Radiology Benefit Managers: Cost Saving or Cost Shifting?

David W. Lee, PhD[a], James V. Rawson, MD[b], Sally W. Wade, MPH[c]

Purpose: Radiology benefit managers (RBMs) are widely used by private payers to manage the utilization of imaging services through prior authorization, and they have been proposed for use in the Medicare program. The authors created a framework for evaluating the impact of key parameters on the ability of RBMs to lower costs and used decision-analytic modeling to simulate the net impact of RBMs on health care costs under uncertainty from a societal perspective.

Methods: The authors' model of a "typical" RBM's prior authorization process used base-case values for each parameter (utilization rate and costs for MR, CT, and PET imaging; physician and staff time spent in complying with RBM requirements; approval and denial rates; and RBM fees to insurers) drawn from published data and the experience of a large, academic institution. Different values were tested in the sensitivity analysis to account for uncertainty in the parameter estimates. A hypothetical 100,000-member private health plan with an imaging utilization rate of 135 per 1,000 members per year was assumed.

Results: Under the authors' base-case scenario, in which RBMs have no net impact on costs, they estimated that 28% ($182,066/$640,263) of the projected RBM-related savings are shifted to providers. RBMs were cost saving in 45% of simulations, and 95% of simulations fell between a cost decrease of $397,880 and a cost increase of $341,991. The probability of an initial approval by the RBM, the RBM's fee, and the imaging utilization rate and associated charges had the largest influence on the results.

Conclusions: The authors' models shows that RBMs shift significant costs to physicians and that their net impact on societal costs depends on parameters for which supporting data are incomplete.

Key Words: Utilization review, health policy, economic model, medical imaging

J Am Coll Radiol 2011;8:393-401.

INTRODUCTION

Radiology benefit managers (RBMs) provide prior authorization for imaging services using proprietary algorithms (typically based on either clinical guidelines or expert opinion from the RBMs' clinical staffs) to determine appropriateness. They promise to reduce utilization through a variety of mechanisms, including denying coverage for services, diverting patients to less expensive imaging services, educating physicians about appropriate imaging and providing feedback about their image ordering relative to their peers, and acting as the gatekeeper or "sentinel," whereby physicians may be less likely to order imaging studies simply because they are being monitored [1,2]. Physicians may also choose to order fewer tests to avoid the cost or "hassle" of complying with RBMs' prior authorization procedures.

As of 2007, the 6 largest independent RBMs covered an estimated 88 million privately insured individuals in the United States [3]. Medicare had also begun to explore the use of RBMs to manage utilization of imaging services among its beneficiaries. In its June 2008 report, the Government Accountability Office [4] recommended that CMS consider expanding its "payment safeguard mechanisms" by adding "front-end" utilization management tactics, such as prior authorization. This recommendation was based on the Government Accountability Office's analysis of private insurers' increasing reliance on RBM programs and was one of the major health care reforms incorporated into the Obama administration's original 2010 budget [5]. Other federal agencies, however, were more circumspect about RBMs' ability to effectively manage imaging utilization. The Medicare Payment Advisory Commission, for example, did not recommend prior authorization for imaging services because it believed that the expected benefits would not outweigh the administrative costs [6].

CME: This article is available for CME credit. Visit www.acr.org, ACR Education, Online Learning, for more information.

[a]GE Healthcare, Wauwatosa, Wisconsin.

[b]Medical College of Georgia, Augusta, Georgia.

[c]Wade Outcomes Research and Consulting, Salt Lake City, Utah.

Corresponding author and reprints: David W. Lee, PhD, GE Healthcare, 9900 W Innovation Drive, RP-2177, Wauwatosa, WI 53226-4856; e-mail: david.w.lee@ge.com.

This study was funded by GE Healthcare (Wauwatosa, Wis).

0091-2182/11/$36.00 • DOI 10.1016/j.jacr.2010.11.016

Table 1. Framework for evaluating the impact of RBMs on health care system costs

Cost	Payers	Providers	Patients
Cost decreasing			
Direct costs	Imaging service payments	NA	Imaging service copayments
Indirect costs	Downstream service* payments	NA	Downstream service* copayments
Cost increasing			
Direct costs	RBM fees	Compliance with RBM procedures	Self-pay for unapproved services
Indirect costs	RBM-related delays in provision of appropriate imaging services	Decreased productivity by diagnosing without imaging	RBM-related disease progression

Note: NA = not applicable; RBM = radiology benefit manager.
*Downstream services are those that would have resulted from the imaging study (eg, additional testing, treatment).

