Imaging represents a substantial and growing portion of the costs of American health care. When performed correctly and for the right reasons, medical imaging facilitates quality medical care that brings value to both patients and payers. When used incorrectly because of inappropriate economic incentives, unnecessary patient demands, or provider concerns for medical-legal risk, imaging costs can increase without increasing diagnostic yields. A number of methods have been tried to manage imaging utilization and achieve the best medical outcomes for patients without incurring unnecessary costs. The best method should combine a prospective approach; be transparent, evidence based, and unobtrusive to the doctor-patient relationship and provide for education and continuous quality improvement. Combining the proper utilization of imaging and its inherent cost reduction, with improved quality through credentialing and accreditation, achieves the highest value and simultaneous best outcomes for patients.

Key Words: Utilization management, computerized order entry system, decision support, preauthorization, prior notification, radiology benefit management company, RBM


INTRODUCTION

Annual spending on diagnostic imaging increased from $220 to $419 per Medicare beneficiary between 2000 and 2006 [1]. More recently, there has been a flattening of the rate of growth of imaging costs in the Medicare population. Apart from increased use due to the positive role imaging is playing in redefining medical practice through safer, less invasive, and more accurate means of collecting diagnostic information, this rapid growth of imaging costs has also been driven by some negative factors, including the incomplete dissemination of appropriateness guidelines in the medical community, the incomplete availability of patients’ imaging histories, leading to duplicate studies and unnecessary radiation exposure, inappropriate economic motivations, defensive medicine, and misguided patient preferences [1].

Many strategies have been used to try to manage or decrease the utilization of imaging. The characteristics of an ideal approach require that it be transparent to all stakeholders...
ers, practical (as unobtrusive as possible in the normal work processes of providers), efficient, consistent, and educational. The system should allow the opportunity for further development, such as using data to guide the further containment of unnecessary utilization. Strategies that offer the best return in the long run will be data driven and result in the continuous education of providers and patients. They will be designed to fit within the framework of normal patient care processes. Providing decision support on the basis of evidence-based utilization guidelines, such as the ACR Appropriateness Criteria®, at the point of computer order entry, meets these criteria. The ideal scenario for the health care system will be the marriage of an effective utilization management system with the delivery of associated imaging services that meet equally rigorous quality standards.

**DRIVERS OF INCREASED IMAGING UTILIZATION**

To define the ideal method, or methods, to control the unnecessary utilization of imaging, it is important to understand the positive and negative factors underlying the trend toward more imaging. On the positive side is the prospect of achieving better, faster diagnoses using contemporary, noninvasive imaging methods, sometimes in place of more invasive and expensive procedures (Table 1). This is overwhelmingly the most important factor in the rapid rise of imaging utilization. It has come from the needs of all medical disciplines and affects patients with a wide spectrum of diseases and conditions.

However, in some instances, the rapid integration of advanced medical imaging into clinical practice has exceeded the ability of the medical community to discern the most appropriate imaging studies for their patients’ clinical circumstances. Additionally, because patients often receive care from multiple physicians and at different facilities, duplicate examinations are performed because ordering physicians do not have access to patients’ complete imaging histories. Also on the negative side of the ledger are factors such as inappropriate economic incentives for providers, defensive medicine by providers, and misguided patient preferences. Finally, the aging US population is also a prevailing factor contributing to increasing imaging utilization. Older individuals are expected to use more of all medical services, including imaging.

Most of the increased utilization in imaging is appropriate and adds value to the care of patients [2]. In addition to improved diagnostic capabilities, imaging is used for surveillance in many diseases, allowing earlier diagnosis, intervention, and changes in therapy when necessary. Many professional societies have developed best practices or clinical algorithms that reflect that imaging is a key feature in the workup of numerous clinical situations [3,4]. However, appropriateness and comparative effectiveness guidelines have not been uniformly disseminated to the medical community, leading to some inappropriate use of medical imaging.

Physician ownership of advanced imaging equipment provides an economic incentive for increased imaging utilization. The in-office ancillary services exception to the “Stark” conflict-of-interest legislation allows “ordering” physicians to provide advanced imaging services (CT, MRI, and PET) in their offices [1]. The ownership of advanced imaging equipment by nonradiologists has dramatically increased over the past 10 years because of the ability of self-referring physicians to increase their own revenue by shifting examinations away from independent imaging centers and hospitals. Although not all of this imaging is inappropriate, it is clear from multiple studies that the utilization of imaging by many ordering physicians increases when they have ownership interest in imaging equipment [5-7].

