

## A Comparison of Abciximab Use in MCO and Non-MCO Populations

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**Objective:** To compare abciximab use in managed care organization (MCO) patients and non-MCO patients undergoing coronary angioplasty, specifically (1) the factors influencing abciximab use, (2) the impact of abciximab on hospital length of stay (LOS), and (3) differences in results in MCO and non-MCO patients.

**Study Design:** A retrospective observational study based on data from 87 US hospitals on 13,384 angioplasty patients.

**Patients and Methods:** Multivariate analysis was used to control for a wide range of factors (patient demographics, health conditions, admission information, and hospital characteristics) that may influence the likelihood of receiving abciximab and hospital length of stay (LOS). Estimation was conducted via a 2-stage sample selection model.

**Results:** Comorbidities, hospital characteristics, and geographic regions influenced abciximab use in MCO and non-MCO populations. In the non-MCO population, women and minority group members were significantly less likely than white male patients to receive abciximab. Both MCO and non-MCO angioplasty patients who were given abciximab had significantly shorter LOSs ( $0.66 \pm 0.27$  fewer days and  $0.87 \pm 0.13$  fewer days, respectively) than did patients who were not given this drug.

**Conclusions:** Access to care for MCO and non-MCO populations differed. Non-MCO women and minorities were less likely than non-MCO white men to receive abciximab, but this difference was not observed in the MCO population. After controlling for high-risk indications and selection bias, MCO and non-MCO patients who received abciximab had significantly shorter LOSs than did those who did not receive abciximab. This finding is consistent with the many clinical trials that have observed a reduction in ischemic complications associated with abciximab use.

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For editorial comment, see page 89.

An increasing number of Americans receive medical care through managed care organizations (MCOs).<sup>1</sup> The basis for this growth is the presumption that MCOs provide medical care at lower cost than does the traditional fee-for-service system.<sup>2</sup> Given the relatively large segment of the population currently enrolled in MCOs, it is important to evaluate the patterns of care and associated patient outcomes in this population relative to the non-MCO population. This paper analyzes utilization of the pharmaceutical therapy abciximab for patients enrolled in MCOs who are undergoing percutaneous coronary intervention (PCI) and compares the results with those in a non-MCO population. The study examines 2 issues: (1) the likelihood of a patient receiving abciximab, and (2) the effects of abciximab on hospital length of stay (LOS). An examination of the first issue allows for an analysis of access to care in an MCO population relative to a non-MCO population. Examination of the second

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issue is important because LOS not only reflects the risk of complications but also is directly related to the resources consumed during inpatient management.<sup>3,4</sup>

Previous clinical trial research has investigated the impact of abciximab on patients undergoing coronary angioplasty. The EPIC trial demonstrated that abciximab reduced acute cardiac ischemic complications in high-risk patients undergoing angioplasty and arethrectomy.<sup>5,6</sup> Reductions in death, myocardial infarction, and revascularization were evident at 30 days and at 6 months, even as long as 3 years after the procedure.<sup>6-8</sup> The EPILOG and EPISTENT trials extended the findings of the EPIC investigators by showing that the benefits of administering abciximab to high-risk coronary intervention patients also were found in lower-risk patients,<sup>9,10</sup> and that abciximab improved the safety of coronary-stenting procedures.<sup>11</sup> In the CAPTURE study, abciximab treatment in patients with refractory unstable angina reduced the rate of myocardial infarction before, during, and after PCI.<sup>12</sup>

In contrast to the clinical trials research, this study examines the use of abciximab in a naturalistic setting. The controlled nature of clinical trials may reduce their suitability in examining such outcomes as LOS. In addition, these trials exclude patients with multiple comorbidities and enforce certain standards of care that may not reflect actual practice. It is therefore important to analyze outcomes in a "real-world" setting, with "real-world" patients. One of the drawbacks of observational data, however, is that they may interject bias into an analysis. For example, compared with patients who are less seriously ill, sicker patients may be more likely to receive abciximab. To overcome this limitation, our analysis is based on a 2-stage econometric model that controls for the influence of possible selection bias across categories of patients. The model controls for observed and unobserved factors that are correlated with a patient's treatment selection and LOS.

