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Notes on Medical Imaging and Healthcare Reform

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This paper summarizes research done over the last year on the economics of medical imaging and its relation to healthcare reform. It is being circulated to persons with an interest in imaging for comments, corrections, and suggestions for improvement.

1. Introduction

On May 13, 2009, a 65 year-old woman was brought to the emergency room of a Boston area hospital. The woman had slipped in the shower, hitting her head as she fell. Upon admission, she received what is now a standard procedure in a U.S. hospital: a head CT study[2] to check for a possible skull fracture and a subdural hematoma - bleeding between the brain and its lining. The study, read by a radiologist, would help to determine the woman's course of treatment. If there were no fracture or bleeding and the woman's vital signs were stable, she would be sent home with instructions to be alert for headaches, nausea, dizziness, and blurred vision - signs of a concussion. If the study

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[2] An imaging "study" refers to the fact that, unlike an X-ray, a single CT scan produces multiple images.

showed a fracture or minor bleeding, the woman would be held in the hospital for observation. If the study showed extensive bleeding, the woman would be taken immediately to the operating room to drain the blood and relieve pressure on the woman's brain.

In this and many other cases, medical imaging has become an indispensible part of modern medical care. At the same time, the cost of medical imaging, from an X-ray of a finger to a PET scan of a potentially cancerous thyroid, now constitutes something over 5% of all U.S. healthcare costs and imaging costs are growing at 7-8% per year.[3]

As Congress considers healthcare reform, an important piece of the debate is the proposition that significant numbers of medical procedures are unnecessary and can be eliminated without reducing the quality of medical care. Public opinion data suggests many people are skeptical. The public wants lower healthcare costs, but they trust what their doctor prescribes and they believe that eliminating procedures must lead to limits on necessary as well as unnecessary treatment – i.e. rationing.[4]

In many medical circumstances, "necessary" treatment is clear-cut, e.g. the necessity of antibiotics to treat certain bacterial infections. In diagnostic processes the "necessity" of more information can be less clear-cut and requires weighing benefits against costs.

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[3] These figures are adapted from Beever and Karbe (2004).

[4] For example, Pew polling results reported in March 2009 show that 86% of Americans believe the government should be doing more to reduce healthcare costs while 46% of the same sample are concerned about the government becoming too involved in healthcare. http://people-press.org/report/517/political-values-and-core-attitudes

We apply such benefit-cost calculations to non-medical situations every day. Each time I get in my car, I would like current information on the chance that my car's brakes will fail. Acquiring this information costs an hour's time and $70 at the local garage and so I usually save the time and money and live with the greater uncertainty.

Similarly, imagine a young man who comes to his primary care doctor with an acute headache and a history of chronic headaches. The doctor says

> I can do a CT of your head that will cost you $275 and we will know immediately if there is a serious abnormality. Alternatively, I can give you antibiotics for a sinus infection and I can do the CT in a week if things don't improve.

If actually confronted with these costs and benefits, the young man might choose to live with a week's uncertainty for the chance of saving $275. In the U.S. healthcare system, however, the decision will likely be made on a different set of costs and benefits.

- **Patients Can Underestimate Costs:** If the man is covered by insurance, his out-of-pocket cost can be much lower than $275 depending on his policy's deductable and copayment. The low sticker price may cause the man to request the CT but the study will still add $275 to the nation's medical costs, with the insured portion factored in to insurance premiums (Newhouse, 2002).

- **Doctors Can Conflate Their Own Benefits with the Patient's Benefits:** If the doctor, rather than the young man, makes the decision, his training tells him to downplay the study's cost particularly since it is covered by insurance. He may recognize a different cost – a minimal risk for the patient from a small exposure to radiation and a small chance of a false positive (which must then be followed up). On the benefit side, there is a chance, perhaps quite small, of discovering a serious abnormality and there are potential non-medical benefits *for the doctor*. The doctor receives added protection against malpractice. If the doctor owns his own scanning equipment and/or reads his own studies, the CT will generate a reimbursement. The CT will let the doctor show the patient he is "doing something". It may let the doctor end an appointment to stay on schedule, and so on.

Unlike the case of the lady falling in the shower, this is a messy decision. If healthcare reform is to "bend the curve" of rising medical costs, it will have to address decisions like these.

In this paper I examine the potential for eliminating unnecessary medical imaging studies in the U.S. The underlying story involves the conflict between a healthcare system with strong incentives to order a study and relatively weak, or inaccessible, clinical guidelines specifying when a study is appropriate. While the focus of this paper is medical imaging, the same tension between incentives and guidelines applies to many other medical procedures (Gerber and Patashnik 2006).[5]

The story makes four points that are relevant to the current healthcare debate.

- *Available evidence suggests that in recent years, 20% or more of CT and MRI studies are medically inappropriate. That is, an imaging expert would not do the study even if it were free (though she might call for a different study).*
- *The growth of medically inappropriate studies reflects both reimbursements that historically were too generous and a lack of accessible, evidence-based criteria on the appropriate study (if any) in particular situations. Evidence-based criteria are hard to develop and, until recently, incentives to develop them have been weak.*

[5]To be sure, medical imaging is an extreme case because it contains few natural "brakes" on utilization like, say, colonoscopies where physical discomfort leads to *underutilization* with people not making or cancelling appointments. The claustrophobia associated with a closed MRI tube was a potential brake on MRI utilization but it is being addressed through newer open magnet scanners. One emerging brake is the set of recent articles describing the potential for radiation exposure in CT scans and X-rays (e.g. Mettler et. al., 2008)

- *Some restriction of imaging studies has already begun, promoted by private insurance companies. The restrictions' impact on medical care is uncertain because the quality of the appropriateness criteria is uncertain (see above).*
- *The current healthcare system contains three strong non-medical incentives to do imaging studies: fee-for-service reimbursement, a doctor's ability to self-refer a patient to the doctor's own imaging equipment, and the desire to avoid malpractice litigation. To the extent that healthcare reform leaves these incentives in place, restricting unnecessary imaging studies will likely require a combination of reduced reimbursements and significant monitoring of doctor behavior. A healthcare system without these incentives would require less outside regulation.*

I make this argument in the six sections that follow. Section 2 contains a short primer on medical imaging in the U.S. Section 3 provides data on the growth of advanced medical imaging – CT and MRI as well as PET. Section 4 defines medically inappropriate studies and unnecessary studies and discusses the factors that might cause a doctor to order such a study. Section 5 reviews evidence on the effect of financial incentives to order studies and evidence on the magnitude of inappropriate studies. Section 6 describes current attempts to control the growth of imaging. Section 7 summarizes the argument.

2. A Short Primer on U.S. Medical Imaging

For readers unfamiliar with the state of medical imaging, this section contains a brief overview of medical imaging in the U.S. including payment methods, the role of radiologists in the imaging process, and the main current imaging modalities.

2.1. Imaging Reimbursement

Like much of the rest of U.S. healthcare, medical imaging is shaped in part by the reimbursement structure. A full description of this structure requires a separate paper. What follows is a brief description of the Medicare reimbursement structure. Medicare reimbursements are important in themselves and they heavily influence private reimbursements.

Medicare's imaging reimbursements rest on two main distinctions:

- Payments made for use the imaging equipment versus payments made for the interpretation of the study.
- Payments made for studies of hospital inpatients versus payments made for studies provided to outpatients imaged in a hospital or outside facility.

If a person is imaged as an outpatient in a hospital, a doctor's office or independent testing facility, Medicare pays on a fee-for-service basis that includes two parts: the "technical fee" that is paid for the use of the imaging equipment and the "professional fee" that is paid for interpreting the study. Both fees vary by the specific procedure – the modality, the body area being imaged, whether the study requires use of a contrast agent, and so on.[6] In most CT scans, MRIs, and PET scans, the technical fee is 75%-80% of the total reimbursement.

[6] More precisely, technical and professional fees are connected to some of the approximately 20,000 Current Procedural Terminology codes (CPT codes). See Raab and Parr (2006, parts 1-3) for a description

When a hospital inpatient is imaged, a professional fee is paid for reading of the study[7] but there is no separate technical fee. Rather, the hospital is paid a DRG (Diagnostic Related Group), a flat prospective payment based on the patient's diagnosis, age, comorbidities, etc. to cover hospital resources, including imaging equipment, used for the patient. The DRG payment means the financial incentives for inpatient imaging are significantly weaker than the financial incentives for outpatient imaging.

This DRG system for inpatients has been in place since 1983 and the Physician Fee Schedule, covering outpatient services has been in place since 1992.

2.2 Major Imaging Modalities

From a technical perspective, medical imaging has made enormous advances over the last four decades. Advances have occurred in both the clarity of images and the ease of taking the image. As one radiologist notes:

> … years ago, the only way to image the brain was with a cerebral arteriorgam (after a direct needle puncture of the carotid artery) and/or a pneumoencephalogram (injecting air into the spinal canal, and turning the patient upside down). Now head CT is painless, takes less than a minute, and provides extremely detailed images. (personal communication).

Such advances lower a doctor's reluctance to order the study and the patient's reluctance to undergo it.

A list of the most used imaging modalities today would include X-rays, CT scans, MRIs, and PET scans.

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of how acquiring a CPT code is a crucial step in obtaining insurance reimbursement for a new imaging procedure.

[7] The professional fee may be paid to the hospital or the hospital may have a contract with a physician group to read images in which case the group bills for the professional fee.

X-rays are the original imaging technology, accidentally discovered by Wilhelm Roentgen in 1895 as he performed radiation experiments (e.g. Kevles, 1998). While basic X-ray technology is now 115 years old, X-rays – technically, radiography - remain the modality of choice in a large number of situations. A recent American College of Radiology survey estimates that X-rays currently represent half of the studies read by a typical radiologist, though this share has declined from 70% in 1992 (Bhargavan, et. al. 2009).