In the work of Gazelle et al [8], the average likelihood of image utilization for 8 medical scenarios was greater than 2 to 1 when there was a financial incentive compared with when the referral was not financially motivated. In percentage terms, this equates to 100% more imaging being performed under conditions of self-referral. To deny this reality is to deny normal human economic behavior. We are not aware of any credible studies showing “neutral behavior” or unchanged ordering habits among physicians after purchasing advanced imaging equipment.

Finally, some have suggested that radiologists are a cause of inappropriate imaging utilization because they recommend unnecessary additional studies. There are no credible studies demonstrating that this is a significant factor in the overall growth of imaging utilization. In fact, there is evidence to the contrary. Lee et al [9] determined that only 8% of follow-up or repeat imaging was associated with radiologists’ recommendations in a large study encompassing

<table>
<thead>
<tr>
<th>Table 1. Imaging studies that replaced other examinations</th>
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<tbody>
<tr>
<td>Prior Evaluation Technique</td>
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<tr>
<td>-----------------------------</td>
</tr>
<tr>
<td>Surgical breast biopsy</td>
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<tr>
<td>Pneumoecephalography</td>
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<tr>
<td>Surgical drainage of abscess</td>
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<tr>
<td>Exploratory laparotomy</td>
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<tr>
<td>Diagnostic angiography</td>
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<tr>
<td>Venography for DVT</td>
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<td>Myelography and CT</td>
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Note: CTA = computed tomographic angiography; DVT = deep venous thrombosis; MRA = MR angiography.
>100,000 examinations. The vast majority of these were appropriate recommendations for disease surveillance or workup of unsuspected clinically significant conditions.

Defensive medicine occurs when physicians’ decision making is influenced by their perceived risk for litigation from their interactions with patients. In this context, imaging studies may be ordered primarily to demonstrate ordering physicians’ care and thoroughness; they are used to exclude unlikely but dangerous diagnoses. Defensive medicine is universal. A survey of 900 providers by the Massachusetts Medical Society in 2008 found that 22% of x-ray examinations, 28% of CT scans, 27% of MRI scans, and 24% of ultrasound examinations were ordered for defensive reasons [10]. Unfortunately, this increased utilization often does not benefit patients, but it does add substantial costs.

Patients’ expectations and preferences also motivate imaging utilization. Increased patient awareness of advanced imaging leads some to expect and even demand imaging evaluations of their clinical concerns. This awareness is a mixed blessing driven by the media, direct-to-consumer marketing, the Internet, and self-help books. Effective and proper patient education can be difficult to define, let alone achieve. Physicians who fail to image these patients risk losing them from their practices. Insurers that refuse payment may be viewed as greedy or obstructive. Patients’ preferences also matter. For example, a recent study of colon cancer screening indicated that almost 40% of the surveyed patients would refuse optical colonoscopy but were willing to undergo CT colonography (unpublished data presented to CMS by Brooks Cash, March 3, 2009).

STAKEHOLDERS AND THE IMPACT OF INCREASED UTILIZATION

Although patients have the biggest stake in having the most appropriate imaging examinations performed, there are many other stakeholders, often with opposing incentives (see Figure 1). Medical equipment manufacturers, physicians, and hospitals have incentive to perform imaging studies, while payers for health care generally have incentive to control costs or raise premiums to be profitable. Ironically, almost all of the stakeholders are paying for health care, and yet the increase in the utilization of imaging services affects each stakeholder in very different ways. The challenge is to align stakeholder incentives with the best outcomes for patients.