... METHODS ...

**Data Source**

The HCIA Clinical Pathways Database provided the data used in this study. The database contains data from all hospitals with catheterization laboratories that agreed to share their data with HCIA. All institutions in the database are short-term, general, nonfederal hospitals located in the United States. The study dataset consists of patients who were discharged from any of 87 hospitals performing

PCIs between October 1, 1995, and December 31, 1996. It contains detailed patient data on demographics, insurance, procedure performed, and diagnostic information.

We performed the following steps to construct the dataset used in the analysis. First, we determined that the 87 hospitals in the HCIA dataset had seen 46,404 patients whose records indicated a primary procedure of PCI. From this group, we selected all patients who had been given abciximab ( $n = 1991$ ). To construct a control group, we then randomly selected a sample of patients who did not receive abciximab so as to maintain an approximate 5-to-1 relationship with patients who received the agent. In this step, 11,393 patients were selected, for a total sample size of 13,384 patients. We then divided the total sample into 2 subpopulations on the basis of insurance categorization. One subpopulation consisted of the 1847 PCI patients who were enrolled in MCOs; 311 of the 1847 patients received abciximab and 1536 did not. The non-MCO subpopulation consisted of 11,537 patients, 1680 of whom received abciximab and 9857 of whom did not. We analyzed abciximab use and its impact on hospital LOS in patients enrolled in MCOs and compared the results with the results in patients who were not MCO enrollees.

**Model**

A simple regression model can be used to control for the factors affecting the likelihood of receiving abciximab and hospital LOS, if all these factors are known. In practice, however, information on some factors is likely to be missing or cannot be determined. In this case, the use of a simple linear regression model will lead to a biased estimate of the differential impact of abciximab on LOS. Thus, a 2-stage econometric model is used to adjust for the missing or confounding factors. These types of models have been widely used in the economics literature<sup>13-15</sup> and are increasingly important to health services research.<sup>16-20</sup> A 2-stage model can be illustrated by the following equations<sup>14</sup>:

$$(1) Y_1 = \beta_1 X + \varepsilon_1$$

$$(2) Y_2 = \beta_2 X + \delta \lambda + \gamma Y_1 + \varepsilon_2$$

In our case,  $Y_1$  measures whether a patient was given abciximab;  $Y_2$  measures hospital LOS;  $X$  is a matrix of factors hypothesized to predict abciximab receipt and hospital LOS;  $\lambda$  is an estimated adjustment factor for the influence of unobservable factors

that are correlated with  $Y_1$  (it is estimated from equation [1] and inserted into equation [2]);  $\beta_1$ ,  $\beta_2$ ,  $\delta$ , and  $\gamma$  are parameters to be estimated; and  $\varepsilon_1$  and  $\varepsilon_2$  are error terms.

We conducted the estimation in 2 stages. In the first stage, estimation of equation (1) as a probit regression showed which factors were associated with a higher probability that a patient would be given abciximab. The probit regression model is a useful and appropriate estimation strategy when the dependent variable is binary (eg, receiving or not receiving a drug). Note, however, that the parameter estimates produced by the regression model do not measure the incremental effect of the respective variable on the probability that a patient received abciximab. We therefore explicitly calculated marginal effects as the change in the conditional expectation of the dependent variable attributable to an incremental change in one of the independent variables.<sup>14</sup> In addition, the results from this estimation allowed for the creation of the adjustment factor,  $\lambda$ , which was necessary for the subsequent analysis.

The second stage of the estimation analyzed factors influencing LOS. Equation (2) states that LOS depends on the hypothesized predictors (the  $X$  variables), as well as on receipt of abciximab ( $Y_1$ ). We used a negative binomial regression model, as LOS takes on nonnegative values and has a skewed distribution. This model is appropriate for estimating count data, such as LOS, which do not have a continuous distribution.<sup>14</sup> In previous research on LOS, natural logarithms have adjusted for the skewed distribution,<sup>3,21,22</sup> but this transformation fails to account for the noncontinuous nature of the data.

