration Page using the link under APPENDIX A.

   b. **Use Certified EHR technology.** Make sure that the EHR technology you are using has been certified by Office of the National Coordinator for Health Information Technology. Refer to Section 3.4.3 for more details on this.

   c. **Be a Meaningful User.** Demonstrate MU successfully for a consecutive 90-day period in your first year of participation (and for a full year in each subsequent years) to receive EHR incentive payments.

   d. **Attest for Incentive Payments.** To get your EHR incentive payment, you must attest (legally state) through Medicare's secure website that you have demonstrated MU with certified EHR technology. Refer to Appendix A for attestation page.

3. **Medicaid EHR Incentive Program**

    a. **Get Registered.** Visit "Medicaid State Information page" (Appendix A) to see if your state is participating in the Medicaid EHR Incentive Program. If it is, register at https://ehrincentives.cms.gov. You can register before you have a certified EHR. For detailed instructions on how to register, refer to the Medicaid registration user guide using the link in Appendix A.

    b. **Get Qualified.** To receive incentive payments in the first year under this program, you must do at least one of the following:

      i. Adopt certified EHR technology.

      ii. Implement certified EHR technology you have already purchased.

      iii. Upgrade your current EHR technology to the newly certified version.

      iv. Demonstrate MU of certified EHR technology for a 90-day period.

    c. **Attest for Incentive Payments**. To get your EHR incentive payment, you must attest (legally state) through your state's Medicaid agency website that you have met all of the eligibility criteria, including having adopted, implemented, upgraded, or meaningfully used certified EHR technology.

3.3. Stage 1 Objectives and Measures

"Meaningful use" includes both a core set and a menu set of objectives that are specific for eligible professionals and hospitals. For EPs, there are a total of 25 MU objectives for core and menu, with 44 clinical quality measures (CQMs).

3.3.1. Core Objectives

Core objectives are mandatory. Each MU objective has an associated measure and reporting requirement. The reporting requirement defines what data to report to CMS.

Radiologists may find that some of the objectives do not apply to outpatient imaging. Five core objectives may be excluded if they do not apply.

The 15 core objectives for EPs are as follows [23]:

1. Computerized provider order entry (CPOE)
2. E-Prescribing (eRx)
3. Report ambulatory clinical quality measures to CMS/states

4. Implement one clinical decision support rule

5. Provide patients with an electronic copy of their health information upon request

6. Provide clinical summaries for patients for each office visit

7. Drug-drug and drug-allergy interaction checks

8. Record demographics

9. Maintain an up-to-date problem list of current and active diagnoses

10. Maintain active medication list

11. Maintain active medication allergy list

12. Record and chart changes in vital signs

13. Record smoking status for patients 13 years or older

14. Capability to exchange key clinical information among providers of care and patient-authorized entities electronically

15. Protect electronic health information

3.3.2. Menu Set Objectives

Five objectives must be chosen from 10 menu set objectives. Not all may be relevant for radiology [22]. Five menu set objectives may be excluded if they do not apply.

The list of menu-set objectives is as follows [23]:

1. Drug-formulary checks

2. Incorporate clinical lab test results as structured data

3. Generate lists of patients by specific conditions

4. Send reminders to patients per patient preference for preventive/follow up care

5. Provide patients with timely electronic access to their health information

6. Use certified EHR technology to identify patient-specific education resources and provide to patient, if appropriate

7. Medication reconciliation

8. Summary of care record for each transition of care/referrals

9. Capability to submit electronic data to immunization registries/systems[2]

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[2] At least one public.

10. Capability to provide electronic syndromic surveillance data to public health agencies.[3]

3.3.3. Clinical Quality Measures

CMS defines a CQM as a measure of processes, experiences, and/or outcomes of patient care, based on observations or treatment that relate to one or more quality aims for health care such as effective, safe, efficient, patient-centered, equitable and timely care [26]. CQMs help CMS to ensure that quality health care is delivered to Medicare/Medicaid beneficiaries by enabling measurement and comparison of delivery of care in a standardized manner.

For EPs, 44 CQM are available. EPs must report on a minimum of six and a maximum of nine CQM. The measures should be chosen in such a way that benefit of measuring them aligns well with clinical objectives for a given provider type. EPs must report three core or alternate-core measures and three out of 38 from the additional CQMs list.

Core CQMs are as follows [23]:

1. Hypertension: Blood Pressure Measurement
2. Preventive Care and Screening Measure Pair: (a) Tobacco Use Assessment, (b) Tobacco Cessation Intervention
3. Adult Weight Screening and Follow-up

Alternate Core CQMs are as follows [23]:

1. Weight Assessment and Counseling for Children and Adolescents
2. Preventive Care and Screening: Influenza Immunization for Patients 50 Years Old or Older
3. Childhood Immunization Status

Additional CQMs are as follows [23]:

1. Diabetes: Hemoglobin A1c Poor Control
2. Diabetes: Low Density Lipoprotein (LDL) Management and Control

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[3] At least one public.

3. Diabetes: Blood Pressure Management

4. Heart Failure (HF): Angiotensin-Converting Enzyme (ACE) Inhibitor or Angiotensin Receptor Blocker (ARB) Therapy for Left Ventricular Systolic Dysfunction (LVSD)

5. Coronary Artery Disease (CAD): Beta-Blocker Therapy for CAD Patients with Prior Myocardial Infarction (MI)

6. Pneumonia Vaccination Status for Older Adults

7. Breast Cancer Screening

8. Colorectal Cancer Screening

9. Coronary Artery Disease (CAD): Oral Antiplatelet Therapy Prescribed for Patients with CAD

10. Heart Failure (HF): Beta-Blocker Therapy for Left Ventricular Systolic Dysfunction (LVSD)

11. Anti-depressant medication management: (a) Effective Acute Phase Treatment, (b) Effective Continuation Phase Treatment

12. Primary Open Angle Glaucoma (POAG): Optic Nerve Evaluation

13. Diabetic Retinopathy: Documentation of Presence or Absence of Macular Edema and Level of Severity of Retinopathy

14. Diabetic Retinopathy: Communication with the Physician Managing Ongoing Diabetes Care

15. Asthma Pharmacologic Therapy

16. Asthma Assessment

17. Appropriate Testing for Children with Pharyngitis

18. Oncology Breast Cancer: Hormonal Therapy for Stage IC-IIIC Estrogen Receptor/Progesterone Receptor (ER/PR) Positive Breast Cancer

19. Oncology Colon Cancer: Chemotherapy for Stage III Colon Cancer Patients

20. Prostate Cancer: Avoidance of Overuse of Bone Scan for Staging Low Risk Prostate Cancer Patients

21. Smoking and Tobacco Use Cessation, Medical Assistance: a) Advising Smokers and Tobacco Users to Quit, b) Discussing Smoking and Tobacco Use Cessation Medications, c) Discussing Smoking and Tobacco Use Cessation Strategies

22. Diabetes: Eye Exam

23. Diabetes: Urine Screening

24. Diabetes: Foot Exam

25. Coronary Artery Disease (CAD): Drug Therapy for Lowering LDL-Cholesterol

26. Heart Failure (HF): Warfarin Therapy Patients with Atrial Fibrillation

27. Ischemic Vascular Disease (IVD): Blood Pressure Management

28. Ischemic Vascular Disease (IVD): Use of Aspirin or Another Antithrombotic

29. Initiation and Engagement of Alcohol and Other Drug Dependence Treatment: a) Initiation, b) Engagement

30. Prenatal Care: Screening for Human Immunodeficiency Virus (HIV)

31. Prenatal Care: Anti-D Immune Globulin

32. Controlling High Blood Pressure

33. Cervical Cancer Screening

34. Chlamydia Screening for Women

35. Use of Appropriate Medications for Asthma

36. Low Back Pain: Use of Imaging Studies

37. Ischemic Vascular Disease (IVD): Complete Lipid Panel and LDL Control

38. Diabetes: Hemoglobin A1c Control (<8.0%)

In 2011, EPs were required to submit aggregate CQM numerator, denominator, and exclusion data to CMS by attestation. In 2012, electronic submission was required [23]. Some MU objectives not applicable to every provider's clinical practice, thus would not have any eligible patients or actions for the CQM measure denominator. Exclusions do not count against the five deferred measures. In these cases, the eligible professional would be excluded from having to meet that measure.

3.4. Certified EHR Technology

Confidence of providers and patients in electronic health IT products and systems to maintain data security and confidentiality while performing a set of defined functions is important for success of the Health IT initiatives. In order to foster such confidence, the Office of the National Coordinator for Health Information Technology (ONC), an office of the Secretary for the U.S. Department of Health and Human Services (HHS), has developed standards, implementation specifications, and certification criteria for

EHR technology. (As noted above, the Medicare and Medicaid EHR incentive programs require the use of certified EHR technology.) These standards and criteria are aligned with the objectives of improving healthcare quality, safety, and efficiency and, ultimately, health outcomes for patients.

