

Costs of Providing Antiplatelet Medication for Percutaneous Coronary Intervention Patients

Nathan W. Carroll, MHA; and Michael P. Dorsch, PharmD, MS

Developments in antiplatelet therapy for patients undergoing cardiac stent implantation have reduced the incidence of thrombosis in patients receiving cardiac stents.¹ However, thrombosis is still an all-too-common occurrence with grave consequences for patient health. Sixty-four percent of patients with stent-related thrombosis experience either an acute myocardial infarction (AMI) or death.² Revascularization is costly also. Patients requiring revascularization within a year of percutaneous coronary intervention (PCI) incur almost \$25,000 more in medical expenses than those that do not.³ A great deal of research has been devoted to describing costs and outcomes associated with antiplatelet therapies for stent patients. However, much less information is available on the cost implications of adherence to these therapies.

Payers may have an opportunity to reduce their medical losses by designing benefits that encourage continuity of antiplatelet therapy during the period immediately following hospital discharge. One study of 3 large US managed care organizations found that 16.3% of patients undergoing stent implantation delayed filling their antiplatelet prescription. The median delay between a PCI patient's discharge from the hospital and the time the patient first fills the antiplatelet prescription was 3 days.⁴ Past studies of unusually restrictive prior authorization programs in Canada have found median delays in filling antiplatelet prescriptions of 9 days.⁵ Given antiplatelet medications' mechanisms of action, it is not surprising that a gap in therapy after hospital discharge is associated with an increased risk of poor outcomes. Even among a population of patients receiving drug-eluting stents, patients with a delay of 1 day or more in filling an antiplatelet prescription after discharge are significantly more likely to experience death or a myocardial infarction.⁴ Furthermore, higher copayments for medications are associated with an increased risk of rehospitalization in acute coronary syndrome patients receiving stents, as well as higher average follow-up costs of care.⁶

There is reason to believe that the way in which payers choose to administer benefits may impact beneficiaries' health outcomes as well as the total costs of treatment. If this is the case, payers may have an opportunity to reduce medical losses and improve the quality of cardiac

care through changes in benefit design. Insurers could develop partnerships with hospitals to fund hospitals' provision of discharge supplies of medication

Objectives: To propose a model in which insurers work with hospitals to provide a discharge supply of antiplatelet medication to patients receiving stents and to examine the cost implications of this strategy.

Study Design: A decision tree was modeled using data from previously published research. The study adopts an insurer's perspective.

Methods: Data on patient delays in filling antiplatelet prescriptions and rates of associated adverse events were taken from published research. The costs of adverse events (death or acute myocardial infarction [AMI]) are taken from Healthcare Cost and Utilization Project estimates of hospital costs for diagnosis-related groups associated with AMI.

Results: In the base case, expected costs totaled \$1782 when stent implantation patients were provided with a discharge supply of medication and \$1857 under the current standard of care, a difference of \$75. Insurers can supply up to 60 days of medication without increasing total costs. The strategy of offering a discharge supply of medication is cost saving under a range of estimated rehospitalization costs and medication costs. However, this result is dependent on the ability of a discharge supply of medication to reduce rates of death or AMI.

Conclusions: Providing discharge supplies of antiplatelet medication resulted in lower overall costs for insurers in most of the cases modeled.

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Take-Away Points

Managed care plans should consider waiving copayments on antiplatelet medications for percutaneous coronary intervention (PCI) patients and collaborating with hospitals to ensure that patients receive a supply of these medications upon discharge.

- Research has shown that failure to begin antiplatelet therapy promptly after PCI puts patients at increased risk for acute myocardial infarction or death, but many patients delay filling prescriptions for these medications.

- In most of the scenarios modeled here, the expected costs of these complications to insurers exceed the cost of providing copay-free discharge supplies of medication to PCI patients.

The model assumed that rates of death or AMI under the alternative strategy would be equal to adverse event rates for the group of patients filling prescriptions upon discharge. The model also assumed that under the alternative strategy 7 days of medication is provided by the hospital and that the patient is completely adherent to therapy throughout the rest of the year. This supply is enough to cover the

to patients receiving cardiac stents. This study examines the cost implications of such a strategy.