Despite their extensive use, X-rays are not a focus of cost reduction efforts because they are cheap. The current Medicare reimbursement for an outpatient frontal and lateral X-ray - a common pair of images taken when a person is admitted to the emergency room with shortness of breath - is $37.95, a figure that includes both the technical and professional fees.[8] Imaging reimbursements from private insurers vary widely across both insurance carriers and customers and average 25%-40% higher than Medicare reimbursements. X-rays are, however, a source of radiation exposure.

Computed Tomography (CT) Scans were first introduced in hospitals in the 1970s. While CT scans are based on X-rays, the two modalities differ in how the X-rays are used. A traditional chest X-ray resembles a photograph that superimposes the ribs, heart, and lungs in a single image. A chest CT scan creates a series of overlapping cross-sectional images of the chest – "slices" – that move up through the heart and lungs. Each slice is constructed by integrating multiple X-ray images of the same cross-section taken by a scanner as it rotates around the body. The resulting slices give more detail of body

[8] Medicare reimbursements vary by geographic region. Examples in this paper are from the Boston region.

parts than a traditional X-ray including detail of areas that might otherwise be blocked by bone.[9] The CT-X-ray distinction came to public attention after the attempted assassination of President Reagan in 1981. An X-ray was sufficient to locate the bullet in Reagan's abdomen but it required a CT scan to locate the bullet in the brain of Jim Brady, Reagan's press secretary.

Like standard X-rays, CT scans can be done quickly and so are useful in emergency rooms. Unlike X-rays, CT scans are relatively expensive. An outpatient CT Scan of the Abdomen with Dye – a study often used in the emergency room to check for appendicitis - is currently reimbursed by Medicare at $311.87 (technical plus professional fee).

Magnetic Resonance Images (MRIs) first became available for hospital use in the mid 1980s. They provide greater detail than CT scans or X-rays of soft tissues particularly when the tissue is shielded by bone– for example, the nerve roots and discs that are shielded by spinal vertebrae. Unlike X-rays and CT Scans, MRIs do not expose the patient to radiation but doing the scan requires significant time and so MRIs are not often used in an emergency room. MRIs are more expensive than CTs - an outpatient MRI of the Neck and Spine with Dye is reimbursed by Medicare at $647.63 (technical plus professional fee).

[9]Kevles (1998) quotes William Oldendorf, one of the theoreticians behind the CT-Scan: "An observer standing in a forest might have a difficult time viewing a distant person because that person might be blocked by trees in between. But if the observer begins to move through the forest, while at the same time looking in the direction of the distant person, then the trees in the foreground would seem to move past while the distant individual would seem to stay still." Integrating multiple X-ray images, taken at different angles, into a single slice requires significant computer power which is why the first CT machines appeared in the mid 1970s even though the numerical principles of integrating multiple images had been laid out two decades earlier.

Positron Emission Tomography (PET) was first introduced in the 1990s and utilization is growing rapidly. Where X-rays, CTs and MRIs give snapshots of a body's structure, PET scans capture levels of cell function – particularly the high rates of metabolism associated with cancerous cells. The Medicare reimbursement of a PET scan of a limited body area - e.g. a thyroid - to check for possible cancer is reimbursed by $1,382.13 (technical plus professional fee). In practice, PET scans are often taken in conjunction with a CT or MRI to show detail of a body part's structure as well as its function.

Other common modalities include mammography (typical Medicare technical plus professional fee = $48.29), myocardial ischemia perfusion scans (i.e. cardiac imaging – outpatient Medicare technical plus professional fee = $254.60)[10], ultrasound (outpatient Medicare technical plus professional fee for examination of abdominal back wall = $135.84), and fluoroscopy (outpatient Medicare technical plus professional fee for fluoroscope examination = $115.61). I briefly return to some of these modalities below.

2.3. The Role of the Radiologist.

Radiologists have played a mixed role in imaging growth. As they frequently note, they rarely order the initial study for a patient.[11] Rather, they read the study that has been ordered by a primary care doctor or specialist (e.g. Levin et. al. 2008). At the same time, radiologists can often suggest the need for subsequent studied. In commenting on an earlier draft of this paper, one internist offered the following comment:

[10] The reimbursement rate is for CPT 78461 (professional fee plus technical fee).
[11] The lack of authority is often described as radiologists not being able to "control their patients."

> …..the constant radiologist recommendation to get another test. This seems to be 100% due to liability concerns. It is getting scary to order a CXR since that will frequently lead to a CT and EVERY(!!!!!!!!!) CT leads to another in 3-6 months and another and another etc. etc. I have not recently done a single CT of chest where at the bottom it did not recommend another. Even when this is the 5th follow up….[12]

This is an extreme characterization but it points to an underlying problem. Under the right conditions, a radiologist can be an important source of advice to the ordering physician on when a study is likely to be useful.[13] To the extent that liability fears inhibit giving such advice, they do a big disservice.

As medical imaging has grown, radiologists' incomes have grown correspondingly. Since only about one-fifth of radiologists own scanning equipment, most radiology income comes from professional fees (Moser and Hastreiter, 2009). In Medicare reimbursements, the basic accounting block for doctor workload is the Resource Based Relative Value Unit (RVU), a measure of the effort, skill, and cost required to perform a particular medical procedure like reading a study. According to surveys by the American College of Radiology, the median radiologist workload was 5,700 RVUs in 1992 and 9,700 RVUs in 2007 (Bhargavan et. al. 2009). A part of this increase reflects the shift in radiologists' workload away from X-rays and toward CT scans and MRIs that carry higher RVUs reflecting their greater complexity. A second part of the increased workload reflects the digitization of images and the related picture archiving and communication

[12] Personal communication. CXR is an abbreviation for chest X-ray.

[13] Useful advice requires trust between the ordering doctor and the radiologist. In practice, digital imaging has reduced this trust by allowing radiologist and ordering doctors to work in separate locations with minimal face-to-face contact. See Levy, 2009

systems (PACS) that allow a radiologist to read a study at her computer terminal rather than having to place hard copy films on a light board.[14]

The latest salary survey data from the radiology web site, www.AuntMinnie.com reports the median base salary for a radiologist (all experience levels) is $330,000 with an annual bonus of $75,000,[15] while the website www.Salary.Com reports salary plus bonus between $400,000 and $425,000 depending on the metropolitan area.

Radiologists are not the only medical specialists to read imaging studies. For example, myocardial ischemia perfusion scans – heart images - are typically read by cardiologists who usually own the equipment on which the scan is taken. Unlike radiologists, they can prescribe the initial image for their own patients and if they or their group own the scanning equipment, they can collect the study's technical and professional fees. This ability to "self-refer" creates a strong financial incentive to do a study and I return to it below.

3. Advanced Imaging Growth – CT, MRI and PET

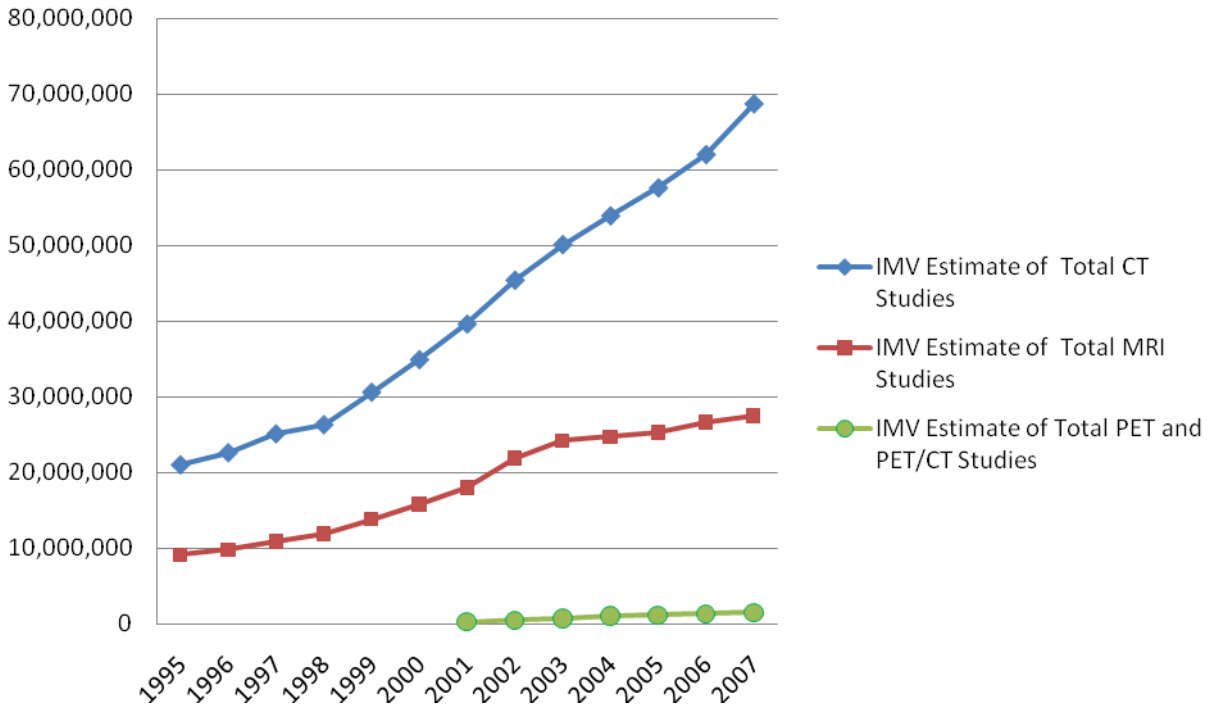
Figure (1) presents estimates from the consulting firm, IMV, on the growth of CT, MRI, and PET – the largest of what are known as "advanced" imaging modalities -

[14] Part of the efficiency gain from PACS allows reading more cases but part is absorbed into reading the multiple images per case generated by a CT scan or MRI rather than the single image of an X-ray. A typical head CT now involves about 35 slices, a number that would be impossible to read using hard copy films on a lightboard. A PACS allows the radiologist to scroll back and forth through the images using the scroll wheel on the computer mouse.

