

The Impact of Reimbursement Changes for Intracoronary Stents on Providers and Medicare

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Abstract

Context: New Medicare reimbursement policies will move stents into a different diagnosis-related group (DRG) than conventional balloon angioplasty (percutaneous transluminal coronary angioplasty [PTCA]).

Objective: To examine the financial impact on hospitals and Medicare of these planned changes, taking into account costs, reimbursement, and the cost-offset effect of prevented complications.

Design: The economic impact of proposed reimbursement changes was modeled by using a retrospective clinical and economic data set from a single institution.

Patients and Methods: A total of 421 consecutive interventional cases from 1996 were examined by using actual cost data. The new, proposed revenues were assigned to these cases. From the hospitals' perspective, the focus was on contribution margin (the difference between revenues and costs), risk adjusted for case-mix severity. From Medicare's perspective, the focus was on expenditures. Various assumptions were adopted for two clinical variables: the effectiveness of stents in preventing the major PTCA-related complications of myocardial infarction and coronary artery bypass graft surgery and the relative proportions of myocardial infarction and coronary artery bypass graft surgery in the mix of complications. Under current Medicare DRG policies, coronary artery bypass graft surgery is highly profitable for hospitals, whereas myocardial infarction as a complication of PTCA has a negative financial impact.

Results: Under the new Medicare reimbursement policies, hospitals experience higher profitability with stents than with conventional PTCA under most assumed levels of clinical effectiveness and mixes of

myocardial infarction and coronary artery bypass graft surgery. For Medicare, under most circumstances (including percentages of stent use and levels of clinical effectiveness that represent contemporary practice) stents lead to greater expenditures.

Conclusions: Medicare reimbursement changes will substantially realign previously misaligned financial and clinical incentives for hospitals. The immediate effect on hospitals will be to enhance profitability, whereas the effect on Medicare will be to increase expenditures.

(*Am J Man Care* 1998;4:1097-1102)

Intracoronary stents have had a substantial effect on the practice of interventional cardiology. Compared with conventional balloon percutaneous transluminal coronary angioplasty (PTCA), stenting leads to improved acute success rates and reduced rates of restenosis and repeat coronary interventions.^{1,2} It also permits the successful treatment of intimal dissection and threatened or developing acute vessel closure.³

The economics of stenting are complex.^{4,5} The perspective that one adopts has a substantial influence on the analysis of the financial effects of stenting. Stenting is substantially more expensive than conventional PTCA, driven by higher equipment and hospitalization costs.^{6,7} However, the higher initial costs are offset by a lower subsequent need for repeat intervention because of the lower restenosis rate.⁸ This long-term cost savings is relevant to third-party payers, patients, and healthcare delivery organizations that function in capitated environments or have global responsibilities (eg, staff-model health maintenance organizations).

Most hospitals, however, function in an episode-of-care environment, whereby each event is both a cost event and a revenue event. The episode may be reimbursed on a fee-for-service, discounted fee-for-service,

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or diagnosis-related group (DRG) basis. Thus, stenting presents double jeopardy to most hospitals. The initial episode of care with stenting (reimbursed under DRG 112) versus conventional PTCA brings the hospital no incremental revenues, with the hospital absorbing the additional cost of the stenting. Subsequently, future admissions and revenues are reduced, representing another financial loss.

Most studies of the economics of stenting have limited themselves to accounting for costs.⁶ We recently broadened the analysis by taking into account clinical effectiveness, associated revenues, and payer mix.⁵ Although hospitals do not get the long-term economic benefit of stenting in an episode-of-care environment, they do get one important cost offset during the initial episode of care.⁴ By enabling the treatment of coronary dissections, stents have been credited with reducing acute complications of coronary interventions.^{9,10} These acute complications, including myocardial infarction (MI) and coronary artery bypass graft surgery (CABG), are important cost drivers of interventional cardiology programs.^{5,11} By preventing these complications, stents can reduce costs. Our recent analysis demonstrated that stents may achieve cost savings under certain circumstances but that stents are never profitable for hospitals under the previous system of DRG reimbursement.⁵ The cause is twofold: the hospitals bear the entire cost of the stent, and one complication (CABG) is handsomely rewarded under the DRG system. Thus, from a purely financial point of view, under Medicare rules, it is more profitable for hospitals when patients have a complication rather than have their coronary artery successfully salvaged with a stent.