3.4.1. Standards

The Final Rule set issued on July 13, 2010 by the ONC establishes the capabilities and related standards and implementation specifications that certified EHR technologies must include [28]. These support the achievement of MU Stage 1 by eligible professionals and eligible hospitals under the Medicare and Medicaid EHR incentive programs [27]. The Final Rule also specifies how eligible healthcare providers will need to use the certified EHR technology to meet applicable MU requirements.

The same standards and certification criteria are applicable if one is planning to get a current EHR system certified for meaningful use and to receive incentive payments. There are two certification options, Complete EHR and Modular EHR.

"Complete EHR" refers to EHR technology that has been developed to meet, at a minimum, all applicable certification criteria in the Final Rule. For Complete EHRs designed for an ambulatory setting, this means all the certification criteria adopted at 45 CFR 170.302 and 45 CFR 170.304. For Complete EHRs designed for an inpatient setting, this means all the certification criteria adopted at 45 CFR 170.302 and 45 CFR 170.306.

"Modular EHR" certification refers to any service or component that meets at least one or certification criteria in the Final Rule but not all of them. An EHR Module must provide a capability that can be tested and certified. Also in order to be certified, a Complete EHR or EHR Module designed for an ambulatory setting must be tested and certified as including at least nine CQM specified by CMS and at least three of the additional measures.

Note that the specifications of the Final Rule are *minimum* requirements. The developers of EHR technology may include other features to support additional objectives, and measures that can be beneficial to providers and patients.

3.4.2. Certifications

ONC issued a Temporary Certification Program in June, 2010, including establishment of Authorized Testing and Certification Bodies (ATCBs) to test and certify EHR technology/products for compliance with the standards and certification criteria. ONC announced two ATCBs on Aug 30, 2010 [29] and today, six organizations have been selected as ATCBs under the Temporary Certification Program. Table 11 gives the complete list.

In January, 2011, ONC issued the Final Rule to establish the Permanent Certification Program for Health IT. However, the Temporary Certification Program was still in effect and was expected to be replaced by the permanent program sometime in 2012 [31]. The transition was not to affect certifications issued to EHR technology. The rules and definitions for certification body were to change under the permanent certification program (refer to the Permanent Certification Final Rule using the link in Appendix A).

Certifying one's own technology involves same process as that for vendors. When the technology has been upgraded to meet MU certification requirements, approach one of the certification providers to get it certified.

3.4.3. Certified EHR Products

The Certified HIT Product List (CHPL) provides an authoritative, comprehensive listing of Complete EHRs and EHR Modules that have been tested and certified under temporary certification program. The list is at http://onc-chpl.force.com/ehrcert.

Each Complete EHR and EHR Module listed on this site has been certified by ONC-ATCB. This site is useful for getting a CMS EHR certification ID, which is required for CMS registration and/or attestation. As of Jan 10, 2012, the products listed in Table 12 represent some of the radiology-related her-certified products from the CHPL.

| ATCB Name | Testing Model | Certification Cost | | Scope of Authorization |
		Complete	Modular	
Surescripts LLC http://www.surescripts.com/	Onsite and Remote	N/A	Free	EHR Modules: E-Prescribing, Privacy and Security
ICSA Labs http://www.icsalabs.com/	Onsite and Remote	N/A	N/A	Complete EHR /EHR Modules
SLI Global Solutions http://www.sliglobalsolutions.com/	Remote	$20,000	$6,000 to $15,000	Complete EHR /EHR Modules
InfoGard Laboratories Inc http://www.infogard.com/	Onsite and Remote	$19,900	$5,000 (8 security and Privacy modules + 1)	Complete EHR /EHR Modules
CCHIT http://www.cchit.org/	Onsite and Remote	$34,300	$7,000 base + $650–$2000 per certification criteria	Complete EHR /EHR Modules
Drummond Group Inc http://www.drummondgroup.com/	Onsite and Remote	$19,500	$6,000–$16,000	Complete EHR/ EHR Modules

Table 11. ONC ATCB List.
Source: [30,45]

Product	Product Version#	Product Classification	Additional Software Required
Centricity RIS-IC	10.7	Modular EHR	7-Zip, Sha256Deep, spreadsheet software
MedInformatix	7.5	Complete EHR	TrueCrypt 2.0, Email software, spreadsheet software
Merge RIS	7.0	Complete EHR	—
Carestream Vue RIS	11	Modular EHR	Nuance, Speech Magic 6
ICS	4.1	Modular EHR	DoseSpot, MIRTH Connect, phpAdmin
Fusion RIS MX (CDI)	4.01	Complete EHR	Medical Professional Web Portal, Cisco Ironport Email Encryption
INFINITT G3 RIS	3.0.11.3	Modular EHR	Microsoft Excel 2007 — §170.302.r

Table 12. Current radiology EHR product list.

3.5. State of Radiology in MU

3.5.1. Radiology in Stage 1

The MU legislation primarily targeted towards the primary care physicians community; hence, most of the objectives, measures, and CQMs defined in Stage 1 are also targeted to primary care physicians. Though this is a large number of EPs, in general MU lacks guidance on the relevance of MU for specialists, including radiologists.

In interviews with many radiologists, business stakeholders, and IT vendors in the industry, and the course of a thorough literature study, the overall response is mixed; most responses indicates that there is general consensus among radiologists that they are "not very clear, confused" on what they have to do for MU. Most don't know whether they are *included* or *excluded* under the criteria and whether they will be subject to payment cuts. Here are some of the comments prevalent in the community:

1) The program requirements are one-size-fits-all.

2) It is targeted at primary care, specialties including radiology are left out.

3) I don't know whether I am qualified or not; excited in general about this but confused about next steps.

4) Stage 1 Objectives and Measures aren't aligned with what I do as a radiologist; meeting the current measures may not ensure improvement in quality, safety in the services radiologists provide day to day.

5) Cost-benefit calculation yields higher cost than overall incentives one could receive.

6) Should PACS be certified as an EHR technology?

7) Taking wait-and-watch approach to see how the industry unfolds, e.g., see if Stage 2 makes these things clearer.

These observations align with the comment made by ACR to the ONC HIT Policy committee on Feb 22, 2011, wherein ACR states that there was a general consensus that the requirements of the Medicare/Medicaid EHR Incentive Program were largely not "meaningful" for radiologist EPs.

Should radiology be qualified to receive incentives? Looked at from the perspective of the end goal of meaningful use, which is to improve quality, safety, efficiency ,and health outcome, should the entire medical community and stakeholders be considered as one ecosystem where radiologists plays an important role? Today's radiology field is considered an "ancillary service," hence essentially kept out of "care coordination groups." This situation is slightly better in teaching-based hospitals.

In this light, some of the fundamental questions that policy makers and medical and IT experts should be asking are as follows:

1) Should imaging data be considered part of the EHR?

2) What role does imaging data play today in diagnosis, treatment, and prevention in healthcare?

3) Should Imaging data be considered as owned by the patient? Should the patient have access to this data, and how it will improve their engagement in making healthcare decisions?

4) What will be the impact to the core MU goals of *not* including radiologists and imaging as part of the requirements?

5) Should radiologists be taking advantage of this opportunity to change the perception in the medical community that radiology is an ancillary service?

3.5.2. Perspectives of Radiologists

Cited below are some specific comments from radiologists in personal interviews. The interviews focused current state of radiology with regard to Technology (PACS, EHR, RIS), workflow, quality, and efficiency in the system, and also their views on the relevance of MU to radiology.

Dr. Keith J. Dreyer MD, PhD, FSIIM

Vice Chair of Radiology Informatics

Massachusetts General Hospital, Boston, MA

Nov. 3, 2011 Washington DC, ACR Imaging Informatics Summit Conference and Dec. 8, 2011 MGH, Boston, MA

1) Radiologists are eligible for MU after a legislative change on April 15, 2010, which clarified the definition of "hospital-based" so that it can include physicians working in hospital outpatient clinics.

2) Stage 1 didn't clearly specify requirements for radiologists and measures aren't aligned with what we do as radiologists.

3) Radiologists are willing to accommodate additional tasks required by measure in the spirit of willingness to help for better health outcomes.

4) We have been using electronic-based records for a longer time now than anyone else in the industry; most of the standards already exist, are proven.

5) Research shows that we may be able to achieve 10–15% reduction in utilization through image/data sharing and another 10–15% through clinical decision support system at point of ordering.