With the potential expansion of RBMs to a larger portion of the population, it is important to view the impact of the RBM from a societal perspective, rather than that of the private insurance industry alone. Taking the societal that of the perspective provides an opportunity to examine how expansion of RBMs might affect not only patients and physicians but also different aspects of the health care system overall, including costs of care, staffing needs, and even patient access.

Despite their popularity among private insurers, little is actually known about the short-term or long-term impact of RBMs on the utilization of imaging services or health care costs. Guideline-driven prior authorization programs may have the potential to reduce utilization and increase the appropriateness of requested imaging studies over time [7]. However, the US Department of Health and Human Services has noted that there is "no independent data—other than self-reported—on the success of the RBMs in managing imaging services" [4].

Information about whether the promised savings from reduced utilization are large enough to offset the true costs imposed by RBMs in private plans is similarly lacking. Radiology benefit managers' direct costs—the amount they charge health plans for their services—are the most obvious way RBMs add costs to the health care system. Their aggregate societal cost impact, however, also includes any costs they impose on physicians, their office staffs or patients who must expend resources to comply with RBM procedures. In this paper, we establish a conceptual framework for evaluating whether and how RBMs shift costs and apply this framework in a simulation model to estimate the total net impact of RBMs on health care system costs from a societal perspective.

METHODS

RBM Cost Framework

RBMs have the potential to directly or indirectly affect societal costs (increase or decrease) and different health care system stakeholders. A framework for understanding the various ways that an RBM may affect societal costs for payers, providers, and patients is provided in Table 1. For RBMs (or any other intervention) to be cost saving, the savings they generate must exceed all costs they impose on the health care system.

Conceptually, RBMs reduce direct costs for payers and patients by decreasing the utilization of imaging services. This can occur through: direct denial of requests or reducing the number of requests by educating physicians about appropriate imaging, the sentinel or gatekeeper effect, or increasing the costs to providers seeking prior approval. Reduced utilization implies lower direct costs through reduced provider payments and lower patient out-of-pocket deductible or copayment expenses. In addition to these immediate savings, RBMs may also allow payers and patients to avoid downstream diagnostic or therapeutic costs that might have been incurred had the initial imaging service been provided. For example, an initial CT scan with indeterminate results or that yields incidental findings may lead to additional testing that increases costs for both payers and patients [8,9].

RBMs also increase costs to the health care system in a number of ways. Payers incur direct costs for providing RBM services, regardless of whether the RBM is in house or a third-party vendor. Physicians incur direct costs (eg, staff and physician time) complying with RBM prior authorization procedures. Furthermore, patients may incur additional costs if they self-pay for imaging services that are denied by an RBM. In this case, costs are simply shifted from the payer to the patient. RBMs may also indirectly increase costs to both payers and patients if the prior-authorization process delays necessary treatment. Such delays may decrease patient quality of life or productivity (eg, dealing with pain over a longer period of time or taking more illness-related time off work) or even result in greater treatment costs or worse clinical outcomes. Finally, RBMs may increase health care costs if clinicians lose efficiency by spending more time diagnosing patients absent the information avail-

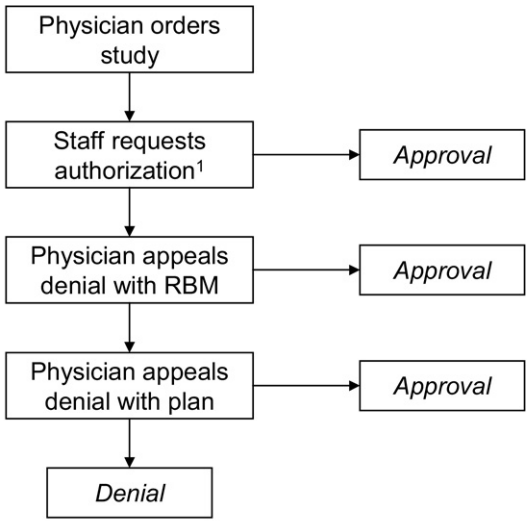

Fig 1. Radiology benefit manager (RBM) model structure.

able from imaging studies, essentially shifting delivery of health care services from capital-intensive to labor-intensive activities.

Estimating the Impact of RBMs on Health Care System Costs

Because there is scant published evidence, we created a mathematical model of a "typical" RBM's prior authorization process that would enable us to simulate the impact of RBMs on health care costs. One of the challenges is that although all RBMs share the same overall goal (to minimize inappropriate overutilization) and tactical approach (prior authorization of imaging services), the details of their prior authorization processes may differ [2]. For example, different RBMs may have different criteria for approving prior authorization requests, different information requirements to adjudicate these requests, or different processes for appealing denials. Our model seeks to reflect what we believe to be typical of most RBMs, but we recognize that the model may not exactly match the experience of any specific RBM.