[15] See the AuntMinnie Salary Scan at: http://www.auntminnie.com/index.asp?sec=mkt&sub=sal&pag=qry. A radiologist who is a partner in a private group practice can receive a bonus from the practice profits.

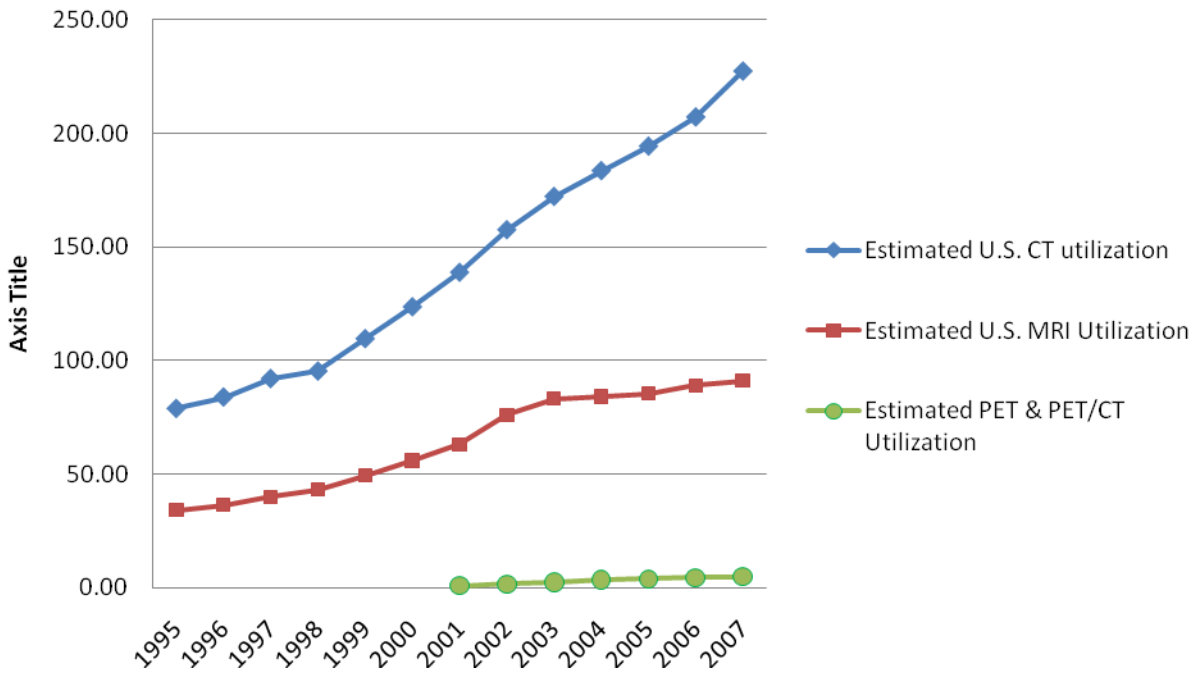
between 1995 and 2007.

Figure 1
Trends in CT, MRI and PET Studies: 1995-2007



Because some of the increased imaging reflects population growth, Figure 2 converts the total imaging estimates into utilization rates – studies per 1,000 persons.

Figure 2
U.S. Utilization Rates for CT, MRI and PET - 1995-2007
(studies/1,000 population)



In interpreting Figure 2, note that 16 percent of the U.S. population lacks health insurance and has only limited access to imaging. It follows that data in Figure 2 should be read as lower bound estimates of utilization as normally defined – the rate of studies among a population of insured persons with ready access to healthcare.

Between 1995 and 2007, lower bound CT utilization grew from 79.5/1,000 persons to 229.7/1,000 persons, an average growth of 9.2% per person per year that shows little sign of leveling off. Over the same period, lower bound MRI utilization grew from 31.4/ 1,000 persons to 91.9/1,000 persons - 9.4% per year - but this growth does show signs of slowing. Because PET was introduced more recently, it remains in the early phases of

adoption. Between 2001 and 2007, lower bound PET utilization grew from less than 1 scan per 1,000 persons to 4.8 scans 1,000 persons, a growth rate of 34.3% per year. This rapid growth is likely to continue since Medicare administrators recently expanded the conditions under which PET scans will be reimbursed (Forrest, 2009b).

Volumes of other imaging modalities include mammograms (36.9 million in 2008) and myocardial ischemia perfusion scans (cardiac images – 15.7 million in 2007).[16]

4. Inappropriate and Unnecessary Imaging – What it is and Why a Doctor Might Do It

4.1. Two Ordering Standards

To put inappropriate studies in perspective, it is useful to set out two standards on how a doctor should ordered a study:

- How the medical expert would order a study.
- How an economist would order a study.

The Medical Expert – a radiologist or other imaging specialist - begins from the premise that almost all studies carry some degree of risk. There is a risk that a study may show a false positive or an "incidentaloma" – a potential abnormality that is unrelated to the ordering doctor's original question (Welch 2004). The ordering doctor must follow up these results which can create inconvenience, anxiety, and, in some cases, serious complications for the patient.[17] If the study involves an X-ray, CT, or PET scan, there is

[16] The number of mammograms comes from the Food and Drug Administration: http://www.fda.gov/Radiation-EmittingProducts/MammographyQualityStandardsActandProgram/FacilityScorecard/ucm113858.htm. The number of myocardial perfusion scans comes from the consulting firm, IMV.

[17] A particularly gruesome example is contained in a published letter written by the chair of Radiology at Emory University Hospital describing his own experience (Casarella, 2002).

also the risk of radiation exposure, a problem that is growing as rates of imaging increase (Mettler et. al, 2008).

A medical expert would judge a study as *medically inappropriate* if she believes the expected value of this risk exceeds the expected value of the study's information. Like the case of the 65 year-old woman who fell in the shower, the information's value usually involves telling the doctor something he didn't previously know resulting in a changed course of treatment.

The basis for the experts' judgment can vary widely. In radiology as with many other medical procedures, randomized controlled experiments to demonstrate efficacy are fairly rare –a subject to which I return. As a result, experts must base opinions on the studies that do exist, their own experience, their observations of others' experience, and so on. The resulting judgment is based only on medical factors and does not consider the cost of the study. A medical expert would also judge a study as inappropriate if she believed a different kind of study – say an MRI or X-ray rather than CT - would have a better risk/benefit relationship.

The Economist extends on the medical expert's logic by adding cost to the calculation. From an economist's perspective, a study should be ordered only if the expected value of the study's benefit exceeds the study's cost. Ideally, the expected value of the benefit is calculated by multiplying the expected gain in the patient's Quality Adjusted Life Years (QALYs) by a dollar value assigned to a QALY – often in the range of $100,000 per year. While assigning a dollar value to a year of life is controversial, it is necessitated by the economist's logic that money is scarce and so the benefit of money

spent on one patient should be compared to the benefit of the same money spent on a different patient or on a different use altogether. As we will see, economic studies of this kind are rare in the case of imaging both because they are hard to design and because there have not been strong incentives to do them.

Compared to these idealized standards, the doctor's decision to order a study is a messier process – a mix of two responses:

- A desire to adhere to professional standards including the use of current medical knowledge, the basic norms learned in medical school, etc.

- A response to the incentives the doctor faces including any reimbursement the doctor receives, the threat of malpractice, the effort required to order the study and so on.[18]

Figure 3 displays the factors that motivate these responses according to where they reside:

- A set of individual factors that potentially arise in any organizational setting including the doctor's psychology, demanding patients, etc.

- A set of organizational factors that vary with the environment including the strength of economic incentives, medical liability, ability to access current knowledge, etc.

[18] Economists refer to this effort as transaction costs. Depending on the organization, ordering a study can require filling out a single computerized form or a twenty-minute telephone call arguing for insurance company authorization.

Figure 3
The Image Ordering Decision:
Individual Factors operating in an
Organizational Environment

4.2. Individual Factors

Discussions of unneeded healthcare emphasize fee-for-service reimbursement and fear of malpractice litigation. I discuss these organizational factors below but I begin by describing the individual factors in the imaging decision that would exist regardless of the financial and malpractice environment.

A doctor may order the study to minimize psychological regret. Diagnosis is an inherently uncertain process. The behavioral economist, Richard Thaler, has described how decisions under uncertainty can be influenced by a desire to avoid regret – the feelings of guilt and responsibility that arise when a person recognizes *ex post* that she made the wrong decision (Thaler, 1980). Since doctors are trained "not to miss something," they are natural candidates for these feelings. Thaler argues that a doctor may look for a second opinion to gain additional knowledge but also to shift some of the

regret if the diagnosis proves incorrect. In the same way, a doctor who orders a study may be sharing potential regret with the imaging equipment and the radiologist who reads the study. As one radiologist remarked, "This guy [the ordering doctor] doesn't know what the problem is, but if I can't tell him what the problem is, he can always blame things on me."[19]

A doctor may order the study because he "just wants to know." Like feelings of regret, "wanting to know" a patient's precise condition is a part of a doctor's education that can be taken too far, particularly in economic terms. A patient presents with shortness of breath, a cough and fever, but is otherwise stable. Given the patient's symptoms, the doctor knows she will give the patient an antibiotic. Because the patient is insured, the doctor can also order an X-ray "just to know" if the patient has pneumonia. But the doctor probably would not pay $35 from her own pocket for the X-ray since the results won't alter her treatment.