Randomization in a clinical trial eliminates treatment selection bias. In observational data, however, randomization to a treatment group has not occurred. In our study, for example, physician treatment choice was intentional, and systematic differences between patients who received abciximab and those who did not receive the drug should be expected. Hence, including the adjustment factor,  $\lambda$ , in equation (2) adjusts for the fact that the patients in this observed dataset did not receive abciximab randomly. The adjustment factor is calculated as a function of the predicted probability of receiving abciximab and is based on the first-stage “selection” equation (equation [1]). If  $\lambda$  is a significant determinant of LOS but is omitted, then the estimates of the impact of the other variables (the  $X$  vector and  $Y_1$ ) on LOS would be biased. A 2-stage sample selection model, developed by Heckman<sup>15</sup> and described above, is specifically designed to control for such bias.

We used the LIMDEP Version 7.0 estimation package to conduct all the analyses.<sup>23</sup> LIMDEP has been designed specifically to estimate models with limited dependent variables, as in equation [1]. In addition, the 2-stage sample selection model is a standard part of this estimation package. As such, LIMDEP routinely provides an estimate of  $\lambda$  that is used in estimating sample selection models.

### Independent Variables

In this study, we used 4 classes of independent variables (the variables in the  $X$  vector in equations [1] and [2]): (1) patient demographic characteristics, (2) admission information, (3) health conditions, and (4) hospital characteristics. These variables adjust for a wide range of factors that may affect a patient’s probability of receiving abciximab or LOS. We based our selection of the variables on clinical trial research that has examined abciximab and on literature that has assessed factors affecting hospital LOS.<sup>3,24,25</sup>

The patient demographic characteristics consist of the patient’s age and indicator variables for female sex and minority status. The analysis also controls for differences in patient admission. Specifically, we constructed an indicator variable for individuals who were admitted via an emergency department (ED).

The patients’ health conditions can be categorized into 2 groups. One group consists of cardiovascular and other conditions that could influence PCI outcomes directly, and one consists of other comorbid conditions. We therefore constructed binary variables to control for unstable angina, acute myocardial infarction (AMI), previous history of AMI, and diabetes mellitus. These conditions and the variable, stent, are given a value of 1 for patients who exhibit the comorbidity or receive a stent during their hospitalization. Categorizing each patient on a scale ranging from 1 to 4, using the all-patient refined (APR) diagnosis-related group severity index, accounts for the other comorbid conditions.<sup>26</sup>

The regression also controls for a variety of hospital characteristics. For example, regional differences in LOS may exist. Thus, we assign midwest and west as the base and northeast and south as dummy variables that are coded 1 for hospitals located, respectively, in the northeastern and southern regions of the country. Each hospital also is characterized by the annual number of angioplasties performed in it.

Finally, equation (2) contains an indicator variable for whether a patient receives abciximab. This variable,  $Y_1$ , is an independent variable that allows for a direct examination of the impact of administering abciximab on hospital LOS.

... RESULTS ...

The unadjusted mean LOS for all patients (MCO and non-MCO) was 4.3 days (SD, 3.5 days); the

median LOS was 2 days (25th percentile, 2 days; 75th percentile, 6 days). The typical angioplasty patient in this study was a white man with an average age of 62 years. A relatively large percentage of patients were admitted to the hospital via the ED (40.0%), diagnosed with AMI (35.9%) or unstable angina (40.8%), or given a stent during their initial hospitalization (37.9%). In addition, patients in the dataset were more likely to live in the southern or midwestern regions than in the northeastern or western ones.

