Because radiology has historically not measured its added value to patient care and thus not communicated it in easily understood terms to all stakeholders, the specialty must correct this to prepare for the eventual transition from the current fee-for-service payment schedule to new value-based reimbursement systems. Given the increasing risk for marginalization, radiologists need to engage clinicians and managers to map the processes and associated costs of episodes of patient care to identify areas for providing and improving integrated diagnostic information and to measure the value thereof. In such time-driven, activity-based costing practices, radiologists should highlight how proper investments in the information generated by imaging and how radiologists’ associated consultative and coordination of services can save greater resources downstream, especially in the nonrenewable resource of physician time, an increasingly scarce health care resource. Using physician time in the most efficient way will be a key element for decreasing health care costs at the aggregate level. Therefore, expressing radiology’s contribution in terms of downstream physician time saved is a metric that can be easily understood by all stakeholders. In a conceptual framework centered on value, the specialty of radiology must focus more on its most important product, actionable information, rather than on imaging technologies themselves. Information, unlike imaging technologies, does not depreciate with time but rather increases in value the more it is used.

**Key Words:** Radiology information business, health care finance, value in health care, time-driven activity

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current fee-for-service physician payment schedule may ultimately shrink considerably in the face of value-based reimbursement, providers and specialty groups may experience an uncomfortable degree of conflict in deciding how much “value” any particular provider contributed to a specific patient-level episode or outcome of care in the absence of an external market. Participants in a health care system will have to come to some agreement on internal metrics to measure contributions to value to guide the eventual distribution of funds. Such a payment system would strive to reward physicians and health care subsystems that deliver integrated, quality care for the lowest cost (ie, the highest value). The measure of value will become a lively topic of discussion.

In the book The Discipline of Market Leaders [7], 3 main value positions are outlined: (1) low-cost, operational excellence; (2) product or service leader; and (3) customer intimacy. If health care is able to function in a “competitive” type market, different value positions will be chosen in the market. Without being exhaustive of these value propositions, real-world examples might help understand them. The pharmacy chain CVS’s MinuteClinics would fall into the low-cost category, being highly standardized, highly efficient, and low cost. The classic example of a product or service leader has been Canada’s Shouldice Hospital, in hernia surgery, a classic example of a product or service leader has been highly standardized, highly efficient, and low cost. The classic example of a product or service leader has been Canada’s Shouldice Hospital, in hernia surgery, a favorite for Harvard Business School case study. The University of California, Los Angeles, and University of Pittsburgh liver transplantation programs also belong to this category. The customer intimacy model is one actively being sought by the accountable care organization initiative in forming truly integrated health care practice units that are accountable for patient outcomes ranging from specific medical conditions to population health. Kaiser Permanente in California and Intermountain Healthcare in Utah are two examples. Each model will strive to unambiguously demonstrate its value-differentiated proposition.

**IMPRESSIVE FOR MEASURING VALUE**

A recent New England Journal of Medicine article suggests that the “system for determining who has earned what portion of payments—keeping score—is likely to be crucially important to the success of these new models of care” [3]. The incentives need to be aligned to deliver true value. For radiologists, keeping score may be increasingly difficult as our business model becomes more disaggregated and decentralized. The problem for radiology would be compounded in a service-line configuration, which can take disaggregation to an extreme. Although radiology has benefited from fee-for-service payments for individual instances of care on a large scale over the past 3 decades, it is unknown how the specialty will fare financially or professionally as payments become increasingly untethered to individual transactions of care [8].

Historically, radiology as a specialty has not concentrated on demonstrating value on patient outcomes or on impact to the overall health care enterprise. Nevertheless, its value is considerable, as a “knockout” thought experiment would show. For instance, consider the paralyzing effects of cessation of a major imaging service on the function of an entire health system. Certainly, a poorly functioning radiology service is easily recognized by the primary and secondary rippling effects, generating service delays and complaints. Thus, it is somewhat disconcerting that radiologists were not invited to participate in the development of current acute care episode demonstration projects, suggesting that the prevailing belief among the health policy community is that as an “ancillary service,” radiology is either unimportant or somehow optional [9]. “Ancillary services,” however, usually interact with more patients per day than most medical and surgical services. Some of this attitude stems from the fact that diagnostic imaging does not seem to have a direct, causal relationship to global patient outcomes such as mortality and morbidity or to process measures such as infection rates or readmission rates. However, much failure lies with radiology’s inability or unwillingness to measure the added value of imaging and to communicate it in easily understood terms to all stakeholders. The negative imaging narrative has been driven by the rising volumes and associated costs which reflect more the status of current financing methods than the value to patients [2].