3- to 4-day average delay in filling reported by some studies.^{4,7} Like other assumptions, this estimate was relaxed in sensitivity analysis.

METHODS

A decision model, using a payer's perspective, was developed to evaluate this strategy. The 2 alternatives are (1) the current state of care, in which patients are responsible for filling their prescriptions for antiplatelet medications and insurers charge a copayment for those medications; and (2) an alternative strategy in which an insurer waives the copayment for a small discharge supply of antiplatelet medication that is provided to a patient by the hospital. The decision tree was modeled using TreeAge Pro software (TreeAge Software Inc, Williamstown, Massachusetts) and is presented in **Figure 1**. Probabilities of patient adherence (defined here as a patient filling a prescription on the day of discharge) and adverse events (defined here as the occurrence of death or AMI) as well as the costs of adverse events were estimated based on published studies. Model parameters are provided in **Table 1**. Sensitivity analysis and Monte Carlo simulation were conducted to evaluate how robust conclusions were to changes in the model assumptions.

Outcome and Adherence Measures

In the base case, 7.9% of patients filling a prescription for an antiplatelet medication immediately following discharge were estimated to experience death or AMI compared with 14.2% of patients who had at least a 1-day delay.⁴ Similarly, the base case estimates that 83.65% of patients will fill a prescription without delay.⁴ This estimate may overstate the true percentage of patients who fill antiplatelet prescriptions upon discharge. Other studies have found results ranging from 64%⁵ to 54%.⁷ The 83.65% estimate for patient adherence is conservative. If the true rate of adherence is lower than 83.65%, the model's estimates of the costs associated with standard treatment will underestimate the true cost of the standard treatment. In that case, the savings afforded by the alternative strategy (in which patients are provided discharge medication) will be higher than estimated here.