6) Quality improvement initiatives haven't given much attention to dose information tracking yet, but having it will be beneficial. For example, systems could be easily extended to track and report cumulative dose lifetime value for patient, a valuable data point in clinical decision support, monitoring quality, etc. Also it can help to monitor incidental episodic radiation that is given unintentionally in certain studies.

7) What we are asking CMS and ONC for Stages 2 and 3 is:

   ✓ Include measures that make sense for radiologists and exclude us from certain measures which do not make sense.

   ✓ EHR standards should include imaging data and requirements for sharing.

   ✓ Mandate EHR to capture and report on dose Information for studies and provide aggregated report. This will greatly help to improve quality, avoid unnecessary radiation exposures. Today there is no obligation for providers to do so for the IT systems.

   ✓ Guidelines to increase quality of reports such as structured reporting.

✓ Standardization on decision support systems at point of ordering to leverage best practices and ACR appropriateness criteria.

Dr. Dreyer is optimistic about working with ACR, CMS, and ONC to educate radiology community, experts. and policy makers about what Stages 2 and 3 should address in terms of radiology and its benefits.

Dr. Tasneem Lalani, MD

Radiologist, Inland Imaging, Seattle

Nov 4, 2011 Seattle, WA

1) Radiologists are viewed as providing ancillary services such as Laboratory, though we could add more value—e.g., suggest an appropriate study for given patient condition and give feedback to referring physicians.

2) Today communication between radiologists and ordering physicians is very low, primarily in private group-based settings where patients are referred from hospitals or primary care groups.

3) Quality of order should be improved by including patient condition, contextual information, and past medical history with the order. Today when we receive orders from remote sites we don't have access to these details most of the time and unable to provide constructive suggestions. This also leads to workflow issues to re-request order information with more details.

4) Don't know on what we need to do for Meaningful Use. The IT division is taking a wait-and-watch approach until criteria are clearer in Stages 2 and 3 on the requirements for radiologists.

5) Often the ordering physician is not aware of or lacks access to ACR appropriateness criteria, which, if improved, can make a difference in imaging utilization.

The discussion with Dr. Lalani clarified some of the workflow issues that exist today, e.g., radiologists' inability to access patient EHRs, impacting quality and causing inefficiencies in the system. Dr. Lalani's view represents a private radiologists' group setting where radiologists primarily service patients referred from other hospitals and/or private-care groups.

3.5.3. Perspectives of EHR Vendors

Interviews were conducted with imaging modality vendors who also offer RIS/PACS solutions. Their opinions were sought on two major topics:

- The current state of radiology with regard to some of the technology issues discussed earlier in this thesis.

- Their perspective on MU, and how they are preparing to help the radiology community achieve MU with their products.

Donald Rucker

Chief Medical Officer, Siemens Healthcare

Nov, 2011

1) In MU Stage 1, there isn't much specified about radiology. Current objectives and measures aren't relevant. We don't know right now what Stage 2 will look like.

2) GE support MU initiatives and we wanted to be ready when customers ask for certified EHR products. We went ahead to get our EMR (GE Centricity RIS-IC v10.7) fully certified so that we are prepared for it.

3) Our radiology component is modular-certified right now.

4) Developments that would help radiology in general are structured reporting, image exchange, standardization of clinical results management and clinical decision support.

Jacques Gilbert

Strategic Marketing Director, GE Healthcare

Dec, 2011

1) Image sharing across vendor PACS and DICOM standards are mostly not an issue today. The interface with EMR using HL7 is where issues continue to exist. Human-captured data often causes the issues as they may not adhere to expected format or standard primarily because some of them are unstructured.

2) Meaningful-use measures aren't right ones for radiologists. I would rather look for measures which are clinically relevant. For example, percent of images/reports transmitted electronically could be a useful measure for radiologists.

3) Siemens chose to wait for further clarification on meaningful use before getting the products certified for MU.

4) Radiologist having access to all patient history can provide much better context to make better decisions, diagnosis and to improve quality of report.

The foregoing two comments provided a contrasting approach being considered by IT vendors and, at high level, are representative of the views of many IT vendors in industry today.

4. BUSINESS ANALYSIS FOR RADIOLOGISTS

The central theme of the MIT System Design and Management Program is "Systems Thinking," an approach to systems from a broad, high-level perspective. Emphasis is on overall structures, inputs/outputs, processes, and patterns rather than looking at a specific part of the problem or challenge one is trying to solve. Here a "system" is any collection of parts and/or subsystems that are highly integrated and/or interfaced to attain larger benefit. The system can accept certain inputs through its interfaces, include several processes, and produce certain outputs—the desired goals of the system. The ability to look at a business system holistically in any environment can help a business to quickly and accurately identify the root causes of issues in their organizations.

This section adopts Systems Thinking to provide a comprehensive business analysis of a radiology system. First, utilizing a system dynamic model discussed in Section 4.1, various drivers in a radiology system are analyzed to reveal what is inducing current behaviors, cause-and-effect relationships within the system, and why things are happening the way they are.

Second, this section addresses the main question of this thesis: "Should radiologists be considered part of the care team, leveraging EHRs for meaningful use, and hence eligible for incentive payments?" It explains in the three following subsections the rationale for building a sustainable healthcare ecosystem where radiologists' values are recognized and are leveraged for delivery of high-quality healthcare in the most efficient, safe, and cost-effective manner possible.

The section concludes by making specific recommendations on changes that should be made to meaningful-use criteria to realize these goals.

4.1. Analysis of Drivers in Imaging

Sections 2.7, 2.8 have described various issues in radiology, including growing utilization, lack of coordination between physicians and radiologists, data-standards issues, and unintended side effects resulting from the pay-for-service payment model. These issues are better understood by looking at key drivers behind them and how their various dynamics interact.

System dynamics is an approach to understanding the behavior of complex systems over time. It deals with internal feedback loops and time delays that affect the behavior of each system in its entirety. The causal loop diagram in

Figure 13 gives a holistic view of all major drivers in the radiology system.Any system comprises drivers that exert positive and negative influence over the system's behaviors. The relative intensities of these drivers determine which, if any, have overall influence on the system. In radiology there are five positive drivers: **R1**, Profit; **R2**, Need for information; **R3**, Diagnostic certainty; **R4**, Incidental findings; and **R5**, Imaging cost. Together, these positive drivers exhibit reinforcing behavior for continual growth in utilization and spending. There are three negative drivers: **B1**, Radiation safety; **B2**, Patient cost; **B3**, Payer cost. These exhibit negative (or balancing) behavior, tending to reduce utilization and spending. The analysis is qualitative, not a simulation or numerical analysis of the radiology system: i.e., the states of the system are not assigned numerical values, and drivers are not assigned quantitative weights.

The major issues in radiology are growing utilization of imaging services, appropriateness of utilization, and imaging's total cost. Below, each driver is analyzed in this context. Italicized terms correspond to variables in

Figure 13.

Negative Drivers (Balancing Behaviors). Negative drivers act against rise utilization and total spending. *Patient cost* (B2) and *Payer cost* (B3) are responses to increases in total *Spending on imaging services*. With growing utilization, the patient's out-of-pocket expenses rise, increasing the patient's motivation to look for way to contain those expenses (*Pressure to reduce spending*). One response is to delay non-emergency exams wherever possible; another is to question physicians about study needfulness. Increased awareness and ability to question reduces *Demand for imaging services*.

The *Payer cost* (B3) increases when spending increases, thus increasing *Pressure to reduce spending*, which results in reduced *Demand for imaging services*. Responses to increased *Payer cost* (B3) include changes in payment policies (e.g., Medicare payment cuts), alternative payment programs, and caps on maximum expenditures, which all

introduce pressure to reduce utilizations. Any such initiatives from payers have an immediate effect on reducing *Demand for imaging services* and/or total *Spending on imaging services*. However, there is always a potential conflict between medical necessity and reduced utilization.

Concern on radiation exposure (B1) increase with increase in number of imaging studies for the patient, and it may reduce further *Demand for imaging services*. *Concern on radiation exposure* usually arises from the patient receiving multiple studies; both patient and physician may be concerned about cumulative radiation dose. Higher exposure to ionizing radiation—not a factor with all modalities—increases long-term cancer risk. The patient's response to this risk is usually to question the need for imaging. As patient involvement rises in this respect, the number of unnecessary studies goes down.