**Table 1.** Patient and Hospital Mean Characteristics, Categorized by Insurance

	MCO Mean ± SD	Non-MCO Mean ± SD	Difference (P)
<b>Sample size</b>	1847	11,537	
<b>Patient demographics</b>			
Age (y)	55.1 ± 9.0	63.2 ± 11.9	-8.1 ( $<0.001$ )
Female (%)	23.2 ± 42.2	33.7 ± 47.3	-10.5 ( $<0.001$ )
Minority (%)	8.0 ± 27.2	7.2 ± 25.9	-0.8 (0.119)
<b>Admitted via ED (%)</b>	35.8 ± 48.0	40.3 ± 49.0	-4.5 ( $<0.001$ )
<b>Health conditions</b>			
AMI (%)	38.8 ± 48.7	35.4 ± 47.8	3.4 (0.003)
Previous history of AMI	12.1 ± 32.7	14.4 ± 35.1	-2.3 (0.003)
Unstable angina (%)	37.4 ± 48.4	41.4 ± 49.3	-4.0 ( $<0.001$ )
Stent (%)	41.0 ± 49.2	37.4 ± 37.4	3.6 (0.002)
Diabetes (%)	18.1 ± 38.5	20.1 ± 40.1	-2.0 (0.020)
APR severity index	1.6 ± 0.8	1.7 ± 0.8	-0.1 ( $<0.001$ )
<b>Hospital characteristics</b>			
Northeast (%)	12.5 ± 33.0	9.1 ± 28.8	3.4 ( $<0.001$ )
South (%)	54.0 ± 49.9	58.1 ± 49.3	-4.1 ( $<0.001$ )
West (%)	0.2 ± 4.6	4.8 ± 21.4	-4.6 ( $<0.001$ )
Midwest (%)	33.4 ± 47.2	28.0 ± 44.9	5.4 ( $<0.001$ )
Angioplasties per year (n)	389.5 ± 204.6	437.3 ± 210.4	-47.8 ( $<0.001$ )
<b>LOS</b>	3.9 ± 3.1	4.4 ± 3.5	-0.5 ( $<0.001$ )
<b>Received abciximab (%)</b>	16.8 ± 3.7	14.6 ± 35.3	2.2 (0.009)

AMI = acute myocardial infarction; APR = all-patient refined; ED = emergency department; LOS = length of stay; MCO = managed care organization.

**Table 1** presents the unadjusted patient and hospital characteristics, classified according to whether patients were insured by an MCO or by a non-MCO, and **Table 2** reports the data classified according to whether the patients received abciximab. Statistically significant differences were determined by using *t*-statistics or *z*-statistics for differences in means or

differences in proportions, respectively. The results shown in Table 1 indicate that, compared with non-MCO patients, patients insured by an MCO are younger, are more likely to be male, and have a hospital LOS that is an average of 0.5 days shorter. Table 2 reveals that patients who receive abciximab are significantly more likely to be diagnosed with

**Table 2.** Patient and Hospital Mean Characteristics, Categorized by Drug Treatment

	Abciximab Mean ± SD	No Abciximab Mean ± SD	Difference ( <i>P</i> )
<b>Sample Size</b>	1991	11,393	—
<b>Patient Demographics</b>			
Age (y)	61.2 ± 11.8	62.2 ± 11.8	-1.0 ( <i>&lt;</i> 0.001)
Female (%)	27.8 ± 44.8	33.0 ± 47.0	-5.2 ( <i>&lt;</i> 0.001)
Minority (%)	5.6 ± 22.9	7.7 ± 26.6	-2.1 ( <i>&lt;</i> 0.001)
<b>Admitted via ED (%)</b>	45.0 ± 49.8	38.7 ± 48.7	6.3 ( <i>&lt;</i> 0.001)
<b>Health Conditions</b>			
AMI (%)	56.3 ± 49.6	32.3 ± 46.8	24.0 ( <i>&lt;</i> 0.001)
Previous history of AMI (%)	11.3 ± 31.6	14.5 ± 35.3	-3.2 ( <i>&lt;</i> 0.001)
Unstable angina (%)	31.5 ± 46.4	42.5 ± 49.4	-11.0 ( <i>&lt;</i> 0.001)
Stent (%)	46.9 ± 49.9	36.3 ± 48.1	10.6 ( <i>&lt;</i> 0.001)
Diabetes (%)	19.3 ± 39.5	19.9 ± 40.0	-0.6 (0.267)
APR severity index	1.8 ± 0.9	1.7 ± 0.8	0.1 ( <i>&lt;</i> 0.001)
<b>Hospital Characteristics</b>			
Northeast (%)	2.0 ± 14.0	10.9 ± 31.2	-8.9 ( <i>&lt;</i> 0.001)
South (%)	49.3 ± 50.0	59.0 ± 49.2	-9.7 ( <i>&lt;</i> 0.001)
West (%)	4.3 ± 20.3	4.1 ± 19.9	0.2 (0.341)
Midwest (%)	44.4 ± 49.7	26.0 ± 43.9	41.8 ( <i>&lt;</i> 0.001)
Angioplasties per year (n)	453.9 ± 193.9	426.7 ± 212.7	27.2 (0.001)
<b>LOS</b>	4.9 ± 3.4	4.2 ± 3.5	0.7 ( <i>&lt;</i> 0.001)