EDUCATION AND STANDARDIZATION OF ORDERS FOR IMAGING

There is sometimes a lack of knowledge on the part of ordering physicians, who want to do what is best for their patients but do not understand which imaging study is best suited to confirming or excluding the diagnosis in question. This may result in an inappropriate study being ordered and performed and often a recommendation from the radiologist for a more appropriate follow-up study. Appropriate management of the utilization of medical imaging should begin with how physicians are trained to use medical imaging to benefit their patients. Although the integration of imaging utilization training into medical school and residency training is beyond the scope of this review, appropriate utilization should become a major focus of medical student or resident training in specialties outside of image-intensive specialties. However, it must be recognized that many practicing physicians have not received any formal training in the appropriate use of advanced medical imaging. To diminish inappropriate utilization and provide education to ordering physicians, order sets and clinical pathways are now being used in some locales to standardize care, including the appropriate utilization of imaging and other resources. Although order sets were initially used to streamline prevailing practice, the focus began to shift from standardizing individual or local practices to standardizing practices within a profession. Professional societies, such as the ACR, have produced standards and guidelines to define standard practices [11]. As evidence-based medicine and patient safety programs grew, the best-practice guidelines used in some locales moved from a consensus basis to data-driven algorithms that crossed specialties and disciplines. Such standardized systems allow physician education at the time of order entry and provide the means to order the appropriate test for the presenting clinical complaints without necessarily having had extensive experience with the current imaging techniques, sensitivity, and specificity in that clinical scenario [12].

MANAGING IMAGING UTILIZATION

A number of methods have been used to manage imaging utilization, with the aim of minimizing or reducing unnecessary imaging studies, especially higher cost advanced imaging examinations (Table 2). Some methods focus on decreasing utilization by restricting access using various
means, while others focus on ordering the correct study through education and feedback. Controlling approval and providing feedback at the time of ordering are common approaches. Managed care organizations attempted to use preapproval programs to control utilization in the early 1990s and received significant public criticism [13,14]. Utilization management systems may also include physician and provider profiling, prior notification requirements or preauthorization processes, network strategies, and unit-of-service payment reductions.

**Table 2. Methods to reduce inappropriate imaging**

<table>
<thead>
<tr>
<th>Method</th>
<th>Example</th>
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<tr>
<td>Order entry/decision support</td>
<td>University of Florida Health Center,</td>
</tr>
<tr>
<td>programs</td>
<td>Massachusetts General Hospital, Minneapolis</td>
</tr>
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<td></td>
<td>Area Imaging</td>
</tr>
<tr>
<td>Accreditation programs</td>
<td>ACR, MQSA, IAC</td>
</tr>
<tr>
<td>Network strategies</td>
<td>CareCore, NIA, etc</td>
</tr>
<tr>
<td>Radiology benefit management</td>
<td>NIA, AIM, Med Solutions, HealthHelp</td>
</tr>
<tr>
<td>Unit cost reduction</td>
<td>Deficit Reduction Act, bundled payments</td>
</tr>
</tbody>
</table>

Note: AIM = American Imaging Management; IAC = Intersocietal Accreditation Commission; MQSA = Mammography Quality Standards Act; NIA = National Imaging Associates.

This is an educational process that does not disrupt patient care workflow or disrupt the physician-patient relationship.

The radiology department at Massachusetts General Hospital has designed an order entry system with decision support on the basis of the ACR Appropriateness Criteria. Their 7-year experience showed a reduction in the quarterly compound growth rate of 2.75% for outpatient CT, 1.2% for outpatient MRI, and 1.3% for outpatient ultrasound during steady growth of clinic visits [15]. This approach can also be applied to inpatients and emergency room patients.

Computerized provider order entry with decision support has proven to be an effective approach to imaging utilization and should be explored further. It has a number of characteristics that are highly desirable and works in a completely transparent manner. It is completely reproducible, unlike the results of phone conversation–based prior approval systems. Computerized provider order entry with decision support is also highly practical because it fits directly into the workflow of a physician’s office. It is efficient and provides continual education because each episode of ordering results in immediate feedback to the provider. The approach is suited to further development because it collects data about ordering patterns, permitting focused review and updating of criteria as well as allowing identification and management of outlier behavior.

**Prior Notification**

Prior notification is a strategy used by several large national payers (eg, UnitedHealthcare, Humana). Prior notification seeks to educate ordering physicians on the best imaging study given the reported clinical indications on a case-by-case basis. The ordering physician maintains the ability to order an imaging study contrary to the advice of the health plan should they believe it is indicated. Health plans using this approach believe that prior notification encourages physicians to select the most appropriate studies on the basis of individual patients’ clinical circumstances [16]. Almost all health plans using prior notification have emphasized their desire to collaborate with physicians rather than simply deny or limit imaging services. Physician profiles may be part of their notification programs, creating a form of peer pressure to be conservative in using imaging resources.