Positive Drivers (Reinforcing Behaviors). Referring to

Figure 13, advancement in technology, with improved identification of many disease conditions in early stages, has led to increases in both physicians' and patients' expectation for more information (*Need for more information*, R2) for early and accurate and for *Diagnostic certainty* (R3). Over time, these advances have increased *Reliance on imaging services*. Increased trust increases *Patient expectations* and thus *Physician's willingness to order an imaging study*, causing *Demand for imaging services* to grow. Imaging studies are also viewed as a more efficient diagnostic method for many diseases; as a result, where there is higher patient volume, emergency departments need to increase patient flow (i.e., there is higher *Desire for shorter patient wait time*), and the *Physician's willingness to order an imaging study* increases. All of these increases in demand for imaging services drive up the number of *Imaging studies* and hence *Spending on imaging services*.

The *Profit* motive (R1) can apply to radiologists, hospitals, private-practice groups, or self-referred providers. As imaging services are more widely utilized in diagnosis and treatment, general consumption and demand have increased total spending and profitability. This has created a business incentive to own equipment, which in turn increases motivation to order more studies. In addition, the *Pay-for-service reimbursement* model and *Fear of litigation* increase *Motivation to order more studies*,

Figure 13. Radiology system drivers.
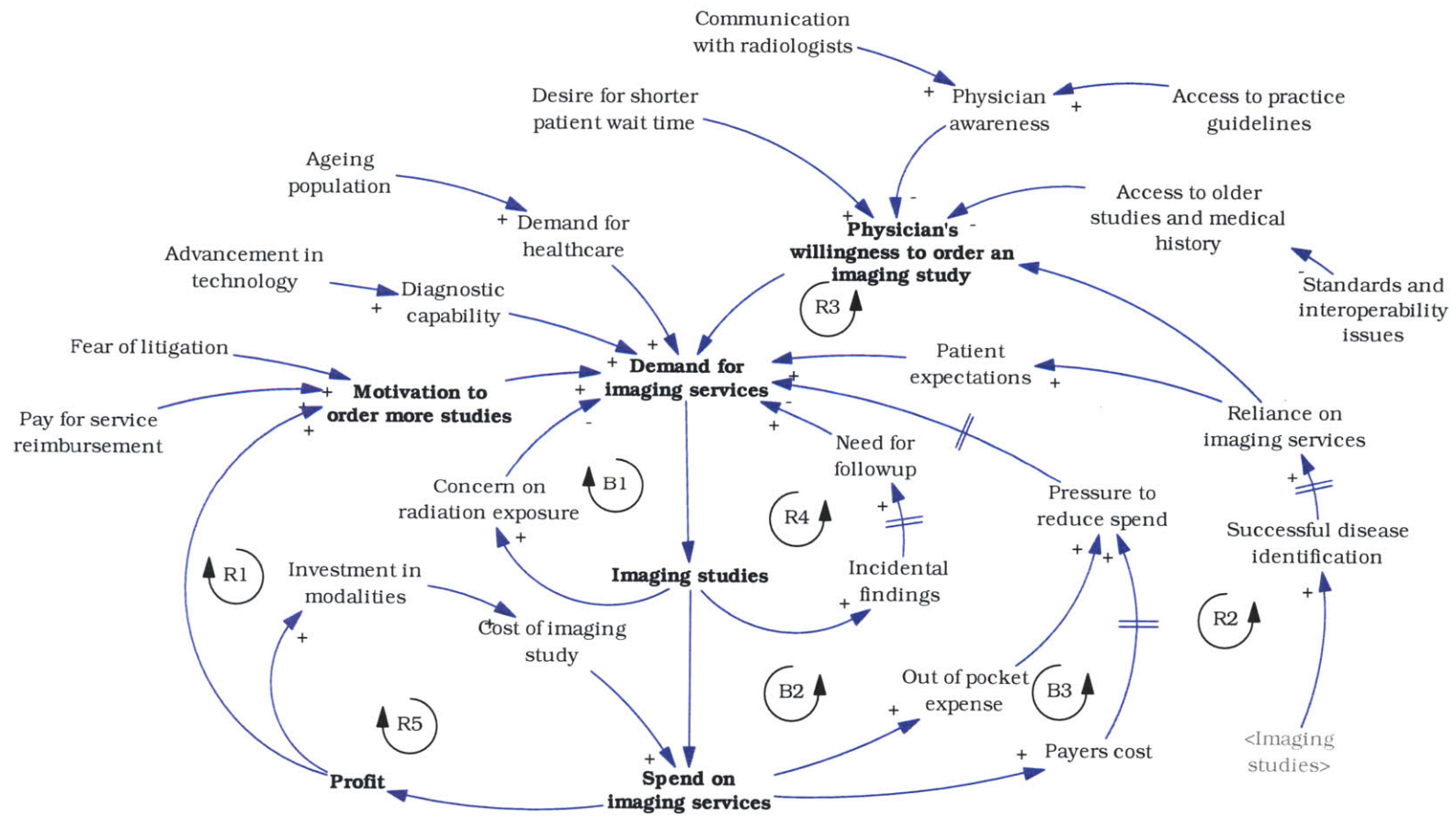
Positive (Reinforcing Loops) :

R1 - Profit   R4 - Incidental findings

R2 - Need for information R5 - Imaging cost

R3 - Diagnostic certainty

Negative (Balancing Loops) :

B1 - Radiation safety   B3 - Payer cost

B2 - Patient cost

thus increasing *Demand for imaging services.* As both radiologists and equipment owners get paid separately (i.e., professional and technical fee components), both benefit by performing more studies; this behavior is more obvious in physician-owned radiology centers (self-referral practices).

Cost of imaging study (R5) drives up *Spending on imaging services* when cost per study increases. As *Profit* increase, providers are motivated to increase *Investment in modalities* which in turn increase *Cost per study.* The rise in cost is due to major investment in new modalities, which are expensive. Providers opt for recent advances in modalities to keep up with demand for ability to diagnose complex patient conditions, keep equipment current, and meet expectations of referring MDs and patients for state-of-the-art technology.

With the increasing number of *Imaging studies* conducted today there are cases where a study exposes a finding that was not the primary diagnostic target. These are referred as *Incidental findings* (R4). Some trigger a *Need for followup,* increasing *Demand for imaging studies.* Followups are either to confirming or ruling out a medical condition, or to fear of litigation for not performing a study.

Additional factors influence *Diagnostic certainty* (R3) behavior by increasing *Physician's willingness to order an imaging study.* These factors fall into three categories (see nodes in Figure):

1) *Access to older studies and medical history.* The ability to refer to an older study in a timely manner to perform a comparative analysis is invaluable in increasing quality of diagnosis. Increase in *Standards and interoperability issues* (in RIS/HIS/PACS) decrease the *Access to older studies and medical history* (especially across hospitals) and in turn increase *Physician's willingness to order an imaging study.* Even if the patient has had a recent exam, if there is no way to access that data at point of care, the natural choice is to order new (and unnecessary) study. Moreover, referring to older studies to compare to new ones helps to characterize the dynamics of a disease condition over time. Lack of access to a patient's medical history gives little context to help the physician order a right study and radiologists to make an optimal diagnosis.

2) *Communication with radiologists.* A value that the radiologist brings to the care team is their ability to diagnose a condition in a manner that reflects ACR appropriateness criteria and to recommend a right study. With limited physician *Communication with radiologists, Physician awareness* of the radiologist's potential contribution is lessened, and *Physician's willingness to order a new study* is increased. The lack of awareness as a result of absence of communication could likely lead to physician's opting for imaging studies more often than necessary. A study ordered by a physician with limited awareness of the radiologist's views may not answer the question the doctor is looking for and can lead to yet further studies (repeats). The side effect of this is Radiologist unable to learn about result of their diagnosis, whether it did have intended impact on patient care. There is lack of opportunity for continual learning and improvements.

3) *Access to practice guidelines.* The physician's awareness of ACR appropriateness criteria and seamless access to such clinical guidelines at time of ordering is crucial to ordering a right study at the right time. However, if such guidelines aren't accessible readily and/or the ordering system is not easy to use, *Physicians awareness* of guidelines may not be up to date. Any such decrease in awareness can increase the *Physician's willingness to order an imaging study,* driving up *Demand for imaging services.*

Both number and intensity of positive drivers in imaging outweigh that of negative drivers, influencing continual growth in utilization. Payers' concern about increasing cost and patients' concern about increasing out-of-pocket expenses does not (or should not) curtail utilization of image services when there is a discernible medical necessity. Though the general concern about radiation exposure is valid, RIS/EMR systems are not matured enough yet to capture dose information from studies in a standardized manner and track and share that information for meaningful use.

Further discussion focuses on drivers and variables related to information systems, as MU is concerned with leveraging EHRs for care delivery.