A doctor may order the study to satisfy a demanding patient or to manage his appointment schedule. In casual conversation, doctors say that ordering a study, even if unneeded, has two virtues: It is a way to end an appointment since there is often little more to be said until the study is read. This is particularly useful if the doctor is on a tight schedule. Ordering the study is also a way for the doctor to show the patient he is "doing something" and taking the patient's anxiety seriously. The internist who read the earlier draft of this paper, added the following anecdote:

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[19]In some settings, the radiologist and the ordering physician know each other well and informal conversation is easy. In larger, more formal settings, the ordering physician can sit in separate parts of the building and deal largely at arms length.

> I have 2 60+ patients, husband and wife, who have been coming to me for years. Somehow they got hooked into "The Head of Cardiology at XXXX Hospital." He did every test!!!!! on each of them including cardiac cath (he could have saved a lot of time and money just by starting with that since based on his approach it would be difficult to imagine his not getting there eventually with everyone.[20]) Everything was normal. Now all I hear is how he is the absolute BEST because of all the tests he did. This is not an isolated instance. This happens all the time.

4.3. Organizational Factors

A doctor may order the study because he is concerned about malpractice litigation. A key question in malpractice litigation is whether the doctor's treatment violates the customary standard of care in the community. A doctor who foregoes a study must consider the possibility that if he is sued, the opposing lawyer can find other area doctors who say they would have done the study. These impacts can be significant. For example, Baicker, et al, using state-by-state data estimate that a 1% increase in malpractice awards per doctor leads to a 2% increase in imaging spending per Medicare recipient.[21] Among doctors, it is a well-known aphorism that no doctor ever was sued for ordering too many tests (though the recent focus on radiation exposure may start to change this).

It is worth noting that radiologists have an ambivalent relationship with malpractice litigation. Like all other doctors, radiologists worry about malpractice litigation, but they

[20] In conversation, the internist suggested the head of cardiology might have given all the tests to demonstrate to medical students how to work up a patient.

[21] The result is strengthened because other "non-defensive" spending - e.g. minor medical procedures – do not show as much sensitivity to the level of malpractice awards.

also recognize that fear of malpractice generates additional imaging studies that increase their business.[22]

A doctor may order a study as a response to financial incentives. Financial incentives are largely an issue for outpatient imaging.[23] Today's outpatient imaging reimbursements have their roots in the 1980s when Medicare began to move from retrospective to prospective reimbursement for outpatient procedures. In the case of imaging, retrospective payment had meant that professional and technical fees were based on "reasonable charges" – the average fee in the local market area. In essence, Medicare was accepting the average price local providers were setting, a procedure with a strong inflationary bias. Prospective payment involved the construction of a Physician's Fee Schedule that announced in advance what Medicare would pay for each doctor outpatient service.

The heart of the new fee schedule was the Resource Based Relative Value Unit (RVU). As noted earlier, RVUs measure the relative effort, cost and skill required to perform specific medical tasks. In the mid-1980's Medicare let a contract to a Harvard group headed by William Hsiao to develop an RVU schedule through surveys of medical professionals.

Well before the contract was awarded, radiologists saw the development of an RVU schedule as "both a threat and an opportunity" as one radiologist noted. Rather than wait

[22] Offshoring adds another dimension to the radiologist/malpractice relationship. For several years, an urban legend held that large numbers of U.S. imaging studies were being read in India. In fact, only one Indian-based firm, Teleradiology Solutions, reads U.S. studies because a radiologist who has not done a U.S. residency and passed U.S. boards cannot purchase malpractice insurance. Teleradiology Solutions was founded by two Indian-born physicians who trained at Yale and are U.S. board certified. See Yu and Levy (forthcoming).

[23] See the discussion of reimbursements at the beginning of Section 2.

for the Harvard group's report, the American College of Radiology (ACR) conducted its own extensive survey to develop relative value units associated with the various radiologist services. The Health Care Financing Administration, the Medicare rate setting body at the time, adopted the ACR's relative value scale as a way to scale Medicare radiologist professional fees. (Physician Payment Review Committee, 1990, p. 120). Technical fees proved much harder to reform and continued to rely in part on "reasonable charges".[24]

The new Medicare Physician Fee Schedule appropriately contained higher RVUs for taking and interpreting CT and MRI images than for standard X-rays. It followed that expanded adoption of both CTs and MRIs would lead to growing total reimbursements.[25] But, depending on the size of technical fees, it remained possible that the new modalities would not be profitable. The point is worth emphasizing. When people describe fee-for-service reimbursements as incentives to overtreat patients (e.g. Brownlee, 2007), they assume the reimbursements are high enough to make the procedures profitable. As a counter example, many imaging providers argue that they lose money on mammograms and would stop offering them except that they fear the resulting public outcry.

In the case of CT and MRI, the sum of professional and technical fees turned out to be generous, a fact underlined by the head of radiology at a large urban hospital in a personal communication:

> When the fee schedule first came in [in 1992], our cost accounting systems weren't very good. On top of that, it was hard to know how to attribute revenue to inpatient

[24] William Hsiao, Glenn Raab, personal communications.
[25] PET was not yet available but as we have seen, it would also be a high RVU procedure.

> imaging because inpatients were reimbursed through DRGs.[26] So we didn't know whether the radiology department was profitable for the hospital. But by the mid-1990s, I was sure we were making money and around 1995 or 1996 I made a bet with our CFO. I said, "Don't count any revenue from inpatient radiology. I'll give you that. Just match the revenue from outpatient imaging against the cost of all radiology – inpatient and outpatient. I'll bet you we are making money on that basis." I won the bet.

Over time, the profitability of advanced imaging under existing reimbursements became widely recognized. For example, at various times some state governments have regulated the number of MRI machines that can operate in their state. Recently, an administrator in one of these state agencies described a strategy of directing new MRI licenses to community hospitals because, as the administrator said, these hospitals were in financial trouble and an MRI machine was a potential source of profit (personal communication).

Ex post, it appears that one aspect of this profitability involved technical fees that underestimated the fraction of time scanners were utilized. As recounted by the Medicare Payments Advisory Commission (MedPAC), when Medicare constructed the technical fees for scanners and other equipment, it lacked data on how often a CT or MRI would be used and so they arbitrarily assumed scanners would be in use 50% of a standard workweek.[27] More recently, MedPAC sponsored a six-city survey which indicated that CT scanners were in use 70 % of the time and MRIs were in use 90% of the time. (MedPAC, 2006, pp. 89-95).

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[26] Recall that DRGs - Diagnostic Related Groups - are the flat Medicare payments, based on the patient's diagnosis, that cover all procedures during a hospital stay including the technical fee for imaging.

[27] Because of a lack of evidence, Medicare applied the same 50% utilization figure to the use of most medical equipment.

When today's MRI is available for a 60 hour workweek, the difference between 50% and 90% utilization is the difference between 40 and 72 patients in a week. From a facility's perspective, the cost of the scanner is fixed and performing more studies in a week involves the modest incremental costs of technicians, etc. Thus a per-study technical fee that covers the scanner's cost assuming 40 patients per week gives significant profits when imaging 72 patients per week.

The final aspect of financial incentives involves what economists call *unbundling* and, ultimately, *self-referral*. In many cases, hospitals used the profits from outpatient imaging to subsidize money-losing activities like the hospital's emergency department. An entrepreneur who sees such cross-subsidies[28] recognizes the opportunity for unbundling – relocating the profitable activities to a stand-alone entity where there are no demands for cross-subsidy.

In the case of imaging, one form of unbundling involved free-standing imaging centers – for example, the chain of Shields MRI centers in Massachusetts that began in the mid-1980s and independent CT facilities that had begun earlier. A different kind of unbundling involves orthopedic surgeons, cardiologists, and other specialists who installed imaging machines in their own offices. This situation - a doctor owning his own scanning equipment – creates a strong financial incentive to order a study since the ordering doctor now receives both the technical fee and the professional fee and it requires a word of explanation.

[28] That is, profits from one set of activities subsidizing other activities within the same organization.

In 1989, Congress passed the "Stark Law"[29] that made it illegal, as of 1992, for a doctor to refer a Medicare patient to a diagnostic facility in which the doctor or a close relative had a financial interest. The logic was obvious. Ordering an imaging study involves substantial doctor judgment and Congress did not want that judgment to be clouded by money. The Stark Law, however, included an in-office ancillary exception: if the diagnostic facility was wholly located in the doctor's office, the Stark Law did not apply.

To understand the exception, recall how the world looked in 1989. There were perhaps one quarter as many CT machines as today and few MRIs. Those CTs and MRIs that did exist were large machines – not easily envisioned as sitting in an individual doctor's office. One lawyer involved in the process suggests that when Congress considered the exception, they were thinking about patient convenience as it related to devices like X-ray machines: A patient who came to a doctor with potentially cracked ribs ought to be able to get an X-ray in the doctor's office without having to cross town to another facility. Since X-ray reimbursements were low, the exception did not appear to have strong financial consequences.

Over time, as the lawyer described it, doctors and equipment manufacturers redefined the doctor's office to "bring the outside world inside." The 'outside world' involved more than advanced imaging[30] but advanced imaging equipment was part of the trend. Salesmen began seeing individual and group practices as potential customers for

[29] Formally, the Ethics in Patient Referrals Act. The in-office exception is at 42 CFR 411.355

[30] A member of a board of a community hospital recently described the problems created for the hospital by doctors who set up laboratories in their own practices that drew profitable lab work away from the hospital.

imaging equipment, a sales strategy that continues through the present.[31] The strategy is particularly clear in cardiology. As early as 2006, 36% of cardiologists' Medicare revenue was related to in-office imaging (GAO, 2008a). Similarly, data from the consulting firm, IMV, reports that the ownership of CT scanners rose from .64 scanners per cardiology practice in 2006 to .91 scanners per practice in 2008 (Barlow, 2008).