For 1998, the Health Care Finance Administration increased reimbursement for stents by moving them from DRG 112 to DRG 116. Hospitals are anticipated to receive approximately \$2,000 more in revenues for a stent case than for a conventional PTCA case. The aim of the present study was to determine whether this proposal adequately addresses the misaligned financial and clinical incentives that the DRG-based system produced in the interventional cardiology arena.

... METHODS ...

Our cost accounting methods have been described in detail previously.⁵ Our cost accounting system is a mature one that comprehensively captures the costs associated with all clinical activities. Cost accounting is performed by using accepted accounting methods of activity-based costing. Every clinical activity has its

cost calculated via a collaborative effort involving the cost-accounting department and the clinical managers (who are, most often, physicians in charge of the divisions). Both fixed and variable costs are thus assigned to each charge item by a method that guarantees complete capture of all institutional costs and allocates those costs in a manner that is clinically equitable.

We performed cost accounting for every clinical case, and we did not derive cost estimates from charge data. The basis of our economic analysis of stents and PTCA is the assessment of the incremental contribution margin. That is, for each case we calculated the contribution margin (profit): the difference between the revenues and the costs. We then compared the contribution margin of cases with stents or complications (MI or CABG) to the average contribution margin of an uncomplicated, conventional PTCA case to determine the positive or negative incremental contribution margin of the stent or complication. As directional and rotational atherectomy are categorized along with conventional balloon PTCA by Medicare's current and future DRG rules, we counted all atherectomy cases together with balloon angioplasty cases.

The context within which PTCA is performed is an important determinant of cost.⁵ Although these cases ostensibly have similar resource consumption (hence their designation into a single DRG), the indications for which PTCA is performed—stable angina, unstable angina, post-MI, acute MI, cardiogenic shock, or "other"—have very different total costs.⁵ We previously identified the differentials in costs associated with the different clinical indications and used these to risk-adjust our case mix.⁵ The incrementally greater (or smaller) costs associated with a particular clinical variable were subtracted from (or added to) the raw cost data to arrive at a risk-adjusted cost. Revenues are not affected by case-mix variables because they are an absolute, fixed quantity in the DRG system. The risk-adjusted contribution margin is defined, therefore, as the difference between revenues and risk-adjusted costs.

We examined 421 consecutive patients over a 6-month period in 1996. We collected clinical and cost data in all cases and adjusted the revenues for these cases to reflect the current proposals before the Health Care Finance Administration. It is anticipated that Medicare reimbursement to hospitals will increase approximately \$2,120 for stent cases and will decline \$192 for conventional PTCA cases.

Our previous model accounted for differences in payer mix.⁵ Because the proposed changes apply only to Medicare reimbursement, we did not repeat our model to assess the impact of various mixes of fee-for-

service, DRG-based, or capitated payers. Rather, we explored the impact of the proposed changes exclusively within the context of DRG reimbursement.

Assessment of the economic impact of stents must take into account the reduction in complications and their attendant costs and revenues. To model the cost-offset effects of stents, we could assume any level of clinical effectiveness. For example, if stents are assumed to be 10% effective in staving off complications (MI or CABG), then for every 10 stent cases, we must deduct the costs, revenues, and incremental contribution margin of one complication. However, there are substantial economic differences between the two major complications. An MI that complicates PTCA has a negative impact on a hospital's finances; however, current reimbursement practices generate greater profit for the hospital when PTCA is complicated by CABG. Preventing MIs will save the hospital money, whereas preventing CABGs will lose the hospital money. Therefore, the overall economic impact of stents will be influenced by the relative proportion of prevented complications. The proportion of MI to CABG among complications of PTCA has ranged from 0.2 to 1.5 in various series.^{5,10,12-15} These two complications are reduced by similar proportions with the use of stents.¹⁰ We therefore modeled the effects of different baseline proportions of MIs and CABGs with the assumption that stents prevent both to an equal degree (ie, if stents reduce 10% of complications, they will reduce both MIs and CABGs by 10%).