4.2. Results

4.2.1. Radiology for MU

I answer the primary question of this thesis —*Should radiologists be considered part of the care team, leveraging EHR for meaningful use and hence eligible for incentive payments?*—at the end of this section. I think it important to first review the bases for the answer given; this is done in the sub-sections immediately following. The question is addressed, in part, using a model to analyze and describe three primary changes in dynamics that can result from using EHR and MU for radiology. The model is central to describe dynamic effect MU induces in the system and is original content here. How these changes in can have positive impacts on imaging utilization and health outcome is reviewed.

4.2.1.1. Radiologists on the Care Team

Initial analysis indicated disconnectedness between radiologists and care teams due to little or no patient contact, low physician interaction, and other factors, including electronic exchange of information most of the time. However, radiologists contributing to core care delivery in at least three meaningful ways:

1) Fundamentally enabling physicians' diagnostic capabilities.

2) Contributing to patient lifetime EHR and thus indirectly enabling the referring physician's meaningful use of imaging records for care delivery. Radiologists themselves use medical history and older studies (electronically in many cases) to achieve MU (to provide diagnosis)

3) Where adequate physician interaction exists, radiologists may recommend more cost-effective imaging studies guided by evidence-based appropriateness criteria

Contrary to the common view in the industry that radiology is an *ancillary service*, careful analysis shows that the radiologist's contribution is central to care delivery in most cases and represents Meaningful Use of information. Physicians rely on diagnosis reports from radiologists for planning next steps, including followups,

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treatment planning, and further diagnosis. Treating radiologists as part of core care teams can bring several additional benefits:

1) Increased care coordination between radiologists and physicians provides an opportunity for physicians to leverage the value of radiologists in ordering the right study at the right time, thereby contributing to cost effective imaging and quality care.
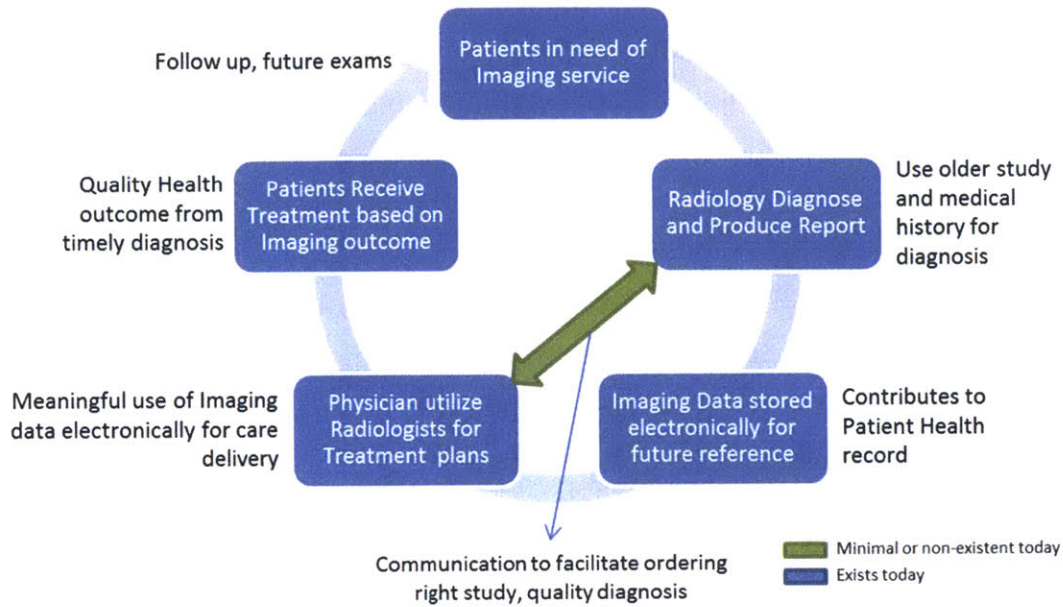
Figure 14. Radiology in the care delivery cycle.

2) Radiologists can continually learn from the impact their diagnostic findings on physician's treatment decisions, in particular, whether they have helped the patient to receive the right care.

3) Radiologists can review and discuss patient medical history beforehand or on demand, improving the quality of diagnoses and recommendations.

4) Physicians can continually improve awareness of clinical guidelines and best practices for utilizing imaging services.

In short, closer coordination increases MU of electronic data by both radiologists and referring physicians.

4.2.1.2. Imaging Data Sharing and Exchange

In Chapter 2 we discussed issues related to DICOM and to interoperability issues with RIS/PACS/HIS-EMR, and learnt how those issues have been contributing (inadvertently) to growing utilization and other radiology trends. So far there have been no incentives for IT vendors to address them, nor for providers to demand a solution. The system dynamic causal-loop diagram in Figure 15 shows the likely impact of MU requirements on a subset of imaging dynamics if those requirements are altered to include imaging data at the core of EMR and to related interoperability requirements to enable data sharing.
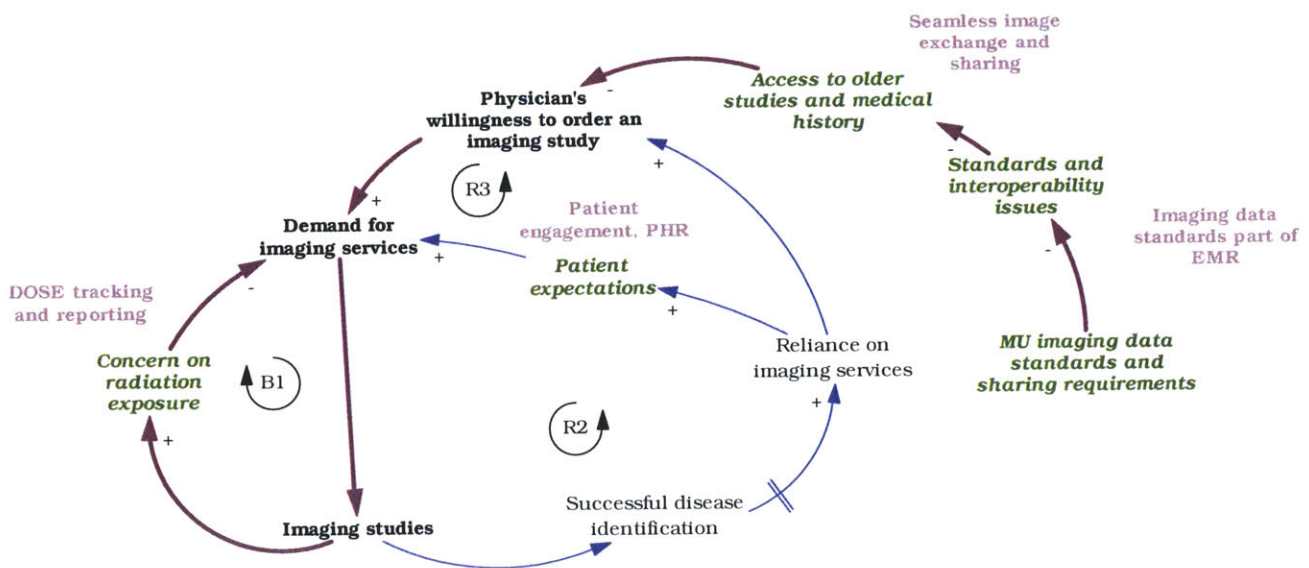
Figure 15. Likely MU impact on imaging dynamics.

The new variable, MU imaging data standards and sharing requirements, (compare

Figure 13) reflects the influence of MU requirements for imaging data and sharing requirements on *Standards and interoperability issues*. These imaging data standards and sharing requirements would, preferably, specify inclusion of imaging data (DICOM, dose information, reports, related metadata) in the patient EHR and hence subject them to standardization, with support for sharing among providers. Variables highlighted in green in Figure 15, and associated arrows, indicate the impacts MU can have on the system.

With MU-mandated requirements for data sharing and inclusion of imaging as part of core EMR and data sharing requirements, providers would likely be moved to demand IT solutions from vendors (whether in RIS, PACS, or EMR) to support these requirements. Such efforts would eventually decrease *Standards and interoperability issues* and increase *Access to older studies and medical history*, likely decreasing *Physician's willingness to order an imaging study*.

Standardization can simplify interface requirements between systems and improve consistency of records and procedures, reducing costly integration tasks. As providers adopt solutions meeting MU requirements, data- and image-sharing capabilities would likely improve, until ultimately providers will be able to share and access imaging data and medical histories seamlessly across providers/hospitals (Medical privacy issues should, of course, be addressed substantively during the design phase of new technical developments.) As referring physicians and radiologists have increased access to information, the decision to order a study will be based more on facts, reducing unnecessary imaging. As the denominator (total imaging studies) declines, the rate of successful disease identifications will go up (with increased average study appropriateness), further increasing *Reliance on imaging services*.