AMI = acute myocardial infarction; APR = all-patient refined; ED = emergency department; LOS = length of stay.

AMI, given a stent, admitted via the ED, or treated at a hospital that performs a relatively large number of angioplasties. Abciximab patients also are significantly less likely to be diagnosed as having unstable angina or to be treated in northeastern or southern hospitals.

Because the unadjusted data indicate that patients who receive abciximab are generally in poorer health than those who do not receive this agent, we used a 2-stage sample selection model to control for differences across patients. The results are presented in **Table 3**. The factors associated with abciximab selection are considered in the first stage of the model. The model examines the likelihood that a patient will receive abciximab while controlling for a wide range of factors that may influence that decision. Specifically, the marginal effect is calculated as the effect of a change in an independent variable on the probability that a patient receives abciximab.

The first column of Table 3 reveals that health and geographic factors have the largest impact on abciximab use in MCO patients. For example, patients with a coexisting AMI have the highest likelihood of receiving abciximab (17.61%). In addition, receiving a stent results in a 7.17% higher probability of abciximab receipt, and a diagnosis of unstable angina increases the likelihood of receipt by 5.25%. The geographic region in which the angioplasty is performed also has a relatively large effect on the likelihood of receiving abciximab, with patients from the southern region 7.85% less likely to receive abciximab and those from the northeastern region 24.17% less likely.

A comparison of the first and second columns of Table 3 reveals many similarities between MCO and non-MCO patients. As with their MCO counterparts, the probability that non-MCO patients will receive abciximab increases if the patients have a coexisting AMI (12.47% increased probability), receive a stent (4.92%), or are given a diagnosis of unstable angina (3.75%). In addition, non-MCO patients whose PCI is performed in a northeastern hospital or southern hospital have significantly lower probabilities of receiving abciximab (-25.51% and -7.35%, respectively). In contrast to patients insured by MCOs, female and minority patients who are *not* enrolled in MCOs are significantly less likely to receive abciximab. Specifically, after controlling for health, admission, and hospital characteristics, female patients and minority patients are, respectively, 2.74% and 3.14% less likely to receive this agent.

The third and fourth columns of Table 3 present the results of the second-stage estimation for the

MCO and non-MCO populations, respectively. In these negative binomial regressions, the coefficients measure the number of days by which each independent variable changes hospital LOS. Given that LOS is measured by increments of 1 day, the coefficients can be interpreted in terms of increases or decreases in the number of hospital days per 100 patients. Patients who receive abciximab have a significantly shorter LOS, regardless of subpopulation group (MCO or non-MCO). Specifically, abciximab receipt by MCO patients is associated with an average of 66 fewer days in the hospital per 100 patients. In the non-MCO population, it is associated with 87 fewer hospital days per 100 patients.

A comparison of the third and fourth columns indicates that the results generally are quite similar for both subpopulations. In both groups, female and minority patients have significantly longer LOSs, as do patients admitted via the ED. Patients in relatively poorer health also have significantly longer LOSs, with AMI, unstable angina, and a higher APR severity index score all leading to significantly longer LOSs. A diagnosis of AMI has the largest impact on a patient's LOS. Patients who are insured by an MCO and are diagnosed as having an AMI stay 59 days longer per 100 patients; patients who are not insured by an MCO and receive this diagnosis stay an average of 54 days longer per 100 patients.