The definition of MI in our study was the elevation of post-PTCA creatine kinase levels to greater than twice the upper limit of normal combined with an elevation of the creatine kinase MB band to greater than the upper limit of normal or the inscription of new pathologic Q waves on the electrocardiogram, or both. Creatine kinase levels were obtained at the discretion of the operating physician and were not obtained in many cases of seemingly uncomplicated PTCAs.

Finally, we analyzed the impact on Medicare expenditures in an analogous fashion. From the perspective of the federal government (as payer), stents represent an additional cash outflow. Preventing peri-PTCA MI has no immediate financial impact because Medicare does not pay any greater amount for a PTCA case with this complication, but a prevented CABG represents a cost savings. We explicitly focused on the index episode of care. Although PTCA, stenting, CABG, or peri-PTCA MI all have long-term implications for patients' prognosis and their subsequent resource utilization, there are no data on which to base

an analysis of the differential long-term economic effects of these events.

... RESULTS ...

Of 425 patients, 113 underwent coronary intervention for stable angina, 168 for unstable angina, 106 in the post-MI setting, 30 for acute MI interventions, 3 for cardiogenic shock, and 1 for other indications. Four patients were excluded because of incomplete clinical information, and all analyses are based on 421 patients. Of these patients, 205 underwent uncomplicated conventional PTCA or atherectomy, 196 received stents without complication, 12 had an MI, and 8 required CABG. Of the 12 patients with MI and 8 patients with CABG, 1 in each group had an out-of-lab closure. Both of these patients had undergone conventional PTCA. All the other adverse events were the result of in-lab events. Ten of the patients with MI received stents and four of the patients with CABG received stents; the others had undergone conventional PTCA alone. There were no out-of-lab vessel closures in stent patients.

There were significant differences in the indications for intervention between PTCA and stent patients. A greater proportion of stent patients ($n = 94$) than PTCA patients ($n = 67$) presented with unstable angina (48.0% vs 32.7%; $P = 0.0014$), and fewer stent patients ($n = 3$) than PTCA patients ($n = 26$) underwent intervention for acute MI (1.5% vs 12.7%; $P < 0.0001$).

Table 1 summarizes the costs, contribution margins, the risk-adjusted contribution margins, and the incremental contribution margins for uncomplicated PTCA, cases complicated by CABG or MI, and stent cases. The length of stay was not significantly different for PTCA patients and stent patients either overall (5.4 ± 26.8 days vs 4.7 ± 9.0 days) or for any of the clinical subgroups (stable angina, unstable angina, post-MI, acute MI intervention). The rates of vascular complications also were not significantly different in PTCA patients and stent patients: 2.0% ($n = 4$) vs 1.5% ($n = 3$).

Figure 1A illustrates the effects of various estimates of the clinical effectiveness of stents and assumptions about the proportional mix of complications. Throughout most of the range of assumptions, stents are profitable for the hospital. Their incremental contribution in comparison to conventional PTCA is a positive one. However, when the highest assumed range of clinical effectiveness is coupled with the assumption that bypass surgery is much more common than myocardial infarction as a complication of PTCA,

stents lose money for the hospital. By successfully preventing profitable bypass surgery cases, stents would cause the hospital to lose money.

Figure 1B examines the effects of these same assumptions on Medicare's expenditures. At the lower ranges of clinical effectiveness, stents are consistently more costly for Medicare than conventional PTCA. At higher ranges of effectiveness stents become cost saving for Medicare. This effect is amplified by a complication mix that includes more bypass surgeries than myocardial infarctions.

... DISCUSSION ...

The changing reimbursement policies for PTCA and stenting will have substantial impact on providers and on Medicare. In our previous analysis of this issue, we demonstrated that reimbursement policies under extant DRG systems penalize stenting (and other modalities designed to prevent complications of PTCA) and reward complications.⁵ Thus, stents are not cost saving for the hospitals at any level of clinical effectiveness.⁵ The proposed Medicare reimbursement changes dramatically reverse this pattern. Stents will increase the profits of the hospital at most levels of assumed effectiveness, although a revenue-losing effect will begin to dominate if bypass surgery (as opposed to myocardial infarction) is the predominant prevented complication.