With an MU requirement to track dose information in each study and to include this information in the patient EMR, physician and patient can readily access cumulative lifetime dose information and make informed decisions before ordering studies. In addition, EMRs could contribute such information to population health studies: standardized tracking and reporting of imaging data and dose information to at a national-level central database would help to mine the data at regional and national levels to understand patterns in imaging studies, diseases, and other variables. Understanding these patterns assists data-driven decisions across the nation for diagnosis and policy changes.

In sum, MU could provide incentives to get both providers and IT vendors to address a range of longstanding issues—with far-reaching benefits.

4.2.1.3. Clinical Decision Support System

Referring physicians' decisions to order imaging studies for a given patient condition depend on multiple factors. These usually include, though they are not limited to,

access to complete medical histories (including older studies if any), the physician's awareness of best-practice imaging guidelines, and the provider organization's needs (e.g., shorter patient wait time).

We have discussed in a prior section (4.2.1.2) the impact MU can have by including imaging data as part of EMR and image sharing across provider systems.

To be fully effective, MU-required access to patient medical history and earlier imaging studies and reports is essential for the referring physician at point of ordering (as discussed in section 4.2.1.2). The radiology community, working with other specialty groups, has developed appropriateness criteria (e.g., the ACR criteria); what have been missing are adequate incentives for providers to utilize them and IT vendors to come up with systems supporting them. To date, only a few EMRs (e.g., Epic has integrated support and uses externally hosted web service) support integrated ordering workflow with consultation of the ACR's appropriateness criteria.

Figure 16 indicates impact MU can have on imaging utilization via a specific data-related aspect of system function, i.e., use of a CPOE (Computerized Provider Order Entry) system. If MU standards require the ordering physician to use a CPOE for radiology orders and especially a decision support system (CDS) conforming to ACR appropriateness criteria, it can enable access to best-practice guidelines. Accessibility and ease of use of CDS can increase the physician's tendency to choose an appropriate imaging study. Because physician ordering behavior is a major contributor to growing and inappropriate utilization, a legislative requirement to use CDS would have direct impact on increasing quality (through increasing appropriate use) and thus on cost effectiveness. It would also reduce or avoid unnecessary imaging, and (for some modalities) patient exposure to unnecessary radiation, thus improving safety. In sum, the dynamics discussed above suggest that MU requirements for CDS use in workflow can have significant impact on improving quality, safety, efficiency, and cost.
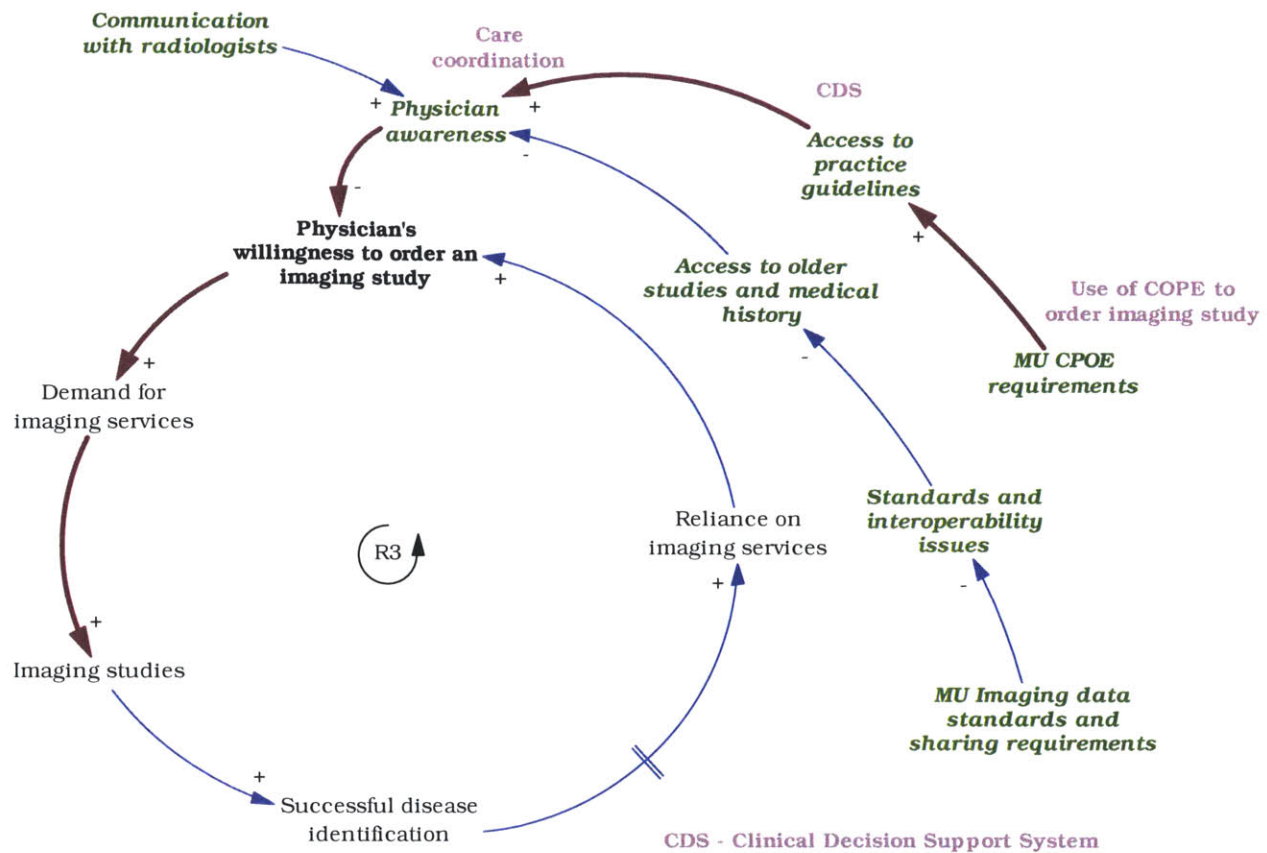
Figure 16. MU impact on imaging study ordering process.

4.2.1.4. MU Impact on Imaging Drivers

Analysis of the likely impact of MU requirements to (1) consider radiologists part of the care team, (2) include standardized imaging data in EMR, and (3) use CDSs in the ordering workflow on imaging drivers indicates the following benefits:

1) Improving meaningful use of imaging data by referring physician; radiologists helping physicians achieve meaningful use.

2) Meaningful use of patient medical history and older radiology studies to improve diagnosis quality.

3) Seamless image sharing, cumulative dose information tracking, and contribution to patient health records and population data.

4) Increased physician awareness of clinical guidelines, with on-demand access to data, improves physician ordering behavior (more appropriate studies).

In addition, data standards in radiology to produce reporting of results in consistent, easy-to-understand format, enables data mining; if there are critical findings during diagnosis, these can be documented and communicated in a timely, accurate, and consistent manner. This can play a role in saving lives when such findings are life threatening.

Figure 17 shows the altered dynamics in the radiology system under the proposed MU requirements' impacts on system drivers. In section 4.2.1, I have discussed the impact to three key dynamics as result of MU; consideration of this system-level model and of individual causal loops in section 4.2.1 shows that MU can have a direct effect on reducing inappropriate studies and cost and on increasing quality. Continued non-inclusion of imaging-related requirements by MU standards could limit the program's ability to achieve its core objective of meaningful use of EHRs to improve health outcomes.