Initially, putting an MRI into a doctor's office was problematic because of the scanner's weight. By the late 1990s, several firms had developed smaller "extremity" MRI's to image arms and legs. Today, ONI Medical Systems of Massachusetts (among other firms) markets such an MRI to orthopedists. The firm's website - http://onimri.com – includes a financial calculator showing how 5-6 imaged patients per day over 5 years can result in a cumulative profit of $1.4 million dollars.

Until recently, apparently freestanding imaging centers were also in a position to benefit from self-referral. Consider the following arrangement:

- A doctor practices at a hospital and has a financial interest in an imaging center.
- The imaging center has a contract to perform imaging services for the hospital.
- The doctor refers outpatients to the imaging center and the hospital, rather than the imaging center, submits the claim to Medicare.

Because the imaging center did not bill Medicare directly, it did not fall under the definitions of the Stark Amendment and so ordering physicians could have financial interests in such facilities without penalty. The regulations were tightened effective October 1, 2009.

[31] For example, the NeuroLogica OTOscan, a portable CT scanner, is described as "perfect for use in your ENT practice, easily converting your smallest office space into a powerful ENT imaging suite." http://www.neurologica.com/ceretom-otoscan.html

Imaging centers also encouraged a kind of self-referral by offering financial incentives to ordering physicians. One much discussed incentive is the "per-click lease" that purports to give the referring doctor "ownership" of the scanning equipment during the time that the doctor's patient is being scanned. In this case, the ordering doctor bills for the service as if he owned the equipment, keeps a portion for himself, and give the rest to the imaging center. In some states, such arrangements violate anti-kickback legislation and have been the subject of prosecution (Forrest, 2009a, MedPAC 2009).

Even without self-referral and "per-click leases" the rapid growth of capacity potentially increases study orders through two mechanisms. One is the reduced transaction costs *for patients*. As capacity expands, doctors know that ordering a study requires minimal patient inconvenience – no need to wait for several weeks or to travel to an inconvenient location[32].

A more subtle mechanism involves the psychological cues that large capacity sends to the doctor. To draw an analogy from another field, Brian Wasink and others have shown that people will eat more of a given portion of food if the food is served on a large, rather than a small plate. The size of the plate – the context – sends a cue about appropriate portions (Wasink et. al., 2007). We can speculate that a hospital with extensive imaging capacity sends a similar cue to its doctors: hospital administrators know that outpatient studies are profitable and so are purposely making capacity widely accessible for ordering doctors. In close cases, this cue may be enough to convince the doctor to order the study.

[32] In practice, however, anecdotal evidence suggests some fraction of offices that own their own equipment are sufficiently booked that appointments still must be scheduled some time into the future.

4.4. A Final Organizational Factor – Information.

A final organizational factor is the presence or (often) the absence of two types of information. The first is evidence-based criteria or protocols on what, if any, study is appropriate in a given situation. To be effective, the criteria needs to be easily accessible at the time a study is ordered. The second piece of information is a log that identifies the doctor who ordered each study.

To understand the value of this information, recall that doctors who face no financial incentives still face other incentives to order a study: defensive medicine, avoidance of regret, satisfying demanding patients, and so on. For these doctors, following accessible, evidence-based criteria could ease the pressure of psychological regret and curiosity. Following evidenced-based criteria could, with significant legal groundwork, become a partial defense against malpractice litigation.[33] Criteria could also provide some basis for explaining to demanding patients why a study is not appropriate. These criteria would likely have the strongest effect among primary care doctors who confront a wide variety of diagnostic situations.[34]

Criteria by themselves would not curb a doctor who is chasing reimbursements, but such doctors might be curbed by the combination of criteria and the ordering log that allows administrators to identify doctors who frequently override criteria.[35]

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[33] Appropriateness guidelines – i.e. medical protocols – could serve as a malpractice defense only through passage of state-by-state legislation or state-by-state evolution of case law. Even with this evolution, the process would be difficult since it is usually possible to argue that the case in question differs in some details from the case described in the guidelines.

[34] Conversations with medical administrators and results from radiology benefits management firms suggests primary care doctors are more likely to order inappropriate images than specialists who have greater experience in a narrower set of conditions.

[35] Thanks to Ramin Khorasani for making this point to me.

The U.S. currently has the beginnings of such a system. In the remainder of this section, I discuss the state of appropriateness criteria. I examine the accessibility of criteria and the ordering log in Section 6, which discusses initiatives to control imaging growth.

An example of evidence-based appropriateness criteria is the Ottawa Ankle Rules developed by emergency medicine doctors at The Ottawa Hospital Civic Campus in the early 1990s in the hope of reducing X-rays of ankles (Steill et. al. 1992). Since that time, extensive evaluations have demonstrated the rules' efficacy. When a patient actually has a fracture or break, the rules are virtually certain to suggest an X-ray, but the rules have reduced total ankle X-rays by 35-40% (Dowling et. al, 2009).

Since the early 1990s, the American College of Radiology (ACR) has produced and updated appropriateness criteria for a number of common imaging situations. Some private companies including Milliman, Inc, have also developed criteria. The criteria seek to codify expert judgment on medical appropriateness as it is defined at the beginning of this section.

Conversations with radiologists involved in the ACR effort indicate that many of the criteria rely on mix of expert opinion and such studies that do exist because there is little experimental evidence of the kind that backs the Ottawa Ankle Rules.[36] Dr. Pamela Douglas, past president of the American College of Cardiology, has written about the lack of evidence specifically in cardiac imaging:

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[36]The ACR criteria can be seen at: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/app_criteria.aspx. For a representative example, see Washington et al (2009) For various views on the criteria, see Blackmore and Medina (2006), a reply by Betterman (2006), and Sistrom (2009). The Milliman criteria are proprietary.

> The barriers to quality cardiovascular imaging include a very limited knowledge base and a system not driven by a "scientific method" approval process, which would include randomized control trials and "hard" patient outcomes. Even diagnostic accuracy is not consistently evaluated before widespread clinical use. There is spotty information on costs and limited consensus on quality standards. *In fact, if imaging were a drug, given the current evidence base, regulatory approval would probably be denied*. (Douglas, 2006, italics added).

The absence of experimental evidence for many imaging situations is explained by several factors:

- Full experiments that can connect the imaging decision to a change in Quality Adjusted Life Years – are hard to design and implement. Only a few areas of imaging have overcome these problems – notably mammography (Fryback et al (2006)).

- Good experiments take time while imaging technology develops quickly and studies run the risk of presenting conclusions about out-of-date technology.

- To this point, few people have had a strong incentive to do the experiments. In the case of pharmaceuticals, a manufacturer has to demonstrate safety and efficacy in specified situations to the Food and Drug Administration. Scanner manufacturers have only to demonstrate that a device is as safe and effective as a previous device already on the market. [37] In this situation, neither the manufacturers nor most medical researchers have reason to fund expensive clinical trials to show efficacy in specific situations, a point Gerber and Patashnik (2006) make with respect to many medical procedures.

4.5. Summary

Taken together, the ideas in this section indicate the problem of medically inappropriate studies is really several problems with a common origin. The problems begin because many potential studies confer little benefit and carry minor risk. If the risk exceeds the benefit, an imaging expert will classify the study as inappropriate. But if this judgment isn't disseminated through accessible appropriateness criteria, each doctor will

[37] I thank Greg Raab for clarification of this point. .

make his own ordering decision. Since the study's risks are minor, the doctor can assume he "does no harm" if he orders the study.

At this point the various incentives come into play. Doctors who own their own imaging equipment have a strong financial interest in doing the study. Other doctors, while not benefitting directly from a study, may work for a hospital that encourages outpatient studies to generate reimbursements. And most doctors, including those facing no financial incentives, face the other incentives we have discussed: building a malpractice defense, dealing with demanding patients or keeping to an appointment schedule, regret avoidance and curiosity. The doctor may know in the abstract that U.S. imaging costs are growing at an unsustainable rate but most of the incentives he faces tell him to order the study.[38, 39]

Given these variations on the problem, it is unlikely there is one single solution. I return to this point in Sections 6 and 7.

5. Empirical Evidence on Financial Incentives and the Extent of Inappropriate Imaging.

In the previous section, I described the incentives for doctors to order inappropriate studies. In this section I briefly review suggestive empirical studies on this issue:

- Studies that demonstrate higher rates of utilization among doctors who self-refer. Such studies give a sense of the effect of financial incentives on imaging.

- Retrospective application of appropriateness criteria to doctors' study orders. Such studies are one way of estimating the magnitude of inappropriate imaging.

[38] The exception s are doctors who work in health maintenance organizations with capitated budgets where extra procedures do not generate extra reimbursement to the physician or the organization.
[39] Thanks to Shomon Shamsuddin for discussion of these ideas.

- Comparisons of national imaging utilization rates with utilization rates at a large health maintenance organization. Since doctors in a health maintenance organization have no financial incentive to order studies, such comparisons provide another way of estimating the magnitude of inappropriate studies.

A fourth kind of evidence – the experience of radiology benefit management firms – is discussed in the next section.[40]

5.1 Self-Referral

We noted earlier that a doctor who images patients on his own equipment has a strong financial incentive to order studies. Beginning with Hillman (1990), a series of studies have shown that among doctors who order studies, those who refer patients to their own equipment order studies at higher rates than doctors who refer patients to radiologists for imaging.