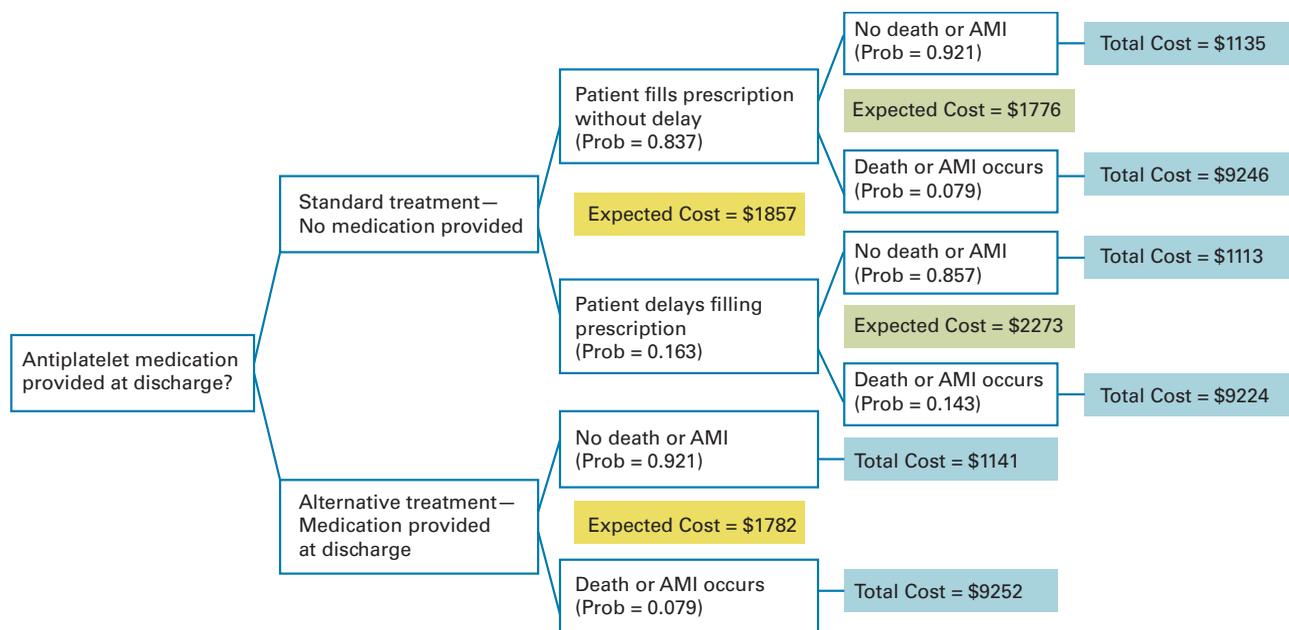
Cost Measures

The model compared the expected cost of rehospitalization for AMI with the higher medication costs insurers would face in supplying patients with discharge supplies of antiplatelet medication without charging copayments. Patients who did not experience death or AMI incurred medication costs for 12 months per accepted guidelines.⁸ Costs related to hospitalizations were estimated to average \$8111 based on hospital costs reported by the Healthcare Cost and Utilization Project for diagnosis-related groups (DRGs) 280-285.⁹ These are actual hospital costs (as opposed to charges) estimated based on hospital-specific cost-to-charges ratios reported to the Centers for Medicare & Medicaid Services. These DRGs include services related to AMI for patients with and without complications and comorbidities. They include costs for services to patients who are discharged alive, as well as for patients who expire. These DRG codes, their descriptions, and the associated costs are listed in **Table 2**. These cost estimates only included hospitalization costs. Any additional costs related to an AMI but attributable to physician services or non-antiplatelet medication costs were not included in these estimates. In addition, any amount paid by insurers in excess of hospital costs was not included in these estimates. These are conservative estimates and if incorrect they would bias the cost minimization analysis in favor of the standard therapy.

In addition to differences in the costs and rates of death or AMI, cost differences between the standard and alternative treatments are driven by differences in medication costs, which were modeled on a cost-per-day basis. Under the standard treatment, insurers bear the cost of a year of treatment. However, it is possible that patient delays in filling prescriptions represent medication savings for an insurer. This would be the case if patients who delay filling prescriptions for antiplatelet medications do not extend the course of their therapy to make up for a delay in beginning therapy. As a result, the model calculated drug costs for a full 365 days of therapy for

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■ **Figure 1. Decision Model**



AMI indicates acute myocardial infarction; Prob, probability.

■ **Table 1. Decision Model Parameters**

Model Variable	Base Case Value	Sensitivity Range			SD	Distribution
		Low	High			
Cost of an adverse event	\$8111	\$3558	\$10,213		182 (assumed)	Normal (assumed)
Probability of an adverse event for patients receiving a discharge supply of medication	7.90%	7.90%	14.30%		0.05 (assumed)	Normal (assumed)
Probability of an adverse event for patients filling the prescription without delay	7.90%	7.90%	7.90%		0.05 (assumed)	Normal (assumed)
Probability of an adverse event for patients filling the prescription with a delay ≥ 1 day	14.30%	14.30%	14.30%		0.05 (assumed)	Normal (assumed)
Daily copay	\$0.84	\$0.33	\$1.67		0.25 (assumed)	Normal (assumed)
Number of days before filling	7	7	365		3 (assumed)	Normal (assumed)
Cost for a day's supply of medication	\$3.95	\$0.00	\$6.00		0.19 (assumed)	Normal (assumed)
Percentage of patients filling without delay	83.65%	64%	95%		0.05 (assumed)	Normal (assumed)

SD indicates standard deviation.

the alternative treatment but for 358 days (365 days less a 7-day delay) under the standard treatment. It is unlikely that a patient would actually reduce his course of therapy after an initial 7-day delay in filling a prescription. However, this is a conservative assumption and, if incorrect, would bias the results in favor of the standard treatment.