Based on these findings, I conclude that **radiologists should be considered part of the care team, leveraging and contributing to EHRs for Meaningful Use, and hence should be eligible for incentive payments under the Meaningful Use initiative**.
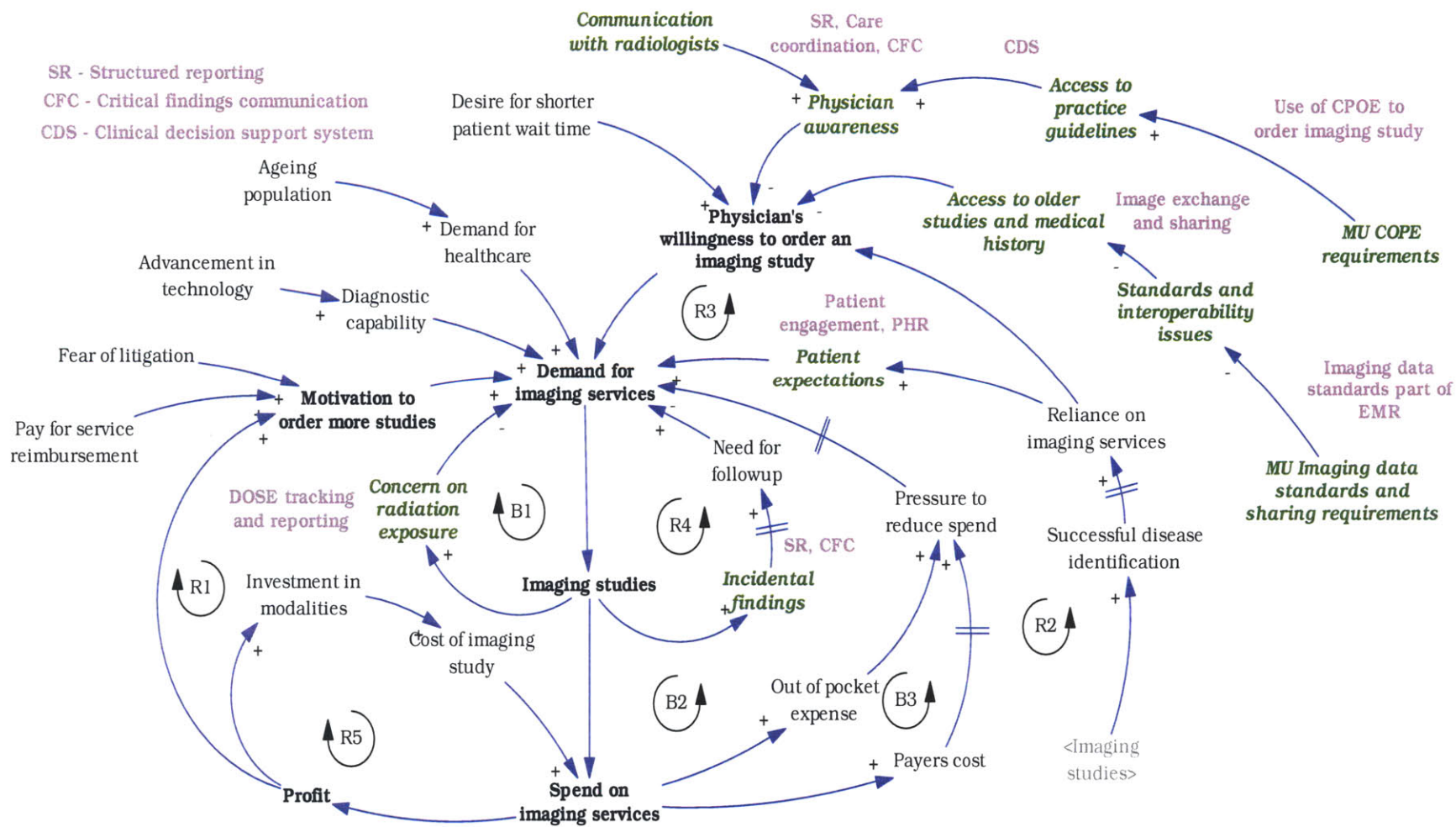
Figure 17. MU influence on imaging drivers.

4.2.2. Revisions to Reimbursement Policy

A primary imaging driver, *Profit* (R1), is fueled by the current *Pay for service reimbursement model*. This issue is not specific to radiology, but occurs throughout the US healthcare system, with system-wide impacts. The system requires a fundamental change in the way providers are reimbursed, from the current pay for service (or quantity) model to one based on *measurable quality of outcome*. However, the complexity of this apparently simple recommendation lies in defining correct measures for quality and measuring them consistently across different specialties and providers in various real-world conditions. Efforts so far by industry (discussed in Section 2.6) to curtail reimbursements appear to be narrowly targeted and thus likely will not be effective in addressing the issue in its entirety.

Because the topic of reimbursement model is related less to EHRs and MU than to policy, its detailed analysis is outside the purview of this thesis. However, I briefly discuss below the ACO initiative of the Affordable Care Act and an effort by a private payer, both of which are targeted at moving from pay-for-service and toward pay-for-quality.

ACO. The Affordable Care Act (2010) includes an initiative for Accountable Care Organizations (ACOs), a payment and delivery reform that seeks to tie provider reimbursements to quality metrics and reductions in total cost of care for an assigned population of patients. An ACO is an organization of healthcare providers that agrees to be accountable for the quality and cost of overall care of Medicare beneficiaries who are enrolled in the traditional fee-for-service program assigned to those providers [47]. The rule proposes quality measures in five key areas that affect patient care:

1) Patient/caregiver experience of care

2) Care coordination

3) Patient safety

4) Preventive health

5) At-risk population/frail elderly health

The ACO model challenges radiologists because it requires fundamental changes in culture, i.e., from a current focus on productivity based on number of examinations interpreted to a focus on productivity based on ability to provide cost-effective care and outcomes [47]. However, the ACO model requires successful care coordination, and thus is advantageous to radiologists as it will encourage communication with care teams. As ACOs enter the fray, it is imperative that radiologists not be seen as a commodity but as value-contributing members of the care team. Radiologists should carefully analyze the impact of ACOs on their business model, weigh risks and benefits, and leverage this opportunity to overcome issues related to commoditization and care coordination, among others.

AQC from BCBSMA. Private payers that provide insurance to large segments of the US population have a role to play by inventing or imitating ACO-like changes to reimbursement models. In my interview with Blue Cross Blue Shield of Massachusetts, I learned of their Alternative Quality Contract (AQC) initiative [13], effective since 2009, which changes the payment model to one based on quality measures. The program's goal is to improve quality, safety, and effectiveness of care by aligning financial and clinical goals. It expects to achieve this goal by enabling the delivery system to provide the patient with best possible care, by the right kind of provider at the right time, and in the most appropriate setting. The new contract model combines a per-patient global budget (fixed) with significant performance incentives based on quality measures (tied to nationally accepted quality measures of quality, effectiveness and patient experience).

First-year results from the program show that it is achieving both cost and quality goals. Provider organizations operating under this model shown greater improvements in quality than during any one-year period previously recorded by BCBSMA, significantly exceeding the rates of improvement on quality measures they were achieving prior to the AQC [14]. Figure 18 shows that quality of patient care in AQC-participating providers is above that of non-AQC physicians [14].

BCBSMA states that it is working with its counterparts in other parts of the country to expand the reach of this program nationally. Initiatives like the ACO model and

BCBSMA AQC are just beginnings, but their success may lay a good foundation for continued improvements in this area.
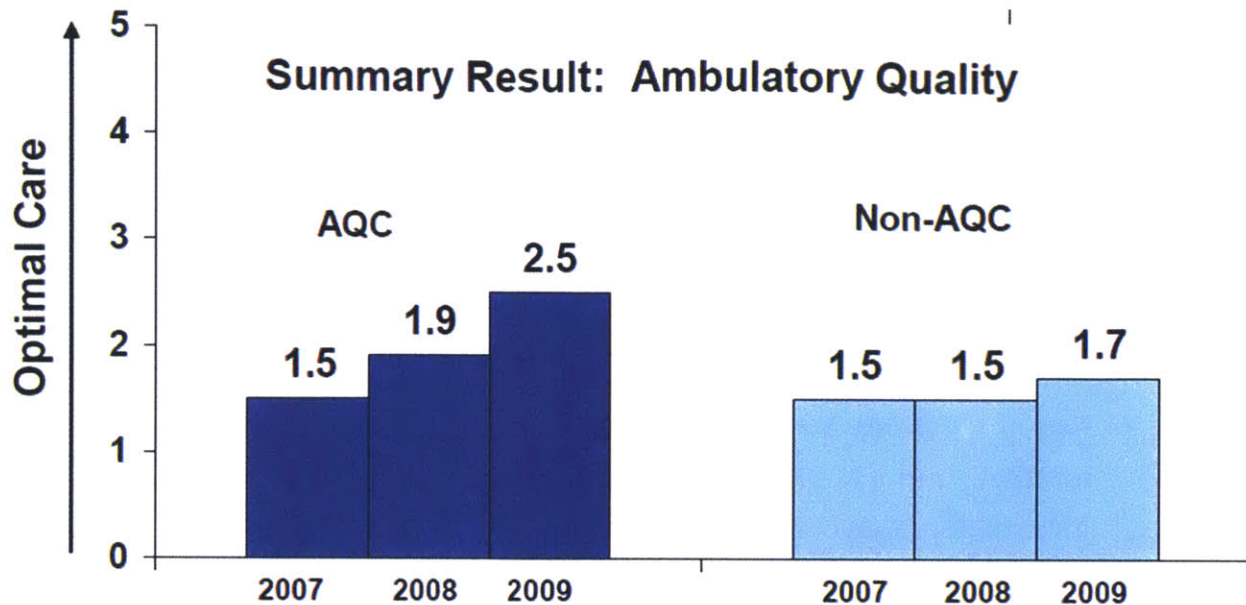
*The gate is calculated from a minimum and upper threshold for each measure. Actual performance is converted to 5-point scale between Minimum and Upper Thresholds. A score of 1.0 (Minimum Threshold) represents a score that is generally at the 50th percentile of the network distribution. A score of 5.0 (Upper Threshold) represents the "observed limits" of performance (end-state vision) or the 99th percentile of the distribution.
NOTE: The measures included in the overall quality score are preventive and chronic clinical process measures.