Given the risk for marginalization, it is imperative that radiologists anticipate the upcoming demands for rationalizing the proper use of imaging and to measure the contribution of imaging information to the costs and benefits associated with individual care episodes, especially the time and cost to arrive at the correct diagnosis [8]. That, in fact, is an important patient outcome and a prerequisite for proper treatment. A corollary of time measure should be time to appropriate treatment because monitoring treatment with imaging may be required to finally achieve effective treatment measures. These two measures of time savings can be converted to costs. They can also be of inherent value to patients because time is a nonrenewable resource. Time can therefore be both a process measure important for internal care strategy and an outcome measure in making treatment more effective and care less discomforting [2]. Radiologists must seize the opportunity to define imaging’s major contribution in conserving time in the screening, diagnosis, management, and treatment of patients throughout their episodes of care, short or long term. In the remaining paragraphs, we present the concept of time saved as a measure of the added value of imaging and to communicate it in easily understood terms to all stakeholders.
tional radiology may be reserved for another discussion as it is more directly tied to outcomes.

TIME AS VALUE MEASURE
The concept of time as a measure of value is not new. Radiology as a specialty, recognizing a need for an empirically based methodology for professional payment, created a relative value system that was ultimately incorporated into the current Medicare RBRVS. From its earliest stages of development, the RBRVS reflected physician work and practice costs involved in each procedure code. A radiologist’s value was conceptualized as the product of the time required for a service and the intensity or amount of work per unit of time [10]. Note that this was an inward-oriented working approach at subspecialty levels and not related at all to patient-centered defined value.

Unfortunately, the current RBRVS system has led to excess utilization for relatively well reimbursed services, such as advanced imaging procedures because this bolstered the financial footing of health care. Although the main driver of this distortion did not arise directly from within radiology, the consequence has been to constrain radiology with a simplified “turning down the spigot” approach to control increasing costs via the Deficit Reduction Act of 2005. Simply lowering the reimbursement for imaging services has, however, done little to actually control overall costs [8]. This is because traditionally, providers have allocated their costs to the level of reimbursement rather than to actual resources used. Renewed attention is now being paid to how to properly measure costs, which is entirely different from the previous focus on reimbursements. Different versions of activity-based costing will increasingly be used in such analyses. Measuring the total cost of a patient care cycle, however defined, requires different data and an allocation schema.

Kaplan and Porter [1] recently published their model for a time-driven activity-based costing (TDABC) system to accurately assign costs to each process in a patient’s episode of care. In this system, costs are no longer analyzed at the specialty or department level; instead, costs consist of treating individual patients with specific medical conditions in their full cycle of care. Such a costing system may lead to a powerful source of value metrics in a bundled payment environment. In this system, value is measured in terms of patients outcomes achieved per dollar expended. The relevant cost is the total cost of all resources expended, including the time of clinical and administrative personnel, supplies, devices, office space, and equipment. The elimination and replacement of some resource use will be as important as the cost of individual resources. When costs and outcomes are measured around patients, there will be reallocation of resources, with time savers receiving more attention. Furthermore, it cannot simply be cost per accounting. Understanding the conceptual difference between “wage rate” (dollars per hour) and “labor cost” (dollars per hour times total hours) will be important. The imaging analogy is imaging cost per test vs total imaging cost to reach a correct diagnosis. One “experiment” test might save time and replace numerous “less expensive” tests (imaging and nonimaging) to arrive at the correct diagnosis, hence lowering total costs in time and money. Only two parameters need to be estimated at each process step: the cost of each resource used and the time spent by the patient with each resource. Of all accountable resources, the most expensive will be professional compensation, including physicians. Physician time is a nonrenewable health care resource as well, and it will be in short supply moving forward [11].