Medication costs under the alternatives also differ with respect to patient copayment. Under the standard treatment, patients are charged a copayment for all medication,

which offsets the insurers' expenses. The alternative treatment, however, provides a discharge supply of medication without a patient contribution. Copayments for a 30-day supply were estimated based on the \$25.19 average 2009 retail copayment for preferred branded medications reported by the Pharmacy Benefit Management Institute.¹⁰ Copayment costs for both the standard and alternative treatments were considered on a per day basis. Consistent with published reports, the base case assumed that a 7-day supply of discharge

■ **Table 2.** Estimated Cost for Rehospitalization of Diagnosis-Related Groups From the Healthcare Cost and Utilization Project

Diagnosis-Related Group Code and Name	Costs, \$	
	Mean	Median
280 Acute myocardial infarction, discharged alive with MCC	12,901	10,213
281 Acute myocardial infarction, discharged alive with CC	8618	7534
282 Acute myocardial infarction, discharged alive without CC/MCC	6799	5972
283 Acute myocardial infarction, expired with MCC	13,329	8696
284 Acute myocardial infarction, expired with CC	6759	5039
285 Acute myocardial infarction, expired without CC/MCC	4649	3558

CC indicates complication and comorbidity; MCC, major complication and comorbidity.

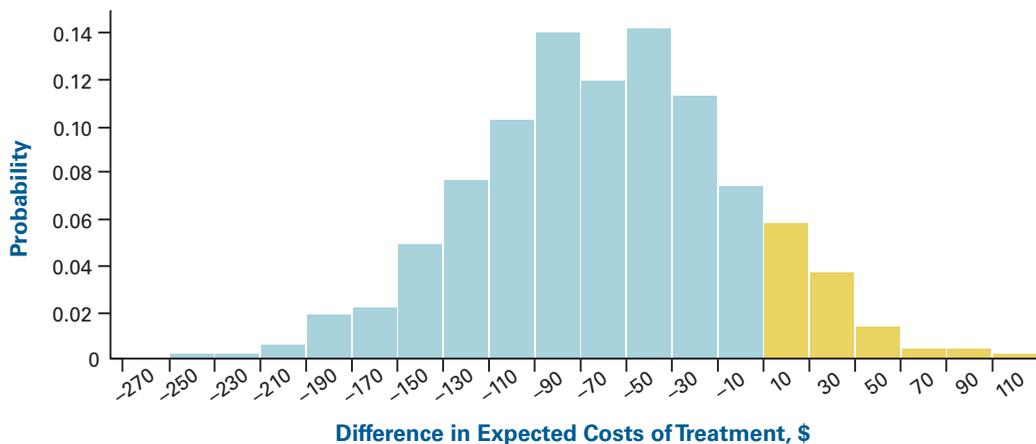
medication would be provided. Medication cost was set at \$3.95 per day, which represents average wholesale price less the average 16% discount offered to retail pharmacies for brand-name medications.¹⁰

RESULTS

Under the assumptions outlined previously, our model suggests that an insurer’s total cost of follow-up care 1 year after stent implantation would be \$75 higher under the standard treatment (\$1857 expected cost) compared with the alternative treatment in which insurers work with hospitals to give patients a 7-day discharge supply of antiplatelet medication without a copayment (\$1782 total cost). This difference in

baseline. Sensitivity analyses addressed 3 possible concerns: that the medication costs estimated were too low, that the rate of death or AMI might not decline when patients are given discharge medication, and, finally, that the estimated costs associated with death or AMI were too high. The potential impact of these factors is shown in the tornado diagram in **Figure 3**. We did not consider costs associated with implementing a program to provide discharge medications. A payer’s cost to implement a program like this one would likely be determined through hospital-specific rate negotiations, and the resulting costs could vary widely. To get a more complete estimate of the savings possible, payers should calculate their own per case costs and deduct these from the estimated per case savings presented here.