A recent example is the work of Gazelle et al (2007) who analyzed private insurance claims data submitted by non-radiologists – i.e. doctors who have the ability to order studies for their patients. The analysis involved four years of data covering six conditions including cardiopulmonary disease, extremity fracture, and stroke. To construct a picture of doctor-patient interaction, separate insurance claims data were grouped to form a single patient disease episode. Doctors were classified by the extent to which they do patient imaging themselves and/or have studies done by another doctor in the same specialty[41] as opposed to sending patients to a radiologist. To simplify

[40] A different kind of evidence involves the large regional variation in imaging utilization as well as other Medical services. These data, however, do not easily translate into estimates of how large overutilization might be.

[41] In these data, when "Cardiologist A" sends a patient for imaging to "Cardiologist B," it is likely that the two cardiologists belong to the same practice and so it is still a case of self-referral.

presentations, comparisons were restricted to the ordering behavior of doctors who self-refer or similar-specialty-refer for at least 80% of their imaging versus doctors who refer to a radiologist for at least 80% of their studies.[42]

In the case of doctors dealing with cardiac problems or coronary disease, self-referring doctors, including those referring to a doctor in the same specialty ordered some kind of cardiac imaging in 11% of all episodes versus 5% for non-self-referring doctors. (Reducing study orders from 11% to 5% of all episodes represent a 54% reduction in study orders.) In the case of stroke, self-referring doctors ordered CT scans in 19% of episodes versus 14% for non-referring doctors (a 26% reduction). Most other studied diagnoses produced similar results. Recent work by MedPAC (2009) confirms the finding of Gazelle et al finding using Medicare outpatient episodes.[43]

These results do not prove that doctors purchase their own scanning equipment only to make money. In theory doctors who order large numbers of studies for non-monetary reasons could find it convenient to buy their own scanning equipment. But the large number of self-referral studies summarized in MedPAC (2009) and the emphasis on making profit in marketing materials for small scanners[44] suggest that profit is an important motivator.[45]

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[42] The distinction is whether the physician who owns the equipment also has the ability to order an image for the patient. All the insurance claims were from physicians (none of them radiologists) who do have that ability.

[43] The MedPAC study also used tax identification numbers to define which doctors belonged to the same medical group, a refinement Gazelle et al. could not make.

[44] For example, the Hologic Extremity MRI is described as offering "an immediate rate of return on investment of less than two studies per day." http://www.hologic.com/mri-imaging/opera-dedicated-mri/

[45] A final point: It is sometimes argued that additional imaging can result in a lower total cost of a medical episode by, for example, eliminating the need for a catheterization or a hospital stay for observation. (The opposing argument is that an image can lead to multiple images to follow up incidental findings, etc.)

5.2 Retrospective Studies to Estimate Inappropriate Imaging

In a paper presented in 2008, Lehnert and Bree describe a retrospective analysis of 461 elective outpatient CT and MRI orders that came from primary care doctors in clinics associated with the University of Washington hospital system. Each order was analyzed after the fact using the patient's clinical history and exam indication – the information available to the doctor at the time she ordered the study. The analysis was performed by applying American College of Radiology appropriateness criteria as modified by HealthHelp, a radiology benefits management firm.[46]

Of the 461 cases analyzed, 74% of study orders were judged to be appropriate and 26% were judged inappropriate. Among the inappropriate cases, most should have had either no study or an X-ray rather than a CT or MRI.[47] Common examples included head CT scans as an initial response to a chronic headache and MRIs of the spine as an initial response to acute back pain without indications of nerve damage. Retrospective studies in other settings (e.g. Hadley et al, 2006) have produced percentages of inappropriate study of similar or higher magnitude.

If Lehnert and Bree's (LB) study were replicated nationally, there are reasons why the 26% estimate might be either higher or lower. The LB sample involved outpatients treated by doctors who worked for clinics. A national sample would also include doctors who self-refer to their own scanning equipment (and who likely have higher rates of

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MedPAC (2009) tested this proposition using medical episodes for Medicare patients with 13 different diagnoses and found that the proposition was untrue: Medical episodes with higher than expected imaging (given the diagnosis) also had higher than expected total cost.

[46] I discuss radiology benefits management firms in Section 6.

[47] This is a tentative conclusion. At the present time, I am working from an extended abstract of the paper as presented at the 2009 RSNA meetings. The author has suggested that I can find full details in the paper when it is published.

inappropriate orders), hospital inpatients (who presumably have lower rates of inappropriate orders[48]) and specialists who typically have lower rates of inappropriate orders than primary care doctors.

In addition, retrospective studies are potentially subject to the "magic words" problem. The problem arises because appropriateness criteria are written with particular cases in mind and so are phrased using particular words. The experience of radiology benefits management firms (Section 6) suggests that some study orders are initially rejected because they are not expressed in the "magic words" but are subsequently approved when the ordering doctor can explain the case details to a reviewing doctor. As LB notes, their ex-post review of case records precluded such clarifying conversations.

As an estimate, we can say that Lehnart-Bree and similar retrospective studies suggest that roughly 20% of CT and MR imaging studies are inappropriate.

5.3 HMO Comparisons to Estimate Inappropriate Imaging

A second kind of evidence comes from comparing national utilization rates with utilization rates in a health maintenance organization (HMO). Because HMO financing is capitated,[49] doctors lack a financial incentive to order an inappropriate study. If the HMO organization is well-integrated, there is also less likelihood that a patient who sees

[48] As explained in section 2 the financial incentives to do inpatient imaging are weaker than the financial incentives to do outpatient imaging. For this reason, it is reasonable to speculate that the rate of inappropriate orders is lower among inpatients.

[49] A capitated healthcare organization receives a flat payment per person per year to cover all inpatient and outpatient expenditures. If expenditures on the individual fall short of the capitated payment, the organization keeps the profit. If expenditures exceed the payment, the organization absorbs the loss.

multiple doctors – e.g. a primary care doctor and a specialist - will be imaged multiple times.[50]

Table 1 compares three sets of utilization rates for CT and MRI:

- Estimated imaging utilization rates for the U.S. insured population under age 65 and for the Medicare (i.e. age 65 and over) population. Estimates are based on data from the consulting firm, IMV and from the Department of Health and Human Services (2007) and are detailed in Appendix A.

- Actual imaging utilization rates for members of a large HMO divided into two groups: HMO members under age 65 and members of the HMO's Medicare Advantage Program. (Forman, et al forthcoming).

- Actual imaging utilization rates for Northeast Region customers of a large private insurer divided into two groups: customers under age 65 and customers age 65 and older in the insurer's Medicare Advantage Program.

[50] Duplicate imaging can occur because the specialist is unaware that the patient was recently imaged or the specialist argues that the existing image "is not of sufficient quality."

Table 1

2005 CT and MR Utilization Rates for the U.S., an HMO and a Private Insurer

Medicare Enrollees (images per 1,000 insured persons)

	Estimated U.S. (All Medicare)	HMO (Medicare Advantage)	Private Insurer (Medicare Advantage)
CT (2005)	568/1000	427/1,000	560/1,000
MRI (2005)	177/1,000	88/1,000	155/1,000

Insured Persons Under Age 65

	Estimated U.S.	HMO	Private Insurer
CT (2005)	139/1000	103/1,000	135/1,000
MRI (2005)	75/1,000	40/1,0000	73/1,000

Sources: See Appendix A

Our focus is the comparison of average U.S. utilization rates with utilization rates in the HMO. Because the U.S. utilization rates are estimates (see Appendix A), the Private Insurer's utilization rates are included as a check that the U.S. estimates are plausible. In fact, our U.S. estimated utilization rates and the Private Insurer utilization rates are quite close suggesting the U.S. utilization estimates are reasonable.

In the table's central comparison, estimated U.S. utilization rates are sharply higher than those in the HMO. For both Medicare enrollees and insured persons under 65, HMO utilization is about 25% lower than U.S. CT utilization and about 48% lower than U.S. utilization for MRI.

HMOs are expected to have somewhat lower utilization rates because they attract relatively healthy enrollees particularly when the HMO is new. This HMO, however, has been in existence for a number of years and serves a significant fraction of its area residents. As such, we can say that the gaps between U.S. and HMO utilization rates do not contradict the estimate that roughly 20% of nation-wide CT and MRI studies are medically inappropriate.

6. Current Initiatives to Slow Imaging Growth

In Section 4, I described a combination of factors that have contributed to the growth of inappropriate imaging. When considering potential policies to slow this growth three areas stand out:

- Reducing financial incentives to do additional imaging.
- Developing strategies to address malpractice that do not require taking large numbers of studies.
- Providing accessible information on the medically appropriate study in a given situation and collecting information on the doctor who orders each study.

There is to my knowledge no current malpractice initiative that specifically addresses imaging but there are partial initiatives to address financial incentives and the provision of information. I use the word "partial" because, it appears that each of these

initiatives, by itself, can be thwarted by sufficiently determined doctors. I return to this idea below.

6.1 Reducing Financial Incentives

The heart of financial incentives facing doctors is fee-for-service reimbursement for outpatient procedures – a process used by both Medicare and some private insurers. In the current healthcare reform debate the Senate Finance Committee's draft bill proposes experiments with alternative payment methods but there are no firm proposals to change this arrangement in the foreseeable future. [51]

In imaging *per se*, the next most important reduction in financial incentives would involve the elimination of self-referral, an issue where there is modest progress. At the state level, Maryland has passed a self-referral ban which prohibits doctors from referring patients to CT and MRI machines that they themselves own.[52] The restriction is currently working its way through the state courts. As noted earlier, Medicare has recently tightened the regulations governing physician ownership of free standing imaging centers. The Senate Finance Committee draft bill healthcare reform contains a "sunshine provision" in which a self-referring doctor must inform the patient of both his ownership interest and other facilities where a study can be done. Federal bans on physician ownership of equipment in their own offices – i.e. repealing the in-office exception fo the

[51] See for example, sections 3021 and 3022 of *America's Health Future Act of 2009.* Because the healthcare reform debate is so fluid, final details are of known. For example, despite the proposals the Senate Finance Committee Bill, a recent *New York Times* article argued that lobbyists have gutted the bill's cost control divisions (Kirkpatrick, 2009)

[52] These doctors can image patients referred by other doctors, however. See Mazer, 2006.