Model Structure. Our RBM model reflects an escalating series of requests for imaging service approval (Figure 1). In the model, physicians who order an imaging study delegate to their staff the collection and communication of the information the RBM requires, with communication to the RBM occurring either by fax, phone, or Internet. This step in the process also includes any physician and office staff time spent responding to any subsequent requests from the RBM for additional information. The outcome from this initial step is either an approval or denial from the RBM. If the request is denied, the physician has the option to initiate an appeal. The appeals process requires the physician's staff to gather the necessary clinical information in advance of the appeal and for the physician to expend time communicating with the RBM about the appeal. If the RBM denies the first appeal, the physician may initiate a final appeal to the health plan's medical director, which ultimately leads to an approval or denial.

Our model ignores the potential impact of RBMs on indirect costs (Table 1) because no such data exist. Consequently, the actual cost impact of RBMs on the health care system will exceed the modeled results by the net amount of these indirect costs.

Model Parameters. We populated the model with data from published sources when possible; otherwise, we relied on assumptions extrapolated from the experience of one of the authors at one large academic medical center (J.V.R.). We further established a base-case set of values for each model parameter and performed a sensitivity analysis over a range of values to account for uncertainty in the underlying parameter estimates. Base-case parameter values, their sources, and ranges for the sensitivity analysis are reported in Table 2.

We assumed a hypothetical private health plan with 100,000 members with an annual advanced (CT, MR, and PET) imaging utilization rate of 135 per 1,000 members on the basis of the mean reported utilization from 2 private plans [3]. Because there is wide geographic variation in the utilization of imaging services, we used advanced imaging utilization rates ranging from 90 to 180 services per 1,000 privately insured plan member when conducting sensitivity analyses [10].

Data on RBMs' ability to reduce the utilization of imaging services are limited. The overall RBM denial rate has been anecdotally reported to be approximately 10% to 15% [11]. Two recent studies have shown that RBMs "flatten out" the growth rate for imaging services, but interplan variability was high, and these studies did not offer specific estimates of the percentage reduction in imaging services caused by the introduction of an RBM [2,3].

Data on the probability that a prior authorization request is approved or appealed at each stage in the RBM process are also limited. Levin et al [2] recently published data on approval rates for HealthHelp (Houston, Texas), an RBM that escalates prior authorization requests to the point of a discussion between the ordering physician and an academic radiologist who can advise on, but not deny, the request [2]. This study reported that 95% of imaging service requests were approved or changed immediately after interactions between the staff and the RBM; approximately 70% of requests appealed to the consulting radiologist were either approved or changed. One other study reported that 80% of denied neuroradiologic studies were subsequently approved during appeals to academic radiologists [12]. On the basis of experiences at

Table 2. Model parameters

Parameter	Base Case	Low	High	Source
Plan size and imaging utilization				
Hypothetical plan size	100,000			Assumption
Images per 1,000 members	135	90	180	Mitchell and LaGalia [3] Parker et al, 2010 [10]
Authorization request				
Staff time (minutes)	20	15	25	Assumption
Staff cost per hour	$15	$10	$20	The Health Care Group [13]
Probability of approval	80%	72%	88%	Assumption
Probability of appeal	80%	72%	88%	Assumption
Physician appeal to RBM				
Physician time (minutes)	20	15	25	Assumption
Physician cost per hour	$117	$105	$130	Medical Group Management Association [14]
Probability of approval	40%	36%	44%	Assumption
Probability of appeal	60%	54%	66%	Assumption
Physician appeal to plan				
Physician time (minutes)	20	15	25	Assumption
Physician cost per hour	$117	$105	$130	Medical Group Management Association [14]
Probability of approval	20%	16%	24%	Assumption
Average imaging service payment	$380	$300	$500	See text
RBM administrative cost per member per month	$0.38	$0.29	$0.48	See text

Note: RBM = radiology benefit manager.

the Medical College of Georgia, we assumed approval and appeal rates at each phase of the RBM review process and allowed them to vary by 10% for purposes of the sensitivity analysis (Table 2). Taken in combination, these assumptions result in the RBM's reducing utilization of imaging services by 12.5%, which is consistent with anecdotal results reported in the literature.