The LOS regression also revealed small, but statistically significant, regional differences. On average, for a sample of 100 southern MCO patients, the regression results suggest that the patients spend 10 fewer days in the hospital relative to MCO patients from the western or midwestern regions. Finally, the sample selection adjustment variable,  $\lambda$ , is positive and statistically significant for both MCO and non-MCO patients, reflecting the nonrandom utilization of abciximab in these observational data and supporting the necessity of a 2-stage sample selection model.

... DISCUSSION ...

In the multivariate analysis, the first-stage regression demonstrates that, for patients whose primary insurance is not an MCO, women and minorities are significantly less likely than white men to receive abciximab. This result is consistent with research that has reported underutilization of cardiac procedures for women<sup>27-29</sup> and minorities.<sup>30-33</sup> (These studies did not focus on methods of payment.) In contrast to these results in the non-MCO population,

**Table 3.** First- and Second-Stage Regression Results

Variable	First-Stage Regression Marginal Effects Dependent Variable: Abciximab*		Second-Stage Regression Coefficients Dependent Variable: LOS*	
	MCO	Non-MCO	MCO	Non-MCO
Constant	—	—	0.52 (0.31; 0.72)	0.40 (0.32; 0.47)
Age	-0.13 (-0.31; 0.06)	-0.05 (-0.10; 0.01)	0.0003 (-0.002; 0.004)	0.003 (0.002; 0.004)
Female	-0.77 (-0.59; 3.05)	-2.74 (-4.06; -1.40)	0.08 (0.02; 0.14)	0.04 (0.02; 0.07)
Minority	-1.13 (-7.11; 4.84)	-3.14 (-5.67; -0.62)	0.16 (0.06; 0.25)	0.11 (0.07; 0.15)
ED	4.15 (0.77; 7.53)	0.89 (-0.37; 2.15)	0.28 (0.21; 0.34)	0.21 (0.19; 0.23)
Previous AMI	-4.09 (-9.67; 1.49)	-0.30 (-2.12; 1.51)	-0.04 (-0.13; 0.05)	0.05 (0.02; 0.08)
AMI	17.61 (12.81; 22.42)	12.47 (10.67; 14.27)	0.59 (0.47; 0.72)	0.54 (0.50; 0.58)
Unstable angina	5.25 (0.35; 10.14)	3.75 (1.99; 5.52)	0.18 (0.10; 0.26)	0.19 (0.16; 0.22)
Stent	7.17 (3.99; 10.36)	4.92 (3.70; 6.14)	0.20 (0.13; 0.27)	0.18 (0.15; 0.20)
Diabetes	0.48 (-3.70; 4.67)	0.17 (-1.37; 1.72)	-0.03 (-0.09; 0.03)	0.01 (-0.01; 0.04)
APR severity	1.06 (-1.02; 3.15)	1.55 (0.77; 2.32)	0.27 (0.24; 0.30)	0.32 (0.30; 0.33)
South	-7.85 (-11.13; -4.56)	-7.35 (-8.60; -6.10)	-0.10 (-0.18; -0.02)	-0.13 (-0.16; -0.09)
Northeast	-24.17 (-1.00; -17.33)	-25.51 (-28.91; -22.11)	-0.01 (-0.15; 0.13)	-0.07 (-0.14; -0.01)
Number of angioplasties per year	0.02 (0.01; 0.03)	0.01 (0.008; 0.015)	-0.00007 (-0.0002; 0.0001)	0.00002 (-0.00003; 0.00007)
Abciximab	—	—	-0.66 (-1.19; -0.13)	-0.87 (-1.13; -0.61)
$\lambda$	—	—	0.41 (0.11; 0.71)	0.49 (0.35; 0.64)
Chi-squared statistic <sup>†</sup>	219.27	807.01	160.39	2002.00
Sample size	1847	11,537	1847	11,537

AMI = acute myocardial infarction; APR = all-patient refined; ED = emergency department; LOS = length of stay; MCO = managed care organization.

\*95% confidence intervals given in parentheses.