Stark Amendment - do not appear to be under serious consideration in either the Senate or the House (Abella, 2009b, Yee, 2009b).[53]

Rather, attempts to limit financial incentives in Medicare have taken the form of requesting Congress to reduce technical fees in various ways. One recent and one current example illustrate this process.

The recent example involved reimbursement included in the Deficit Reduction Act of 2005. The Medicare Physician Fee Schedule, used to pay doctors for outpatient treatments, involves highly detailed reimbursements for specific procedures (e.g. CPT Code 70491 = a CT Scan of Soft Tissue in the Neck with Dye). In the late 1990s, Medicare developed a simplified reimbursement schedule for doctors treating hospital outpatients. This new Outpatient Prospective Payment System (OPPS) had a smaller number of billing codes that aggregated specific procedures into something closer to a patient-doctor encounter. The OPPS applied to hospital outpatients only: patients treated in doctors' offices or independent testing facilities were still reimbursed under the Medicare Physician Fee Schedule.

Each OPPS code was reimbursed using a weighted average of the procedures it represented. As a result of this calculation, the reimbursement for most outpatient imaging studies done in a hospital was now lower than reimbursement for the same study performed in a doctor's office or independent imaging center.

[53] As this paper is being completed, Congresswoman Jackie Speier of Northern California has introduced legislation in the Congress that would restrict equipment ownership but to this point, her legislation has no co-sponsors and is judged to have little chance of passage (Yee, 2009b).

When the Deficit Reduction Act of 2005 was in a House-Senate conference, the conference committee, desperate for savings to put to other uses, adopted an OMB recommendation that effective January 1, 2007 outpatient studies done in any setting would be reimbursed at the lower of the reimbursements in the Medicare Physician Fee Schedule or the OPPS. In the past, this change would be met with strong opposition from manufacturers and professional specialty groups. In this case, the rate change was inserted in the bill at the last minute and came as a surprise. As one lobbyist said, "At six o'clock on one day, the proposal wasn't in the bill. The next day it was" (personal communication).[54]

In a preliminary report, GAO estimated that in the first year of operation advanced imaging per beneficiary continued to grow at about 4%, but imaging expenditure per beneficiary declined by about 11% with most of the decline due to lower fees on advanced imaging – in particular CT and MRI (GAO, 2008b). Related articles suggest the change has caused some consolidation among independent imaging centers (Yee, 2007, 2009a) and a slight decline in radiologist incomes (Moser and Hastreiter, 2009**).**

The technical fee reduction now being debated by Congress is based on the previously discussed MedPAC survey showing that CTs and MRIs are in use well above the 50% of a normal workweek assumed in current technical fees. Following its initial finding and responding to critics of its survey,[55] MedPAC advanced a second argument

[54] The conference committee also reduced reimbursement for some multiple studies performed in the same session – e.g. when an abdominal CT and pelvis CT were taken at the same time, the pelvis CT received half its stand-alone reimbursement.

[55] For example, critics argued that the sample of six metropolitan areas did not capture the experience of rural areas where utilization was, of necessity, lower.

for technical fee reduction: that it is wasteful to purchase scanners costing over $1 million unless the scanner is utilized 90% of the time and technical fee reimbursements should be set accordingly. As of this writing, the bill reported out by the House Committee on Energy and Commerce, the "America's Affordable Health Choices Act", reduces the technical fee for all imaging by raising the utilization assumption for all equipment (not just equipment costing over $1 million) from the current 50% to 75% while the draft Senate Finance Committee bill raises the utilization assumption to 65%. It is reasonable to assume that any final healthcare legislation will contain a technical fee reduction along these lines (Abella, 2009).

In economic terms, reduced reimbursements in a fee-for-service environment create mixed incentives. Assuming private insurers follow Medicare's lead, lower reimbursements will likely discourage some potential providers from actually entering the business.[56] To the extent that inappropriate studies arise from supply-induced demand, this is an obvious plus. At the same time, lower reimbursements will encourage *existing* providers to generate more studies in order to maintain incomes. Thus lower reimbursements by themselves are not a complete solution.

6.2 Radiology Benefits Management Firms

Consider next the availability of information: evidence-based criteria available at the time a study is ordered, and the ability to identify the doctor who orders each study. Progress is being made on this goal but big gaps remain.

[56] I.e. a doctor decides not to purchase an in-office scanning machine or investors decide not to set up a new imaging center. See Yee (2009a).

There is, first, the quality of the criteria. As we saw in Section 4, existing appropriateness criteria are based more on expert opinion than on experimental evidence, which is relatively thin.

While existing criteria are increasingly applied to ordered studies, they are not applied in a way that makes them accessible to ordering doctors. The seeming contradiction arises because the criteria are applied to ordered studies by radiology benefit management firms (RBMs), firms typically hired by insurance companies to hold down imaging growth.

Radiology benefits management firms attempt to slow the growth of imaging by requiring doctors to obtain prior authorization for studies they order[57]. Without authorization, the patient's insurer will not reimburse the study. The prior authorization process usually involves three components: increased doctor effort to order a study, a check that the patient's insurance covers the study, and a check of the ordered study against the firm's appropriateness criteria.

The first RBM, Medicon (now American Imaging Management) began screening orders in 1988, a reaction to the rapid diffusion of CT scanners. One industry veteran estimates that 100-130 million persons are now in private health insurance plans covered by such services. While Medicare currently does not use RBMs, the Government Accounting Office has suggested that Medicare begin to do so (GAO, 2008a)

A common form for an RBM involves several levels of review. A doctor initially calls in a study order to an operator who may check whether the patient's insurance

[57] Usually, prior authorization is restricted to expensive studies – CT, MRI, PET - but not to inexpensive studies like X-rays and mammograms.

covers the study and will check whether the order conforms to the firm's version of the ACR appropriateness criteria. The GAO report (2008a) contains this example:

> …. prior authorization is typically used by RBMs for physicians requesting imaging services for lower back pain, a common condition for which physicians inappropriately request MRIs. Typically, the process works as follows: A physician requests an MRI of the lumbar spine with contrast for a patient with symptoms of lower back pain and no other symptoms. In considering this request, the RBM's nurse manager[58] follows a protocol of questions based on the ACR clinical guidelines for "acute low back pain, uncomplicated." Such questions could include "How long has the patient had symptoms? Have you tried conservative management?" These questions are aimed at discouraging the use of advanced imaging at the condition's onset, unless certain other symptoms or conditions are present.[59]

If the previously mentioned "magic words" problem is going to arise, it will arise at this first stage.

If the operator denies authorization, the doctor can appeal to the second level of review - typically a nurse. If authorization is denied at the second level, the doctor can appeal to the third level of review – typically another doctor. In this process, an RBM can, if it chooses, build a record of the studies ordered by each doctor it covers. During the process, the ordering doctor never sees the RBM's criteria – it is this sense in which the criteria are not accessible. I return to this lack of transparency below.

Beyond reviewing eligibility and order appropriateness, RBMs may also privilege the kinds of studies an individual doctor can order.[60] And to reduce costs (rather than reducing utilization per se), the RBM may negotiate discounted rates with imaging providers.

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[58] While the quote refers to "nurse manager", some firms use trained operators rather than nurses per se.

[59] As reported by GAO (2008a), these other conditions could include recent significant trauma, unexplained weight loss, unexplained fever; history of cancer and duration of symptoms greater than 8 weeks.

[60] For example, an orthopedist would not be approved to order cardiac images.

RBMs and the healthcare organizations that employ them have been cautious in sharing data. As a result, there are to my knowledge only two published evaluation studies, both of which have industry connections.[61]

Despite this possibility of bias,[62] the largest impacts reported in these studies agree with estimates I have received from other sources. One estimate comes from the previously mentioned industry veteran who requested anonymity. In his experience, the typical client would call when CT and MRI imaging was rising in double digits – often 20% per year. The RBM program would cause a first year reduction of 15-20% in the level of imaging followed by a return to growth at about 4-8%. Similarly, the medical director at a large, western state multispecialty medical group reported a 17% first year drop in MRI studies after starting internal prior authorization. Health plans interviewed by GAO report RBMs reducing CT and MRI growth rates from the 10-20% range to less than 5% (GAO 2008a).

The industry veteran estimates that about one-third of the observed reductions come from "hard denials" – rejecting the study due to a lack of insurance eligibility or failure to meet eligibility criteria. The remaining two thirds of the reduction come from the "sentinel effect"[63] – the fall-off in orders because the doctor knows the request is marginal and is likely to be rejected or he doesn't believe the study is worth the effort of dealing with the RBM.

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[61] The studies are Mitchell and LaGalia (2009) in which LaGalia is an employee of National Imaging Associates and Dobson et. al, (2009) which was commissioned by MedSolutions, Inc.
[62] The obvious place for bias would occur in an RBM's selection of cases to be analyzed.
[63] "Sentinel" refers to the idea that people are less likely to perform questionable acts if they know they are being watched.