The amount of physician and office staff time needed to comply with the RBM prior authorization requests and the appeals processes is also unknown, so we again relied on time estimates from the Medical College of Georgia. For a single request, we assumed 20 minutes (range, 15-25 minutes) of staff time for collecting and submitting the initial information required by the RBM and responding to all subsequent RBM requests for additional information, 20 minutes (range, 15-25 minutes) of physician time to appeal an initial denial to the RBM, and 20 minutes (range, 15-25 minutes) of physician time to appeal a final denial by the RBM to the plan. We used an hourly cost of $15 for staff time, on the basis of the national average hourly salary for an insurance coordinator [13]. Finally, we used an hourly cost of $117 for physician time, on the basis of calculated hourly compensation for a general internal medicine physician [14]. This cost understates the actual cost for physician time to the extent that specialists who have higher hourly costs order imaging services. Hourly costs for both physicians and their staffs also exclude benefits. Using these conservative cost estimates biases the model in favor of RBMs by potentially underestimating the cost of physician compliance.

We estimated the average private insurance payment for imaging services requiring RBM prior authorization to be $380. This was calculated as the weighted average of the combined professional and technical component payments from the 2009 Medicare Physician Fee Schedule payments for 2 common advanced diagnostic imaging services: Current Procedural Terminology® code 70450 (CT, head or brain; without contrast material; $218.56) and Current Procedural Terminology code 72148 (MR [eg, proton] imaging, spinal canal and contents, lumbar; without contrast material; $423.44). The weighted average calculation assumed a CT/MR ratio of 1.3 [15] and adjusted the Medicare payments up by 25% to the level expected for private insurance plans [16]. We allowed this payment to vary from $300 to $500 to account for uncertainty and geographic variation in private payment levels for advanced diagnostic imaging services.

Finally, we were unable to locate any published information on the amount that RBMs charge health plans for their services; however, our search of company and internet websites did identify one anecdotal report indicating that per member per month (PMPM) RBM costs ranged from $0.15 to $0.32 [17]. It is not surprising that RBM fee information is unavailable because RBMs are private entities that compete on the basis of price.

RBM fees are likely to be positively correlated with the health plan's utilization rate for advanced imaging ser-

vices for 2 reasons. First, in a plan with high utilization, the RBM will need to process more requests, which translates into higher operating costs. Second, the RBM is also likely to create more value in a high-utilization health plan because, all else equal, there may be more opportunity to reduce utilization and to potentially charge a premium fee for the additional value provided. Because RBM fee information is critical to the cost analysis, we used the model to calculate RBM fees that would result in the RBM being cost neutral given all the other base-case parameters in the model ($0.38 PMPM) and used a range of ±25% of this value ($0.29-$0.34 PMPM) for the sensitivity analysis.

Sensitivity Analysis. We performed a probabilistic Monte Carlo sensitivity analysis by assuming that the model parameters were uniformly distributed within their assumed ranges. We then randomly drew 10,000 parameter value sets from each parameter's distribution and calculated the resulting net impact of the hypothetical RBM on total costs. The sensitivity analysis allowed us to assess the percentage of iterations under which the RBM was likely to increase or decrease costs, and it allowed us to compute pseudo–confidence intervals around the base-case estimates. It also allowed us to identify those model parameters that had the greatest impact on the net cost estimate (ie, parameters that accounted for the most between-iteration variation in net costs).

RESULTS

By design, the model predicts that the RBM would have no impact on health care costs (the unknown PMPM rate was set to ensure this result). Under this scenario, RBMs were projected to achieve cost savings of $640,263 (allocated by assumption to the payer [80%] and the patient [20%]) through a 12.5% reduction in imaging utilization (Table 3). By assumption, these cost savings were offset by RBM fees of $458,197, as well as costs of $182,066 to physicians and their staff members who expended resources complying with RBM procedures. In other words, approximately 28% ($182,066/$640,263) of the total projected savings provided by an RBM are shifted to providers (Table 3).

Results from the probabilistic sensitivity analysis reflect the large uncertainty in the underlying variables (Figure 2). Note that the distribution is not symmetric because of asymmetric parameter value ranges used as inputs to the sensitivity analysis. Roughly 45% of the simulations showed that RBMs reduced costs, while 55% showed RBMs increasing costs. Moreover, 95% of the simulations fell between a cost decrease of $397,880 and a cost increase of $341,991. Variables that had the largest influence on the simulation results were the probability of an initial approval by the RBM, the RBM's PMPM fee, the advanced imaging utilization rate, and the allowed charge for an advanced imaging service.