■ **Figure 2.** Difference in Expected Total Cost of Treatment Options (Expected Cost of Providing Medication vs Standard Treatment)^a

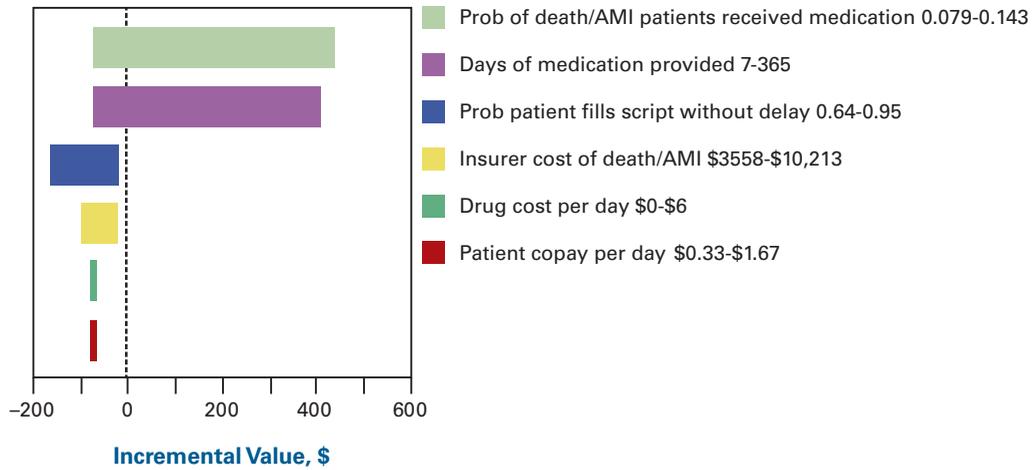


^aNegative values occur when the expected cost of providing medication is less than the expected cost of standard treatment. The yellow bars represent trials in which the standard therapy was the cost-minimizing option.

expected costs was the result of greater expense driven by a higher rate of death or AMI in the group not receiving a discharge supply of medication. We performed a Monte Carlo simulation to test the robustness of these results and found that the alternative strategy was less costly than the standard strategy in more than 91% of cases. These results are shown in **Figure 2**. In addition, we performed sensitivity analyses to test whether or not these conclusions were consistent under assumptions different from those made at

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Figure 3. Tornado Diagram: Expected Cost of Medication Provision Versus Standard Treatment



AMI indicates acute myocardial infarction; Prob, probability.

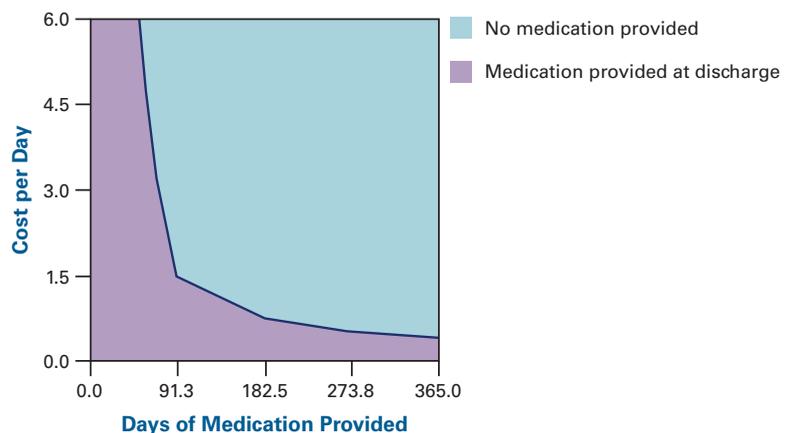
Medication Costs

The first concern is that the total cost of medication therapy we modeled was too low. Total medication cost is affected by both the number of days of therapy provided under the alternative treatment and the cost per day of medication. This estimate would be low if many patients experienced delays of more than 7 days in filling medications and as a result, required larger supplies of discharge medication, or if medication costs were higher than the estimated \$3.95 per day. **Figure 4** shows the sensitivity analysis conducted on per day medication cost and days of medication supplied. At the \$3.95 per day price we estimated, insurers could offer a 60-day supply of discharge medication and still expect to realize roughly the same medical losses they do under standard therapy. Similarly, if the medication cost were \$6 per day, insurers could provide almost 50 days of medication without increasing the expected cost of treatment. At a per day cost of about \$0.25, insurers could supply 365 days worth of discharge medication and still expect lower total medical costs than under standard treatment. A per day cost of only \$0.25 is much lower than current antiplatelet medication prices, but the patent for the most frequently prescribed antiplatelet medication (clopidogrel) is due to expire soon, at which point this much lower cost may be more realistic. The \$3.95 medication cost estimate is based on retail pricing, and hospitals are likely able to purchase antiplatelet medications for less.