**Prior Authorization**

Prior authorization (sometimes referred to as precertification) is a more stringent process for imaging utilization management that has been used by insurance companies and the RBM companies they have hired. Prior authorization requires an ordering physician to obtain authorization from the insurance company or its designee before a study is performed in order to receive payment for the service. The ordering physician is required to contact a center and obtain authorization on the basis of the proprietary guidelines,
purportedly built from the ACR appropriateness guidelines but often including proprietary clinical algorithms [17]. Unfortunately, these programs are not using the ACR Appropriateness Criteria as envisioned by the College, as they seem to ignore the comparative effectiveness, function, and educational value of these criteria. Prior authorization programs introduce barriers to patient care by introducing a layer of administrative complexity that creates additional costs and administrative burdens for referring physicians, hospital outpatient and freestanding imaging centers, and radiology groups [18]. Prior authorization can also delay the provision of appropriate health care to patients if authorization is not obtained at the time the examination is requested by the referring physician. Payment denials are often based on procedural “errors” rather than a lack of medical necessity [19]. Some of these programs are intentionally burdensome to discourage utilization. Because of its somewhat cumbersome structure, prior authorization functions only in the outpatient setting. Few physicians find this process “educational” beyond learning how to game these systems to get requested examinations authorized.

The RBM companies claim to improve the quality of patient care while saving health plan partners millions of dollars a year. However, the effectiveness of prior authorization is not uniformly accepted. The Medicare Payment Advisory Committee, in its 2005 report to Congress, wrote that prior authorization was costly and ineffective in controlling imaging utilization [20]. In a follow-up 2008 report, the Government Accountability Office opined that prior authorization by RBM companies could be useful in controlling imaging utilization. In responding to that report, the US Department of Health and Human Services pointed out that “there is no independent data—other than self-reported—on the success of RBMs in managing imaging services” [1]. Furthermore, the effectiveness of the algorithms used by RBM companies in maintaining the quality of care has not been validated for the Medicare population, in which the prevalence of disease is higher than in the general population, and delays in diagnosis associated with obtaining prior authorization could cause detrimental outcomes due to the frequent comorbid conditions in Medicare patients.

In a recently published variation of preauthorization, imaging studies not meeting the RBM company’s preauthorization criteria were referred to an academic neuroradiologist for review with the referring physician. After consultation, an additional 29% of these studies were performed or changed to more appropriate examinations. This study also demonstrates the burdensome nature of preauthorization programs. Thirty-seven percent of studies not meeting the RBM company’s preauthorization criteria were initially withdrawn because the referring physician did not immediately call to review; however, 36% of these were ultimately performed. It was not stated whether the delays resulted in any adverse outcomes [21].

Although there may be savings to insurance companies associated with preauthorization programs, these dollars do not leave the health system. The savings are a cost shift to other stakeholders in health care, such as additional staff members in doctors’ offices and hospitals [22].

**Network Strategies**

Network strategy efforts tend to focus on examination cost, quality, or a combination of these factors. Accreditation is a system to ensure that when an examination is performed, it is done properly. UnitedHealthcare and others use accreditation as a significant factor in profiling providers for network inclusion or payment [23]. Some plans profile providers strictly by cost with little regard to quality and then actually divert patients to these facilities, sometimes over the objections of the treating physicians and patients; quality and continuity of care are ignored in such cases (Omega Diagnostic Imaging, PC v CareCore National, LLC et al). Other plans use some combination of quality and cost profiling to encourage a value-spending approach. Such efforts range from advisory to compulsory in their design and function. As health savings accounts become more common, patients are also demanding more cost and quality information from their plan administrators. Some RBM companies have extended into at-risk agreements with insurers, creating a situation in which the RBM companies’ profit (or loss) is directly tied to their denial rates [24]. Patients enrolled in these plans are rarely honestly informed about such incentive arrangements.

**Ensuring Quality: Accreditation Programs and Practice Guidelines**

The ACR’s accreditation programs were first established in 1963 and are continuously expanded and updated to remain current with new technologies. There are currently 9 accreditation programs: mammography, radiation oncology, ultrasound, stereotactic breast biopsy, MRI, breast ultrasound, nuclear medicine, CT, and PET. The ACR accreditation programs are based on the *ACR Practice Guidelines and Technical Standards*, which are created through a thorough consensus process and are approved by the Commission on Quality and Safety as well as the ACR Board of Chancellors, the ACR Council Steering Committee, and the ACR Council. Many of these guidelines are collaborative efforts with other medical specialty societies [25].