Table 3. Results for a 100,000-member hypothetical private plan

Endpoint	Estimate
Reduction in imaging services	
n	1,680
%	12.5
Costs	
Cost decreases	
Health plan	$512,210
Patient	$128,053
Total cost reductions	$640,263
Cost increases	
RBM fee	$458,197
Staff compliance with RBM processes	$67,500
Physician appeals of RBM denials	$114,566
Total cost increases	$640,263
Net cost impact	$0

Note: RBM = radiology benefit manager.

Given the large influence of these parameters, we used the model to compute the impact of RBMs on total costs for selected values of these 4 parameters: initial RBM approval rates that would yield overall reductions in imaging services of 5%, 10%, and 15%; RBM PMPM fees of $0.20, $0.40, and $0.60; advanced imaging utilization rates of 90, 135, and 180 per 1,000 members; and advanced imaging allowed charges of $300, $600, and $900.

Table 4 reports the net cost impact of RBMs per 100,000 members under all combinations of these 4 highly influential variables. Not unexpectedly, RBMs lower overall health care costs when they are more effective in decreasing utilization, their fees are low, the plans have higher utilization of advanced imaging, and payments for advanced imaging are high. For example, RBMs reduce costs for all imaging procedure cost and utilization rate scenarios when they achieve a 15% reduction in utilization and charge only $0.20 PMPM (Table 4). This scenario may be unlikely, however, because RBMs would presumably charge higher fees to health plans with high baseline utilization. If an RBM charges $0.38 PMPM, more than half of the scenarios examined (13 of 17) result in the RBM increasing costs.

DISCUSSION

Our analysis demonstrated that RBMs have the potential to either increase or decrease societal costs under a range of plausible assumptions about the parameters that govern their economic impact. We also show that significant RBM-related costs are shifted onto physicians and their staff members who expend resources complying with RBM requirements. This cost shifting creates scenarios in which RBMs are cost saving from

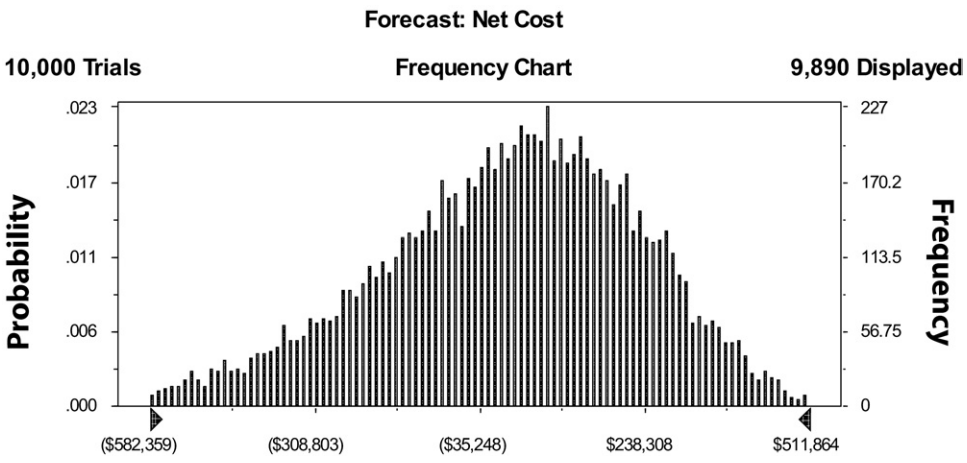

Fig 2. Probabilistic sensitivity analysis results (10,000 iterations).

the perspective of a health plan but actually increase costs to the health care system overall.

Overall impact on cost and outcomes needs to be addressed from a broad perspective, taking into account short-term and long-term impacts. Rather than using the RBMs as a short-term fix to increased utilization of imaging, health care researchers, policymakers, and administrators may gain more by taking a more holistic approach. The overarching goal of such an approach would be to better understand how to obtain the most value from imaging services, identify factors that drive utilization, and develop appropriate incentives to minimize low-value utilization.

Under our baseline scenario, in which RBMs have no net impact on costs, we estimate that for a population of 100,000 insured individuals, RBMs impose costs of $182,066 on physicians and their staffs. When scaled up to the approximately 88 million Americans currently covered by private health plans with RBMs, the model suggests that the cost shift to providers caused by RBMs is approximately $160 million per year. Furthermore, the number of RBMs increases, the magnitude of RBM-related costs borne by physicians and their staffs will likely increase nonlinearly because each office will need to simultaneously manage unique requirements and processes imposed by different RBM systems.

Given the recent growth in Medicare's spending on diagnostic imaging, it is not surprising that RBMs have been recommended by the Government Accountability Office [4] and also by the Congressional Budget Office [18]. RBMs were also part of the president's 2010 budget proposal to ensure that Medicare makes appropriate payments for imaging services through the use of RBMs and were projected to reduce Medicare spending by $260 million over 10 years [5,19].