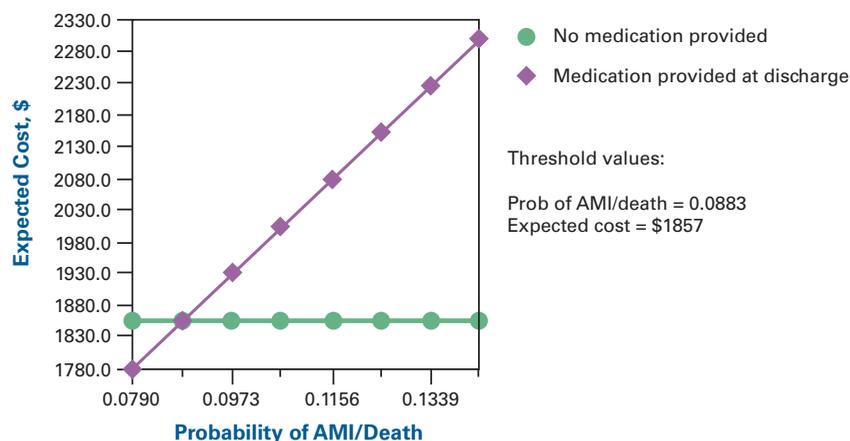
Rates of Death and Acute Myocardial Infarction

The second sensitivity analysis varied the rate of adverse events in the group that received a discharge supply of medications. The base case assumed that 7.9% of patients in this group would experience death or AMI. This is the same rate as that in the group that did not delay filling a discharge supply of medications. The assumption is that if patients are given a supply of medication when they are discharged, they will begin taking it without delay and as a result have outcomes similar to those of patients who do not delay filling their prescriptions. However, this may not be a valid assumption. Even with a discharge supply of medication, some patients may delay taking the medication and, as a result, experience higher rates of death or AMI. It is also possible that patients who

Figure 4. Sensitivity Analysis on Days of Medication Provided and Cost of Therapy



■ **Figure 5.** Sensitivity Analysis on Probability of Death or Acute Myocardial Infarction for Patients Receiving Medication

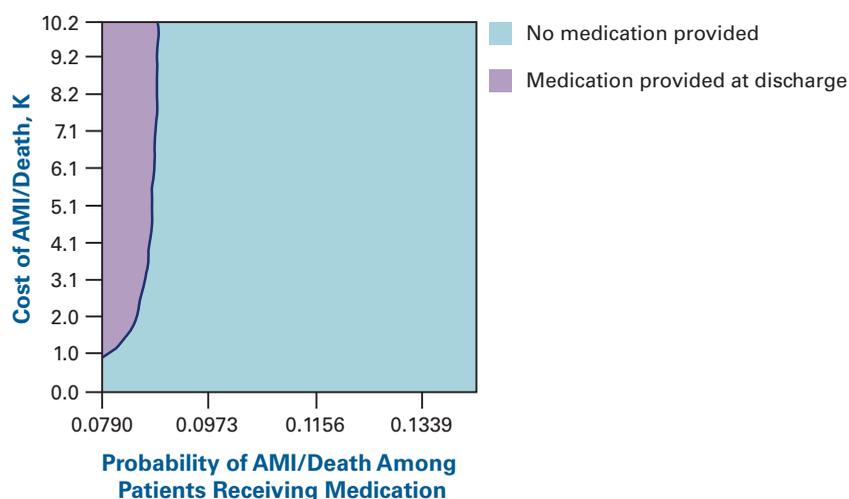


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In 2007 an estimated 1,178,000 PCI procedures were performed in the United States¹¹ and while not all PCI patients receive a stent, the majority do. Clearly, if the \$75 per case expected savings were realized, the total savings would be significant. Sensitivity analyses suggest that this result holds when estimates of re-hospitalization costs (for death and AMI) and medication costs are varied within reasonable ranges. However, this result is much less sensitive to variations in the rates of death or AMI assumed to prevail when patients are given a discharge supply of medication.