ACR accreditation is an educationally focused evaluation of practices as well as a peer-reviewed assessment of image quality and radiation safety. Qualifications of personnel, equipment performance, and the effectiveness of quality control and assurance measures as well as outcomes data are also evaluated in the process. Facilities that achieve accreditation meet a high standard of service, and as such, reimbursement programs that require accreditation from providers who provide imaging services promote quality practice and patient care.
The focus on quality and the potential to reduce or eliminate inappropriate utilization by facilities that do not meet the rigorous standards of accreditation is what has led some payers, such as UnitedHealthcare, to require facilities to be accredited to receive reimbursement for certain imaging procedures. The Mammography Quality Standards Act (MQSA) was passed in 1992 and established minimum standards for performance and interpretation of mammograms [26]. By 1994, 9.5% of the 10,000 mammography sites existing before MQSA had closed because they could not meet the new standards [27]. Changes in MQSA in 1997 required written communication of results to patients. Because only accredited mammography programs are reimbursed, this new patient safety enhancement almost immediately reached 100% compliance. The Medicare Improvements for Patients and Providers Act of 2008 mandates accreditation for advanced diagnostic imaging services, including MRI, CT, nuclear medicine, and PET, by January 1, 2012 [28].

**Unit Cost Reduction**

It has been argued that advanced imaging studies are overvalued and that the unit cost must be lowered to reduce utilization. The Deficit Reduction Act of 2005 lowered the unit price of the technical fee in the Medicare Physician Fee Schedule to the lower of the Medicare Fee Schedule or HOPPS payment [29]. Unit cost reductions mandated by the Deficit Reduction Act reduced spending on imaging per Medicare beneficiary by 10.5% but did not significantly affect utilization. The growth of tests subject to the HOPPS caps was almost 4 times higher than that of those not subject to the HOPPS cap [30]. Self-referral situations are very likely to respond in this manner when unit prices decrease.

**DISCUSSION**

A review of the criteria for appropriate imaging utilization, the drivers of imaging utilization, and the current methods of utilization management allows the analysis and optimization of strategies to eliminate the inappropriate uses of medical imaging. Ordering physicians have the pertinent clinical information to make the best decisions for their patients, and that knowledge can be supplemented with evidence-based comparative effectiveness guidelines that can be accessed at the time of order entry. The ideal method is an evidence-based educational process to ensure that the correct imaging study is chosen for the current clinical scenario and in similar scenarios in the future. Programs that intervene at the time of decision making without obstructing clinical workflow have the highest likelihood of acceptance by the ordering physicians. A computerized order entry system with decision support for medical imaging based on standardized comparative effectiveness criteria such as the ACR Appropriateness Criteria is best suited to transfer these goals into clinical practice. Providing a standardized, evidence-based guide to ordering imaging studies should help mitigate defensive medicine practices. Integration with portable electronic health records will make patients’ prior imaging histories available at the time of order entry, eliminating duplicative examinations. Establishing mandatory accreditation and credentialing for imaging providers can further enhance quality and patient safety. Accreditation will ensure that the imaging study ordered is performed in a way that the expected diagnostic yields are obtained. Utilization management strategies should include measures to ensure and improve quality, diminish defensive medicine, and eliminate financially motivated imaging. If these are accomplished and imaging is used appropriately, cost savings will follow.

**CONCLUSIONS**

A review of existing practices shows that providing physician education at the time of order entry using computerized order entry with decision support is a solution that is educational, transparent, efficient, practical, and consistent. Combined with an electronic imaging history to eliminate unnecessary duplicate studies and the elimination of incentives that lead to unnecessary imaging either from defensive medicine or conflicts of interest, this strategy could completely eliminate inappropriate imaging utilization. Facility accreditation will ensure that imaging studies are high quality and provided in a safe environment for patients. Although there are numerous alternatives for managing the costs associated with medical imaging, the choice of strategy will ultimately depend on whether the goal of the stakeholder is to merely reduce the number of imaging examinations performed, reduce costs, or increase the likelihood that the appropriate examination is ordered and inappropriate utilization is eliminated. The choice of strategies may vary on the basis of the perspective of the various stakeholders; however, the perspective of patients must be paramount in the decision-making process.

**REFERENCES**


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