It is telling, however, that none of these pro-RBM recommendations considered the broader, systemwide perspective. Instead, they were based solely on a calculation of the costs and benefits of RBMs to Medicare, without consideration of any other sectors in the health care system. As demonstrated above, one consequence of Medicare adopting RBMs would be to increase costs to providers. What may not be readily apparent is that a Medicare RBM prior authorization program would also likely result in a cost shift to private payers. To the extent that health care providers have market power, they will pass the increased costs of complying with Medicare RBM requirements on to private payers; RBM costs cannot be passed on to Medicare because Medicare reimbursement rates are fixed.

It is also interesting that cost shifting has not been included in the national discussion of RBMs, given that the growing body of evidence that prior-authorization programs for drugs and other health care services are associated with both cost shifting and added costs to the health care system overall. In one recent study, physicians reported spending an average of 3 hours per week interacting with insurers, while nursing staff members devoted an average of 19.1 hours per physician per week in contact with insurers, and nonclinical staff members spent an average of 35.9 hours per physician per week on insurance matters [20]. This translates into substantial increases in costs for individual practices [21] and a cost of $31 billion to the health care system as a whole [20]. Physicians are also averse to being second-guessed by third parties [22].

It is equally telling that principles of evidence-based medicine have not been applied to assessing the value of RBMs [23]. Given the near complete lack of published data on RBMs' ability to reduce utilization of imaging services, the lack of data on whether RBMs cause harm by potentially denying approval for appropriate imaging services, and the absence of data on RBMs' impact on overall or component costs, there is little doubt that formal technology review groups such as the US Preventive Services Task Force and the Medicare Evidence Development and Coverage Advisory Committee would conclude that the level of available information is "insufficient" to warrant recommending RBMs for widespread use. Thus, extrapolation of RBMs to

Table 4. RBM cost impact for selected model parameter values for a 100,000-member private plan

	RBM PMPM Fee								
	$0.20			$0.40			$0.60		
Advanced imaging utilization rate	90	135	180	90	135	180	90	135	180
5% utilization reduction									
Average imaging service payment									
$300	$180,681	$151,021	$121,361	$420,681	$391,021	$361,361	$660,681	$631,021	$601,361
$600	$45,683	($51,475)	($148,633)	$285,683	$188,525	$91,367	$525,683	$428,525	$331,367
$900	($89,314)	($253,971)	($418,628)	$150,686	($13,971)	($178,628)	$390,686	$226,029	$61,372
10% reduction									
Average imaging service payment									
$300	$76,359	($5,461)	($87,281)	$316,359	$234,539	$152,719	$556,359	$474,539	$392,719
$600	($193,638)	($410,457)	($627,276)	$46,362	($170,457)	($387,276)	$286,362	$69,543	($147,276)
$900	($463,635)	($815,453)	($1,167,270)	($223,635)	($575,453)	($927,270)	$16,365	($335,453)	($687,270)
15% reduction									
Average imaging service payment									
$300	($27,966)	($161,949)	($295,932)	$212,034	$78,051	($55,932)	$452,034	$318,051	$184,068
$600	($432,969)	($769,453)	($1,105,938)	($192,969)	($529,453)	($865,938)	$47,031	($289,453)	($625,938)
$900	($837,971)	($1,376,957)	($1,915,943)	($597,971)	($1,136,957)	($1,675,943)	($357,971)	($896,957)	($1,435,943)

Note: PMPM = per member per month; RBM = radiology benefit manager.

a different population (eg, the Medicare population) would not be supported by existing evidence.

Clinical decision support tools are one option for reducing the cost shifting caused by RBMs. Decision support tools are similar to RBMs in that both provide feedback on the appropriateness of the imaging study being ordered; however, decision support tools do not approve or deny requests but rather provide appropriateness information electronically and on a real-time basis [24,25]. Consequently, decision support tools reduce the cost shift because there is no request denial or approval process; the system simply scores the appropriateness of the requested study on the basis of a comparison with treatment guidelines. The use of clinical decision support has been shown to reduce imaging utilization [25,26], and a demonstration project evaluating the use of this approach to ensure appropriate use of imaging was part of the Medicare Improvement for Patients and Providers Act of 2008 [27].