The 15-20% immediate reduction is potentially consistent with the estimates in Section 5 of the extent of inappropriate imaging. Similarly, slowing the growth of imaging to 5% or less is important if healthcare costs are to rise no faster than GDP. At the same time, the RBMs' lack of transparency means these results should be treated cautiously. Another observer - a medical administrator –agreed that the 15-20% reduction was an average effect but "these firms can dial [the reduction] up or down depending on what you want."[64] The fact that RBMs do not disseminate their appropriateness criteria facilitates this flexibility. From the RBMs' perspective, disseminating criteria would let doctors avoid rejected authorizations by using the "magic words" at the outset. But the lack of transparency has costs. In particular, evaluations of RBMs generally focus on reductions in imaging and not on what kinds of studies are being eliminated. Thus it is not clear how much the firms are eliminating inappropriate studies rather than rationing appropriate studies. As the medical administrator said, "The RBM is a financial tool – there is no physician education going on here."

Like lower reimbursements, RBMs can be one part of a solution but they are potentially vulnerable to doctors who infer the firm's criteria over time and work to order more appropriate studies.

The first line of defense against this behavior is doctor profiling – comparing a doctor's ordering behavior to the ordering behavior of his peers. Profiling is useful for

[64] Personal communication. For example, when a physician orders an abdominal CT scan, a radiologist on duty at the time of the scan often recommends an abdomen/pelvis CT scan. The RBM, anticipating this, can give advance approval for both scans or it can approve only the abdominal scan in which case the patient arrives, the radiologist recommends the pelvis scan be added and the process has to stop until RBM approval of the pelvis scan is requested and obtained.

identifying outliers but if most doctors in a given area order large numbers of studies, a stricter level of review is required. For example, doctors who order frequent studies with few positive findings would potentially face administrative review. This, of course involves significant administrative effort.

6. 3 Order Entry Systems

A recent variant on RBMs are a set of web-based order entry systems that offer decision-support information to the ordering doctor.[65] The systems require a doctor to order n study by filling out a series of questions in a web-based form. The software uses an algorithm to compare the order to appropriateness criteria (similar to the criteria used by an RBM). It then gives the doctor decision support advice on the order. For example, the Nuance *Radport* system[66] gives numerical ratings:

- A rating of 1-3 means the study is likely to be of low utility.
- A rating of 4-6 means the study is likely to be of marginal value.
- A rating of 7-9 means the study is likely to provide useful information.

In addition to rating the order (which is color coded), the system may suggest and rate other studies that might be used in the situation. The system may also provide summary information comparing the doctor's ordering behavior to the ordering behavior of his peers in this situation.[67]

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[65] There are currently two major systems in the field – the Nuance *Radport* being developed in cooperation with Massachusetts General Hospital and the Medicalis *Percipio* system being developed in conjunction with Brigham and Women's Hospital.

[66] http://www.nuance.com/healthcare/products/radport-for-radiology.asp

[67] RBMs are, themselves, adopting web interfaces but it appears most of these interfaces accept or reject image orders without providing ratings, alternative possibilities, or information on orders from peers.

Compared to RBMs, these new order entry systems adopt a softer approach, giving recommendations rather than hard denials and letting the doctor know how he compares to his peers. The installation of the Medicalis Percipio system[68] in Brigham and Women's Hospital strengthens this requirement by requiring that a doctor who wants to override a system suggestion must first consult with a radiologist on duty.[69]

To my knowledge, there has been one published evaluation of such a system done by a group that included two unpaid advisors to the firm that was marketing the system (Sistrom et. al., 2009). The system was implemented in a hospital where outpatient visits (with or without imaging) were growing at slightly under 5 percent per year. Implementation of the system did not produce any immediate decline in outpatient CT or MRI images. Over the next two years, however, the system slowed the rate of growth of outpatient CT images from 3.0% per quarter to .25% per quarter and the growth of outpatient MRI images from 2.9% per quarter to 1.7% per quarter. [70] Because this result is based on a single hospital, these results may overstate or understand what would happen in another setting. [71]

In sum, these order entry systems provide the ordering doctor with significant useful information and they create a log of the studies each doctor orders. They represent an important alternative to RBMs in reducing inappropriate studies. At the same time, for these systems to operate effectively, they must be backed with sanctions for doctors who

[68] http://www.medicalis.com/pdfs/news/ACR%20guidelines%20press%20release.pdf
[69] Recall the point noted in Section 2 that radiologists can be excellent sources of advice on imaging if they are not inhibited by malpractice concerns.
[70] The system also slowed the rate of ultrasound growth but the software used for ultrasound did not include decision support information like the ratings of alternative treatments, etc.
[71] In particular, the lack of an immediate drop in studies in a single hospital may reflect the fact that the hospital had been emphasizing judicious use of imaging before the system was introduced.

continually disregard system recommendations. Sanctions are particularly necessary if the system is to work outside a hospital setting in the offices of individual doctors.

7. Conclusion

Over the last forty years, medical imaging has produced enormous diagnostic benefits. But it exists in an environment where malpractice is a concern, outpatient reimbursement rates have been set too high, and the criteria for appropriate imaging are not well developed nor widely diffused. Some wags have compared the resulting situation to the line from the movie *Field of Dreams* – "If you build it, they will come"- where "it" and "they" are, respectively, an imaging facility and patients.

The result, as we have seen, is a reasonable presumption that something like 20 percent of CT and MRI studies are medically inappropriate. If studies were judged by cost-effectiveness criteria rather than medical appropriateness, the percentage would be somewhat higher.

Current healthcare reform proposals argue that by reducing unnecessary medical procedures, it is possible to reduce healthcare costs per person while not compromising healthcare quality. In this concluding section, I summarize the paper's logic of how this might be accomplished in today's current U.S. healthcare system.

- The most direct step toward reducing medically inappropriate studies is the elimination of the financial incentives embodied in fee-for-service reimbursement for outpatient imaging. The current healthcare reform debates are taking only small steps in this direction.

- A second important step toward reducing medically inappropriate studies is eliminating financial incentives for self-referral by barring ordering doctors from owning their own imaging equipment. Medicare has

recently taken one step in this direction[72] but no other significant steps are being considered.

- A third step toward reducing unnecessary studies involves reducing financial incentives by lowering reimbursements. One such reduction was contained in the Deficit Reduction Act of 2005 and another will almost certainly emerge from the current healthcare reform debates.[73] Lower reimbursements will discourage new providers from entering the industry but they may encourage existing providers to do more studies to maintain incomes.

- It follows that to reduce inappropriate studies in a fee-for-service system, lower reimbursements must be used in conjunction with appropriateness criteria, administered by either an RBM or through an order entry system with decision support.

- Both RBMs and order entry/decision support systems can be "gamed" by recommending increased numbers of appropriate studies and so the combination of lowered reimbursements and RBMs or order entry systems must be accompanied by more detailed monitoring of doctor behavior – doctor profiling, tracking the results of tests, and so on.

- Even in the absence of financial incentives, doctors face other incentives to do studies beginning with the threat of malpractice litigation. It follows that a complementary approach to reducing medically inappropriate studies involves greater development of evidence-based appropriateness criteria – criteria that have some chance to withstand challenges in malpractice litigation. Several proposals in the current healthcare debate envision a strengthened version of MedPAC to determine what Medicare will reimburse by undertaking cost-effectiveness studies.[74] Such studies (which may include running new experiments in the many cases where evidence is slim) could form the basis for revised criteria and would have the force of Medicare behind them.

There is a reason this summary has a heavy regulatory emphasis. In our current healthcare system, healthcare reform resembles an isometric exercise: strong incentives

[72] i.e. the recently implemented restriction limiting a physician's ability to invest in a free standing imaging center to which he refers patients.
[73] See Section 6.
[74] See, for example, the letter from President Obama to Senators Edward Kennedy and Max Baucus dated June 2, 2009, http://www.whitehouse.gov/blog/The-President-Spells-Out-His-Vision-on-Health-Care-Reform/ and the language proposing a Center for Innovation in the Senate Finance Committee Bill.

to do procedures pushing hard against an expanding list of policies to reduce waste. [75]It is reasonable to ask whether there are better ways to do business.

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[75] Tobacco is a similar analogy: government subsidies to tobacco growers and government funding of anti-smoking initiatives.

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Appendix

Construction of 2005 U.S. Imaging Utilization Estimates in Table 1

Estimates of 2005 total U.S. CT and MRI came from the consulting firm IMV. For purposes of Table 1, it was necessary to divide total studies into studies done under Medicare and all other studies (an approximation to studies done on the under 65 population).

Medicare Studies

In 2007, the Department of Health and Human Services, Office of the Inspector General, issued a report that included 2005 estimates of all Medicare CT and MRI studies except those done under Medicare Advantage (DHHS, 2007). The estimates exploited the fact that though an inpatient study does not generate a separate technical fee, it does generate a separate professional fee for the radiologist's services. [76] By contrast, Medicare Advantage – Medicare administered by health maintenance organizations - receive a flat fee to cover all medical expenditures for an enrollee and there are no reporting requirements for individual procedures.

To address this problem, I approximated utilization rates for all Medicare Advantage recipients by the utilization rates of Medicare Advantage recipients in the specific HMO that appears in Table 1. Since that HMO has a reputation for efficiency, this is a conservative assumption. The total numbers of studies in Medicare Advantage were

[76] Technical fee, professional fee and DRG are defined in the beginning of Section 2.

estimated by combining these utilization rates with the total number of persons enrolled in Medicare Advantage in 2005.

The remainder of the estimation proceeded as follows:

- Estimates of total studies done in Medicare Advantage were added to numbers in DHHS(2007) to estimate total numbers of Medicare CT and MRI studies in 2005.

- Estimated Total Medicare Studies were then subtracted from the IMV estimates of total U.S. studies to estimate total U.S. studies for non-Medicare recipients, an approximation to studies done for the under 65 population.

- To move from total studies to utilization rates, Medicare studies were normalized by the Medicare recipient population. Non-Medicare studies were normalized by the total insured U.S. population other than those on Medicare. This is an upper bound estimate on utilization for persons under 65 since some studies involve people who have no insurance but receive studies in the emergency room.

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