TIME SAVED AS VALUE MEASURE
If such a costing model proves effective, radiologists must take an active role in multidisciplinary TDABC activities. However, when embarking on interdisciplinary TDABC exercises and determining areas of downstream savings, radiologists must focus on actionable information they provide rather than on features of the technology they successfully use. In an information business, the use of IT focuses less on the technology than on the actionable information generated [12]. Even in its current professional structure, radiology is a simple information business. Information, unlike expensive equipment, does not depreciate but rather increases in value the more it is used.

The diagnostic information available in an individual abdominal CT scan may ultimately be more than what is portrayed in the initial radiology report if it becomes “data mineable.” Because imaging information has a long shelf life in a PACS, radiologists may be consulted at a later point in time by the clinical team to identify modified, possibly new actionable information. Furthermore, images can be postprocessed at a later date to obtain additional meaningful, quantitative data [13]. In essence, the initial acquisition of images becomes a fixed cost, but the continuous exchange or extraction of diagnostic information between radiologists and multiple downstream consultants is a matter of increasing returns. These returns are amplified when this imaging information becomes “data mineable.” Identifying these instances in TDABC process maps will be critical for quantifying added value, but radiology will also need to provide these ongoing services.

MR machines are purchased or leased not for mere possession but for their information generation capability. In the current reimbursement environment, however, capital equipment purchases are based more on financial considerations, such as payback period or discounted cash flow analysis, than on the informational impact on patient care. In a potential “value” environment, such MRI decisions may increasingly depend on
expansion of informational output that changes patient outcome for the better. One important impact would be measured time savings in diagnosis and in effective treatment onset or treatment change.

With this in mind, radiologists partnering with clinicians and administrators can define the care delivery workflow for a medical condition or episode of care, including the charting of key information exchange activities in the care cycle. Through such collaborations and increased transparency of the exchange of actionable information, radiologists will be able to better demonstrate their added value to referring physicians, patients, and the health system. In mapping care delivery workflow, it is highly likely that more value will be placed on early cost-saving and time-saving activities in disease detection, in diagnosis, and in treatment initiation or change: the considerable strengths of diagnostic radiology.

An emergency CT scan in the acute setting presents such an example. Increasingly, radiologists are consulted for imaging services before specialist referral to detect serious acute conditions needing immediate intervention. Emergent CT scans for unobvious acute abdominal pain represent the pivotal process in diagnosis and have serious implications for the ultimate series of events that patients will experience during their episodes of care. Investing in a radiologist’s time, a technologist’s time, the use of scanner time, and other imaging-related direct and indirect imaging costs up front may be less costly than downstream expenditure of the surgeon’s time, intensivist’s time, operating room time, ancillary staff time, surgical equipment, longer hospital admission stay, and so on. Moreover, the potential diagnostic information available for reference in archived images of the CT scan at a later point in time can have further implications on the patient’s overall care apart from the primary diagnosis. This additional information, exclusive of the variable radiologist’s time, incurs no additional fixed costs. In this example, ultrasound could easily substitute for CT in some situations. The basic point of early, sophisticated imaging diagnosis remains.

By mapping out different possible sequences of processes and the physician time associated with each, all stakeholders collectively will be able to appreciate the impact of early imaging in relation to their own limited resources, especially time. In bundled payment for an episode of care, saving downstream physician time for multiple specialists by an early, relatively rapid imaging consultation would highlight value in radiologic services.

It is likely that investments made in more precise diagnosis with the aid of imaging consultation will spare patients from more complex and more expensive care downstream in any given process map, enabling imaging to be recognized as of relatively high value in individual episodes of care. Counterintuitively, a perceived “expensive test” might be very cost effective when considered in the context of a cycle of care using TDABC.

Nonradiology physician time can be valued in relation to the relatively fixed annual cost of salary and fringe benefits. Thus, the time spent by physicians examining, interacting with, and performing procedures on patients becomes a resource that will be increasingly scarce in the future. It can further be quantified and converted to dollar amounts. Using physician time in the most efficient way will be a key element for decreasing health care costs at the aggregate level. Therefore, expressing radiology’s contribution to an episode of care in terms of downstream physician time saved is a metric that can be easily understood.