Reducing the administrative burden on providers also has important ramifications within the broad context of health care reform. Increasing the number of Americans with health insurance will necessarily increase the demand for health care services, therefore stressing providers' capacity to deliver this additional care [28]. In our theoretical insurance plan of 100,000 members, physicians spent an estimated 980 hours on RBM processes annually when the RBM was cost neutral. Assuming 15 minutes per visit, this translates to approximately 4 additional visits per 100 patients. For the estimated 88 million Americans currently covered by health plans with RBM services, this projects to approximately 3.4 million visits lost annually to the administrative burden imposed by RBMs.

Our conclusion that RBMs may increase rather than decrease cost is based on parameter values used in the simulation model that have not yet been substantiated. RBMs have the greatest potential to reduce overall societal health care costs when their fees are low and they significantly reduce utilization for expensive imaging services ordered by primary care physicians. In particular, RBMs that focus authorization efforts on imaging services ordered by specialists are less likely to decrease overall costs and may even increase them because specialists are more expensive and may be more likely to appropriately order imaging services [11]. In contrast, we have overstated the ability of RBMs to lower costs if our parameter values for RBM operating costs or physician and staff time costs are too high. As noted above, certainty about whether RBMs do or do not lower health care costs would be greatly improved with more and better data about these and other key model parameters obtained from multiple RBMs over multiyear periods.

Our simulation model also disregarded indirect cost effects, which could be very important in the overall RBM cost calculus. For instance, RBMs shift costs to

patients when patients self-pay for imaging services denied by the RBMs, and this cost shift is exacerbated if the patients are unable to receive the imaging services at the discounted rates negotiated by insurers. RBMs also have the potential to increase or decrease potential "downstream" costs resulting from an imaging service, but estimating the net impact is complex and challenging. Clearly, RBMs reduce these indirect downstream costs when they prevent a chain of diagnostic procedures that could impose harm (eg, radiation exposure) with no patient outcome benefit. On the other hand, the denial of an imaging service may result in a delay in patients receiving care, as might be the case when a denied cardiac CT angiographic study would have incidentally revealed a lung cancer. Twenty-five percent of lung cancers are asymptomatic and are detected incidentally during diagnostic imaging [29]. If such delays exacerbate a patient's condition, downstream costs could increase if the patient misses more time from work (lost productivity), endures greater pain (quality of life), sustains a poorer clinical outcome, and potentially requires more extensive or expensive treatment.

Providers can also mitigate the cost shift caused by RBMs by proactively working to ensure that imaging study orders are appropriate. The radiology community can assist in this effort by continuing to improve and expand the ACR Appropriateness Criteria® so that physicians who order imaging studies will have better information to guide their decisions, and radiologists can work locally to ensure that appropriate imaging occurs in their communities [30]. Primary care physicians, surgeons, and other providers who order imaging studies also have a responsibility to be knowledgeable about these criteria and apply them in their day-to-day practice. When appropriate imaging rates are sufficiently high, RBMs will no longer be economically viable.

Where most physicians diverge from the Government Accountability Office, many governmental decision makers, and private payers is in their recommendation that treatment decisions should ultimately remain in the hands of physicians and patients, under the guidance of evidence-based appropriateness criteria [31]. The work presented in this paper, we hope, will contribute to this debate by highlighting the importance of looking at RBMs from a broader perspective and by providing a framework that brings the previously hidden costs of RBMs into the light for consideration when determining "what works and what doesn't" in health care delivery.