This study has a number of limitations. The most formidable relate to problems with a lack of detailed data on outcomes and costs associated with delays in filling prescriptions for antiplatelet medications after stent implantation. This model is based on a previous study that found that 14.3% of patients who delayed filling their prescriptions experienced death or a myocardial infarction.⁴ However, it would be useful to have a better understanding of whether this increase in adverse events comes primarily from patients delaying only a few days or is driven mainly by patients with longer delays. Ideally, the model would be more detailed. We would like to have considered outcomes for patients undergoing elective PCIs for stable angina separately from outcomes for patients with PCIs prompted by acute coronary syndrome. We would also have liked to include measures of the patients' existing comorbidities and pill burden in the model. Unfortunately, these data were not available. Similarly, because these data were based on a single observational study, we could not be sure that the higher rates of complications in the group that delayed filling could be attributed to their delay and not some other factor correlated with the delay (perhaps the availability of family care or support). The baseline results also assumed that adherence would improve if patients were provided with discharge supplies of medication that did not require a copayment. Prior research suggests factors like lower copayment levels and access to medication encourage adherence to antiplatelet therapy.¹² However, the same research suggests that factors not considered in this analysis could affect adherence, for instance, a patient's understanding of the medication's importance or a patient's ability to remember to take it. There are also potential problems with the way the costs of complications were modeled, although these

■ **Figure 7.** Sensitivity Analysis on Cost and Probability of Death/Acute Myocardial Infarction for Patients Receiving Discharge Medication



AMI indicates acute myocardial infarction.

estimates were extremely conservative and likely understated the true costs associated with the standard therapy. The cost estimates used were based on hospital costs reported by the Healthcare Cost and Utilization Project, and these are surely lower than the rates that insurers pay hospitals. Moreover, these estimates do not include physician services, additional medications required because of an AMI, or the costs of other necessary medical services. One study that did consider all of these costs suggests that patients with a recurrent ischemic event incur \$22,000 more in medical costs than PCI patients without a second ischemic event.¹³ This is almost 3 times the \$8111 base case hospitalization cost presented here. Still, sensitivity analyses showed that the results were robust to a wide range of cost estimates for complications. Finally, Monte Carlo simulation showed that providing a discharge supply of medication was cost saving in 91% of cases, although these results should be interpreted with caution. Data on the standard deviations and distributions of a number of the variables used in this analysis were not available, and the assumptions made in defining these parameters may not hold up in reality.

Despite some limitations, this study offers several useful insights. It shows that insurers may well be better off waiving patient copayments and paying hospitals to provide a discharge supply of these medications. Moreover, the results show that the cost advantage of this strategy is robust to a range of different estimates of the costs of complications. However, providing discharge supplies of antiplatelet medications is not a cost-effective strategy if it fails to improve adherence and adverse-event rates to levels similar to those observed among patients who do not delay in filling their prescriptions. This article does not seek to

address the logistic considerations that supplying patients with medication upon discharge would involve and does not account for the administrative expense this effort would surely require. It merely suggests that this strategy may be worthy of consideration by insurers and hospitals. As the Centers for Medicare & Medicaid Services expands the list of adverse events for which it refuses to reimburse and encourages the creation of accountable care organizations that bear more responsibility for patient outcomes, hospitals and insurers should be open to new relationships that can improve patient care while reducing costs. Collaborations that allow insurers to fund hospital-supplied antiplatelet medications to patients may be one way to accomplish both of these frequently incompatible goals.

Author Affiliations: From Department of Health Management and Policy (NWC), School of Public Health, and Department of Pharmacy Services (MPD), University of Michigan Health System, College of Pharmacy, University of Michigan, Ann Arbor, MI.

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Address correspondence to: Nathan W. Carroll, MHA, 1415 Washington Heights, Ann Arbor, MI 48109-2029. E-mail: natcar@umich.edu.

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