From Medicare's perspective, stents will be cost saving if their effectiveness surpasses a minimum threshold. The precise threshold depends on the rela-

tive frequency of MI and CABG among PTCA-related complications. As the economic impacts on provider and payer depend on the assumed clinical effectiveness, it is important to place this analysis in the context of current practice. An early study reported an approximately one-for-one reduction of complications for each stent placed (a clinical effectiveness approaching 100%)¹⁰; however, this is not likely to represent current practice. Lindsay et al reported that as stent usage reached 47.8%, emergency CABG rates fell from 4.5% to 1.2%.⁹ Although they did not report the incidence of MI, we might assume that the MI rate fell to a similar degree.¹⁰ This would translate into an absolute decline of complications of approximately 7%, or clinical effectiveness of approximately 15% (ie, for every 200 interventional cases, 100 involve stent implantation and 15 complications are averted). At this level of effectiveness, stents will be profitable for hospitals and will not save money for Medicare (Figure 1A and 1B). Stent usage rates nationwide approximate those reported by Lindsay et al.⁹

The major limitation of our study is that we focused exclusively on the initial episode of care. Stents reduce restenosis and the need for subsequent repeat revascularization procedures.⁸ In a DRG environment, this represents a loss of future revenue events for hospitals and a cost savings for Medicare. The long-term trends, therefore, offset the immediate effects on providers and payers.

The identification of MI after PTCA is an area of considerable debate.¹⁶ Even modest, asymptomatic elevations of creatine kinase after PTCA have an adverse impact on prognosis.¹⁶ The adoption of specific cutoff

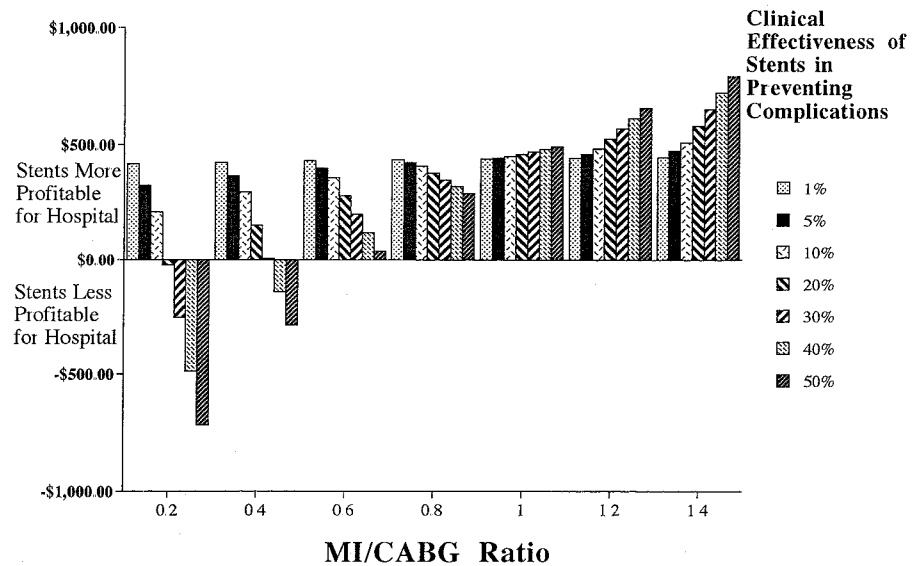
Table 1. Estimated Costs, Contribution Margins, and Incremental Contribution Margins of PTCA, Complications, and Stents Under New Medicare Policies

Cost or Margin*	Uncomplicated Conventional PTCA	CABG	MI	Stent
Total cost	\$7764 ± \$6040	\$23,911 ± \$17,979	\$12,643 ± \$3852	\$8809 ± \$3764
Contribution margin	\$2252 ± \$5352	\$5320 ± \$17,979	-\$558 ± \$4027	\$3463 ± \$3751
Risk-adjusted contribution margin	\$2111 ± \$5352	\$5779 ± \$18,283	-\$1485 ± \$3444	\$2693 ± \$3524
Incremental contribution margin		\$3668	-\$3596	\$582

PTCA = percutaneous transluminal coronary angioplasty; CABG = coronary artery bypass graft surgery; MI = myocardial infarction
 *Contribution margin indicates difference between revenues and costs; incremental contribution margin indicates difference in contribution margin for a case with a complication or a case with a stent versus an uncomplicated conventional PTCA.