Given a meager history in communicating value, it will be critical that radiologists engage in creating transparent process maps and TDABC systems to ensure that their information-driven contributions in saving patient, physician, and health system time are well documented and available. Although computerized physician order entry with decision support will aid in reducing some advanced imaging, it is unlikely to fully displace the critical cognitive and consultative services that radiologists provide with regard to resource utilization. Computerized physician order entry is an artifact of referring physician ordering of imaging tests. In developing costing systems, nonimaging interpretative tasks and consultative services should be considered as their own processes, further highlighting the patient care coordination roles that radiology provides without explicit reimbursement. Interestingly, radiologist consultation is increasingly becoming one of the key triaging resources and decision points in the acute care setting, even on the battlefield.

Consultative tasks will become more important at the primary care level, where providers are being asked to practice at increasingly higher levels of expertise. Here, radiologists may also interact with nonphysicians (eg, nurse practitioners) who fill the primary care provider shortage [5]. It is another interaction that would save significant amounts of physician time by reducing referrals to specialists. Radiologists can also help in integrating within episodes of care by combining diagnostic and therapeutic imaging (eg, interventional radiology procedures), potentially replacing more time consuming and more costly inpatient procedures requiring limited surgeon time, anesthesiologist time, operating room time, and a host of other scarce resources.

**FUTURE DIRECTIONS**

Physician time saved will be one key resource driver in calculating internal costs and a powerful measure in the value equation. Patient time saved is an external benefit in the equation that can create positive outcomes because of more timely treatment and reduced patient discomfort—measures to be determined [2]. To reiterate, time is a nonrenewable resource for patients, physicians, and the health system as a whole. It affects both the numerator.
and denominator in the value equation. In several categories of patient outcomes, direct and indirect costs will also need to be collected as part of TDABC systems. These additional cost measures will require advances in medical informatics and hospital information systems. It will take some time to develop a new set of intermediate outcomes measures and validate them. It will fall to radiology to collaborate with clinicians and managers to create process maps for common complicated diagnoses or acute episodes to identify opportunities for saving physician and patient time. Radiologists must concentrate on developing their major strategic asset, actionable information, rather than on the technology itself. The valuation process should conduct analyses at two levels, one at the value of diagnostic information as it is currently used and the other based on potential ways that information could be used and reused for the single initial cost. In so doing, radiologists will concurrently demonstrate their added value to patient care and identify strategies for closing the information gap: the discrepancy between the current value of the information they provide and the potential increased value on the basis of the additional actionable information they would ultimately provide. In essence, it means becoming an information business.

These multidisciplinary accounting exercises will also aid radiology in moving from a mind-set of simply interpreting images to creating and organizing information for improved accuracy and lower cost in medical decision making in an integrated environment [11]. Ultimately, these efforts will likely decrease the number of advanced imaging studies performed. The loss in volume will be compensated for by an elevation of value. Consultative activities will make the valuable nonbilled coordination and utilization management roles radiologists fill during the entire care cycle more visible to all stakeholders. If radiology can deliver desired outcomes more efficiently by providing actionable information, it will be fairly rewarded in health care systems [1].

CONCLUSIONS
In the upcoming integrated, accountable care organization–like environments, some interesting theoretical questions will arise. Health care systems will need to develop some internal pricing market as is the basis of the division of labor as advanced by the economist Ludwig von Mises almost a century ago [14]. Division of labor is, of course, an essential ingredient of an integrated health care system. In addition, the values of production factors do not depend entirely on the valuation of the end product by consumers [14]. For these reasons, radiology must show its value in both domains, patient value and internal production value. Time savings will be a critical factor in both.

TAKE-HOME POINTS
- Radiologists must prepare for the eventual transition from the current fee-for-service payment schedule to new value-based reimbursement systems that will likely have both bundled payment and capitation components.
- To measure and identify areas for providing and improving integrated diagnostic information, radiology must engage clinicians and managers to map the processes and associated costs of episodes of patient care.
- In TDABC, radiologists should highlight how proper investments in imaging, information systems, and associated consultative and coordination services can save even greater resources downstream, especially physician time, an increasingly scarce health care resource.
- In a conceptual framework centered on value, radiologists must focus more on their most important product, actionable information, than on their imaging technologies.

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