<sup>†</sup>The chi-squared statistic examines the hypothesis that the slopes are jointly equal to 0.

female and minority patients enrolled in MCOs are as likely as white, male patients to receive abciximab, suggesting that MCOs may perform relatively better than other insurance types at providing equal access to care for women and minorities. In light of decreasing public confidence in MCOs,<sup>34</sup> this finding has important implications with respect to access to care and public perceptions of MCOs.

The finding that patients who were diagnosed as having an AMI were significantly more likely to receive abciximab is consistent with studies that initially recommended this agent for high-risk patients undergoing angioplasty.<sup>5,6</sup> It suggests that physicians generally were using abciximab as initially recommended. The finding of regional differences in the likelihood of receiving abciximab is also consistent with research on regional differences in cardiac procedure and treatment rates.<sup>28,35,36</sup> Given that reductions in deaths and myocardial infarctions have been associated with abciximab,<sup>6-8</sup> and that abciximab patients in this study had relatively shorter LOSs, these regional differences may have a significant impact on patient outcomes.

The LOS regression shows a statistically significant reduction in hospital LOS for angioplasty patients who are given abciximab, after controlling for observed and unobserved differences across patients. The finding of a statistically significant shorter LOS for patients who are administered abciximab relative to patients who are not administered it is generally consistent with research demonstrating reductions in acute ischemic and thrombotic complications in patients who are given abciximab.<sup>33-39</sup> These reductions should lead naturally to shorter LOSs. In addition, the finding of decreased LOS for abciximab patients supports the research that has reported favorable cost-effectiveness ratios for patients who undergo PCI and receive abciximab.<sup>40,41</sup>

This study uses data from a naturalistic setting. Its “real-world” analysis may yield results that are more generalizable than are inferences drawn from regulated behaviors in a clinical trial. In addition, the estimation model explicitly controls for sample selection bias stemming from factors correlated with both treatment selection and LOS. Some researchers have argued that the danger of sample selection bias is the most central concern when using observational datasets to compare outcomes across patients who are given different treatments.<sup>42</sup> In our analysis, a sample selection model was estimated to control for the possibility of such bias. The adjustment factor,  $\lambda$ , was positive and significant for

the MCO and the non-MCO populations. This result supports the use of a 2-stage model and implies that the parameter estimates for the remaining variables would have been biased upward if the effects of these unobserved characteristics had not been controlled for in the model. As a result, the impact of independent variables on hospital LOS would have been overestimated.

The study findings should be interpreted in the context of the limitations of the study design. First, although the data represent 87 hospitals across the United States, the hospitals were not randomly selected, so that it may not be possible to extrapolate the sample to the country as a whole. In addition, there may be potential bias attributable to the fact that the HCIA database contains only hospitals that agreed to share their data. Second, we limited the analysis to patients whose primary procedure was a PCI. Although this restriction has the advantage of producing a relatively homogeneous sample, it does not allow for an examination of all patients who receive abciximab. Third, this study was unable to assess a patient’s risk of bleeding even though this risk potentially could affect a physician’s decision to administer abciximab. Fourth, given the nature of the dataset, we are unable to provide any information about the policies of the managed care plans included in the analysis. Fifth, the method of analysis may overestimate the small area variations in hospital rates.<sup>43</sup> Finally, as with any empirical study, sample selection models do not control for all biases.

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... CONCLUSION ...

This paper presents an examination of “real-world” utilization of abciximab and its impact on MCO patients’ and non-MCO patients’ hospital LOSs. In our study, after controlling for observed factors (ie, demographic, admission, and hospital characteristics and health conditions) and unobserved factors, female and minority patients in the MCO population are as likely as white, male patients in that population to receive abciximab. This result suggests that MCOs may perform relatively better at providing equal access to care for women and minorities than do other types of insurance. Furthermore, regardless of insurance type, patients who are given abciximab have a significantly shorter LOS relative to patients who do not receive abciximab. When considered in combination with the favorable outcomes and long-term cost offsets reported in previous research for abciximab



patients,<sup>6-8,41,44,45</sup> this finding suggests that abciximab administration appears to offer short-term and long-term benefits. Future research should examine the robustness of the promising results demonstrated here.

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