REFERENCES

1. Koike A, Klap R, Unutzer J. Utilization management in a large managed behavioral health organization. Psychiatr Serv 2000;51:621-6.
2. Levin DC, Bree RL, Rao VM, Johnson J. A prior authorization program of a radiology benefit management company and how it has affected utilization of advanced diagnostic imaging. J Am Coll Radiol 2010;7:33-8.
3. Mitchell JM, LaGalia RR. Controlling the escalating use of advanced imaging: the role of radiology benefit management programs. Med Care Res Rev 2009;66:339-51.
4. US Government Accountability Office. Report to Congressional Requesters. Medicare Part B imaging services: rapid spending growth and shift to physician offices indicate need for CMS to consider additional management practices. Available at: http://www.gao.gov/products/GAO-08-452. Accessed July 19, 2009.
5. Available at: http://www.gpoaccess.gov/usbudget/fy10/index.html. Accessed December 12, 2009.
6. Medicare Physician Payment Advisory Commission. Report to the Congress: Medicare payment policy. Available at: http://www.medpac.gov/publications/congressional_reports/Mar05_EntireReport.pdf. Accessed December 12, 2010.
7. Blachar A, Tal S Mandel A, et al. Preauthorization of CT and MRI examinations: assessment of a managed care preauthorization program based on the ACR Appropriateness Criteria and the Royal College of Radiology Guidelines. J Am Coll Radiol 2006;3:851-9.
8. Hall WB, Truitt SG, Scheunemann LP et al. The prevalence of clinically relevant incidental findings on chest computed tomographic angiograms ordered to diagnose pulmonary embolism. Arch Intern Med 2009;169:1961-5.
9. Siddiki H, Fletcher JG, McFarland B, et al. Incidental findings in CT colonography: literature review and survey of current research practice. J Law Med Ethics 2008;36:320-31.
10. Parker L, Levin DC, Frangos A, Rao VM. Geographic variation in the utilization of noninvasive diagnostic imaging: national Medicare data, 1998-2007. AJR Am J Roentgenol 2010;194:1034-9.
11. Iglehart JK. Health insurers and medical-imaging policy—a work in progress. N Engl J Med 2009;360:1030-1037.
12. Friedman DP, Smith NS, Bree RL, Rao VM. Experience of an academic neuroradiology division participating in a utilization management program. J Am Coll Radiol 2009;6:119-24.
13. The Health Care Group. Staff salary survey 2009. Plymouth Meeting, PA: The Health Care Group; 2009.
14. Medical Group Management Association. Physician compensation and production survey: 2008 report based on 2007 data. Englewood, Colo: Medical Group Management Association; 2008.
15. Bhargavan M, Sunshine JH. Utilization of radiology services in the United States: levels and trends in modalities, regions, and populations. Radiology 2005;234:824-32.
16. Medicare Physician Payment Advisory Commission. Report to the Congress: Medicare payment policy. Available at: http://www.medpac.gov/documents/Mar09_EntireReport.pdf. Accessed December 12, 2010.
17. Prior authorization takes command: meet imaging's new decision makers. Diagn Imaging 2008;30. Available at: http://www.diagnosticimaging.com/display/article/113619/1348618?pageNumber=1. Accessed December 12, 2010.
18. United States Congressional Budget Office. Budget Options, Volume 1: Health Care. December 2008. www.cbo.gov/ftpdocs/99xx/doc9925/12-18-HealthOptions.pdf. Accessed December 17, 2010.
19. Department of Management and Budget. A new era of responsibility: renewing America's promise. Washington, DC: US Government Printing Office; 2009.
20. Casalino LP, Nicholson S, Gans DN, et al. What does it cost physician practices to interact with health insurance plans? Health Aff (Millwood) 2009;28:w533-43.
21. Sakowski JA, Kahn JG, Kronick RG, Newman JM, Luft, HS. Peering into the black box: billing and insurance activities in a medical group. Health Aff (Millwood) 2009;28:w544-54.

22. Hillman BJ. Mother, may I . . . . J Am Coll Radiol 2006;3:827-8.

23. Institute of Medicine. Knowing what works in health care: a roadmap for the nation. Washington, DC: National Academies Press; 2008.

24. Rosenthal DI, Weilburg JB, Schultz T, et al. Radiology order entry with decision support: initial clinical experience. J Am Coll Radiol 2006;3:799-806.

25. Solberg LI, Wei F, Butler JC, Palattao KJ, Vinz CA, Marshall MA. Effects of electronic decision support on high-tech diagnostic imaging orders and patients. Am J Manag Care 2010;16:102-6.

26. Sistrom CL, Dang PA, Weilburg JB, Dreyer KJ, Rosenthal DI, Thrall JH. Effect of computerized order entry with integrated decision support on the growth of outpatient procedure volumes: seven-year time series analysis. Radiology 2009;251:147-55.

27. Text of H.R. 6331 [110th]: Medicare Improvements for Patients and Providers Act of 2008. Available at: http://www.govtrack.us/congress/billtext.xpd?bill=h110-6331. Accessed January 27, 2010.

28. Buchmueller TC, Grumbach K, Kronick R, Kahn JG. The effect of health insurance on medical care utilization and implications for insurance expansion: a review of the literature. Med Care Res Rev 2005;62:3-30.

29. Lung carcinoma. Available at: http://www.merck.com/mmpe/sec05/ch062/ch062b.html. Accessed January 28, 2010.

30. Clark CE. The role of radiologists in unnecessary imaging. J Am Coll Radiol 2010;7:746-7.

31. Abella HA. White House calls for imaging preauthorization in budget plan. Diagn Imaging. Available at: http://www.diagnosticimaging.com/news/display/article/113619/1383371. Accessed July 19, 2009.

CME: This article is available for CME credit. Visit www.acr.org, ACR Education, Online Learning, for more information.