Figure 18. AQC Groups outperform rest of network on quality.

Source: BCBSMA [14]

4.2.3. Changes to MU for Radiology

The analysis in Sections 4.1 and 4.2.1 reveals several benefits of folding radiology into Meaningful Use criteria and leveraging EHRs for meaningful use. The discussion of system dynamics in those sections showed how radiologists, as meaningful users, can help physicians achieve more meaningful use and contribute to improved quality, efficiency, safety, and cost.

However, MU requires certain changes to address the gaps within it (see section 3.5); the present section summarizes specific recommendations for Stage 2 and Stage 3 of MU. Categorization of recommendations by stage is based on analysis performed in the course of this thesis, on my background experience in Software Information systems development, and domain exposure in radiology gained through research, interview, and literature study.

Stage 2 Changes. Recommended Stage 2 changes focus primarily on fundamentals to integrate radiology into MU, EMR, and ecosystem; this would set the foundation for Stage 3, for further expansion of meaningful use.

- Expand the scope of EMR to include imaging data, images, and related metadata.

- Define standards for vendor-neutral image sharing between providers. Radiology community should work together to address the metadata issues in DICOM, which limits seamless sharing today. Some specific changes in DICOM that would help are:

  - ✓ Constraint the optionality and extension mechanisms in DICOM metadata.

  - ✓ Require interface support to exchange messages in-network, through the internet, through offline media, and through NHIN (National Health Information Network) and HIE (Health Information Exchange).

- Define a CDS standard in terms of centralized access to ACR appropriateness criteria and standard API interface to access them (either as web service or hosted). Optionally, include a test system for use by providers and IT vendors across the nation in developing such systems.

- Include objectives and measures (CQM) clinically aligned with radiology practice. These should have direct relation to functions radiologists perform day-to-day and should align with improving quality, efficiency, and safety. Several might be:

  - ✓ Out of total Prior studies existed for the patient, how many of them Radiologists were able to access electronically and meaningfully use in diagnosis (Measure)

  - ✓ Use Clinical Decision Support system integrated with ACR appropriateness criteria to order an imaging study (Objective)

  - ✓ Radiologist use Medical history of patient from EMR in providing diagnosis report (Objective)

  - ✓ Use of Structured reporting for providing diagnostic report to referring physician (Objective)

Stage 3 Changes.

- Data standards to track DOSE information

- Define or extend NHIN/HIE standards to include image-exchange guidelines and requirements for consistent image sharing. The guidelines should cover infrastructure, standards for architecture, message formats, and related points.

- Development of NHIN/HIE infrastructure support to include image data sharing.

- Recommended Measures (CQM) and objective clinically aligned with radiology practice:

  ✓ Meaningful use of cumulative lifetime dose information by physicians in ordering decisions and by radiologists during protocoling.

  ✓ Use of population health data in ordering and diagnosis for imaging services.

  ✓ Image sharing using HIE/NHIN networks across providers spread geographically and/or outside of immediate network.

  ✓ Track DOSE information in each study and contribute to EMR (Objective)

- Data standards and template for radiology reporting in structured format. The standard should comprise the following:

  ✓ Standard template for several types of exams, with a common base section to capture information for all studies and a section to capture exam-specific information.

  ✓ Capture incidental findings in standardized manner.

  ✓ Enable more effective, trackable and consistent communication of critical findings.

  ✓ Store report data in structured format supporting aggregation, data mining, and analysis.

  ✓ Meet DICOM standards for transformation between structured reports (based on standard templates) to HL7-compatible Clinical Document Architecture format, the international standard for clinical reports [43].

5. CONCLUSIONS

This thesis has investigated the contribution that radiologists can make to delivery of healthcare in terms of improved quality, efficiency, and cost by leveraging and meaningful use (MU) of electronic health records (EHRs). A systems analysis outlines the many benefits for healthcare of bringing radiology under the aegis of MU, with all this implies.

The perception of radiology among referring physicians and those consuming imaging services tends—in many, though not all institutions and other settings—not to include the values that radiologists contribute to care delivery. Limited or no interaction with patients or referring physicians, as well as technological advancements, has enabled radiologists to perform their work remotely, with some advantages but contributing to this disconnect. Moreover, some technological advancement has significantly increased diagnostic capability for certain disease conditions and treatments, acting as an unanticipated positive driver for utilization, cost, and safety issues. Despite the fact that radiology has been using electronic images for a long time now, the field has been at risk of getting commoditized. Moreover, the lack of incentives for stakeholders to work together has allowed many of issues in the system to linger and grow over time.

Healthcare delivery in the present century requires that a complex network of specialties and technologies work together to deliver care. This requires that information systems used by subspecialties—utterly integral today to the practice of medicine—work together in an integrated manner; however, this has been achieved to only a limited extent due to a variety of technological, policy, and monetary barriers (reviewed herein). The HITECH Act and its Meaningful Use (MU) framework seek to break down these those barriers by providing incentives for the use of EHRs for delivery of care, but current Stage 1 guidelines for MU, centered in primary care, have left many questions open with regard to what MU means for specialties, including radiology. I have argued that the ultimate goal of these healthcare reforms cannot be achieved by targeting primary care alone. Rather, all specialties, including radiology, should be considered as part of the care team; measures, objectives, and incentives

should be aligned with clinical goals for each specialty to improving healthcare outcomes.

A suite of novel, specific MU recommendations reflecting both information-systems and radiology perspectives has been offered. Radiologists should leverage provisions in the Affordable Care Act and MU for addressing growing utilization, improving quality, and being treated as part of care teams. Integrating imaging data with use of medical history data from EMR in ordering decisions and diagnosis increases the value of these data for healthcare quality. Therefore, I argue, every provider organization should, consider bridging the gap between radiologists and physicians by establishing internal processes that encourage and incentivize them to coordinate care. This process should target continual improvement in use of evidence-based practice guidelines, self-learning through feedback, technical interoperability of information systems, and aggressive use of EMRs to track, use, and share data. Finally, the ACO payment model presents an opportunity to integrate radiologists into care teams and eliminate the risk of their work being further commoditized.

Radiologist should educate policy makers and industry stakeholders about the values that they add to the care team. It will require concerted effort from the community to produce the changes in payer, provider, and technology organizations to bridge the gap between current systems and MU requirements. Not leveraging this opportunity could result in further alienation of radiologist from core care teams, ultimately with losses for all involved, from payers to patients. At the same time, the MU standard's failure to include radiologists may prevent that standard from achieving its core objective: to improving the quality, safety, and efficiency of care the patient ultimately receives.

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GLOSSARY

A/I/U – Adopt, implement, or upgrade

ACO – Accountable Care Organization

CAH – Critical Access Hospital

CMS – Centers for Medicare and Medicaid Services

CPOE – Computerized Physician Order Entry

CQM – Clinical Quality Measures

CY – Calendar Year

EHR – Electronic Health Record

EP – Eligible Professional

FQHC – Federally Qualified Health Center

HHS – U.S. Department of Health and Human Services

HITECH Act – Health Information Technology for Economic and Clinical Health Act

HIE – Health Information Exchange

HITPC – Health Information Technology Policy Committee

HIPAA – Health Insurance Portability and Accountability Act of 1996

HPSA – Health Professional Shortage Area

MU – Meaningful Use

NHIN – Nationwide Health Information Network

ONC – Office of the National Coordinator of Health Information Technology

PA – Physician Assistant

RHC – Rural Health Clinic

APPENDIX A: MU RESOURCES

Medicare EHR Incentive Program

Registration User Guide for Eligible Professionals

http://www.cms.gov/EHRIncentivePrograms/Downloads/EHRMedicareEP_Registrat ionUserGuide.pdf

Registration Page

http://www.cms.gov/EHRIncentivePrograms/20_RegistrationandAttestation.asp

Attestation Page

http://www.cms.gov/EHRIncentivePrograms/32_Attestation.asp

Medicaid EHR Incentive Program

Registration User Guide for Eligible Professionals

http://www.cms.gov/EHRIncentivePrograms/Downloads/EHRMedicaidEP_RegistrationUserGuide.pdf

ONC EHR Standards and Certifications

ONC Standards Final Rule

http://edocket.access.gpo.gov/2010/pdf/2010-17210.pdf

ONC Permanent Certification Final Rule

http://origin.www.gpo.gov/fdsys/pkg/FR-2011-01-07/pdf/2010-33174.pdf