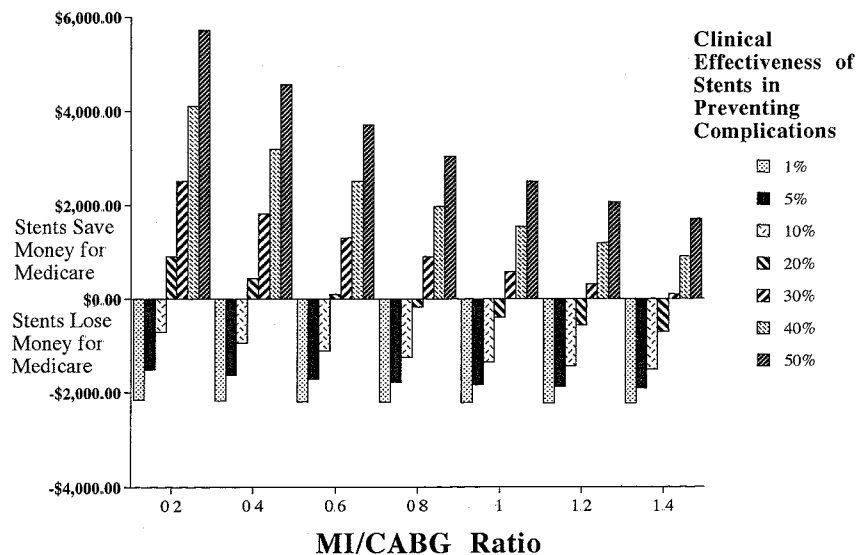
values and subsequent practice (eg, prolonging hospitalization) will have substantial impacts on the costs of caring for these patients as well as the apparent effectiveness or ineffectiveness of therapeutic modalities intended to forestall complications of PTCA. The criteria that were adopted at our institution were stricter than some recently advocated criteria.¹⁶ However, creatine kinase determination was not performed routinely in all cases. This reflects prevailing practice patterns, as recommendations for routine isoenzyme determination were proposed only recently.¹⁶ It is unclear whether the adoption of even stricter criteria would have much impact on our economic analyses. Low-level elevations of creatine kinase may affect long-term prognosis, but they have not been demonstrated to have much short-term effect. Therefore, it is uncertain whether prolonging hospitalization for patients with small creatine kinase elevations would benefit them, and this recommendation has not been made.¹⁶ Consequently, within the context of our analysis of cost during the index hospitalization, small creatine kinase elevations may have negligible cost impacts if physicians do not choose to prolong their patients' hospitalizations.

Figure 1A. Financial Impact of Stents on Hospitals as a Function of the Clinical Effectiveness of Stents in Reducing Complications and the Ratio of Myocardial Infarctions (MIs) and Coronary Artery Bypass Graft Surgeries (CABGs)



Bars above zero imply added profitability for the hospital, whereas bars below zero imply a financial loss for the hospital.

Figure 1B. Financial Impact on Medicare for the Same Range of Assumptions Shown in Figure 1A About Possible Clinical Effectiveness and Complication Mix



Bars above zero represent a positive impact on Medicare, and bars below zero represent a negative impact on Medicare (ie, increased expenditures for Medicare).

... CONCLUSION ...

The new Medicare reimbursement policies will substantially realign financial incentives with clinical practice. Stenting has proven benefits for patients both in the immediate peri-PTCA period (reduced complications) and in the longer term (reduced restenosis). Previously, hospitals were financially penalized for stenting. The new policies will permit a more equitable reimbursement for hospitals and will allow them to offer stenting with increased revenues that simultaneously address the higher initial costs of stenting and the decreased later revenue events. From Medicare's perspective, stenting will almost certainly translate into increased initial expenditures, but will then have a cost offset because of reduced repeat interventions.

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