Changes in Rates of Beta-blocker Use in Community Hospital Patients with Acute Myocardial Infarction

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OBJECTIVE: To examine changes in the rate of beta-blocker (BB) use at admission, in hospital, and at discharge between 1994 and 1995 (MICH I) and 1997 (MICH II) in patients with acute myocardial infarction (AMI).

DESIGN: Comparison of two prospectively enrolled cohorts.

SETTING: Five mid-Michigan community hospitals.

PATIENTS: We studied 287 MICH I patients and 121 MICH II patients with AMI who had no contraindications to BB use from cohorts of consecutively admitted cases of AMI (814 in MICH I; 500 in MICH II).

RESULTS: Prescription of BBs to ideal patients with AMI increased in patients with previous history of myocardial infarction on arrival at the hospital (12.5% vs 36.0%; $P = .01$), in hospital (47.0% vs 76%; $P < .01$), and at discharge (34.0% vs 61.9%; $P < .01$). Neither race nor gender was a predictor of BB use. Younger age predicted BB prescription at discharge (odds ratio [OR], 2.07; 95% confidence interval [CI], 1.32 to 3.23). Later study cohort was the most important predictor of BB use in hospital (OR, 3.4; 95% CI, 2.09 to 5.25).

CONCLUSION: BB use improved dramatically over the study period, but additional work is needed to improve use of BB after discharge and among elderly patients with AMI.

KEY WORDS: myocardial infarction; beta-blockers; secondary prevention; quality of care; drug utilization.
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Studies have demonstrated that beta-blocker (BB) use in acute myocardial infarction (AMI) decreases both early and late cardiovascular mortality and reinfarction and increases survival by 20% to 40%.¹⁻⁶ Meta-analyses of AMI trials further showed that long-term administration of BBs led to a reduction of 25% in cardiac deaths, 26% in reinfarction rate, and 30% in risk of sudden death.⁷ Despite this overwhelming evidence supporting the use of BBs following AMI, there still exists a large variation across geography, physician type, and patient type regarding the use of BBs following AMI.^{8,9}

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In a previous study of 5 mid-Michigan community hospitals from January 1994 to April 1995, our group, the Michigan State University Inter-Institutional Collaborative Heart (MICH I) Study Group, found underutilization of BBs in patients admitted with AMI. Among patients with AMI without any contraindications, only 12.5% with a history of previous AMI were on a BB at the time of admission. While in hospital, 47% received a BB and only 34% were discharged on a BB.¹⁰

Since then, several initiatives, including performance feedback to hospitals by the Michigan Peer Review Organization (MPRO), have been instituted to improve the quality of care and the use of evidence-based medications following AMI. Furthermore, BB use has been adopted as a Health Employer Data Information System (HEDIS) quality measure, a U.S. performance measure for managed care organizations. In a study of a second cohort from the same 5 community hospitals from February to September 1997 (MICH II), we looked at the trend in the use of BBs for AMI.

Our current objective was to assess whether the rate of BB prescription for AMI on admission, in hospital, and at discharge increased over the 3-year period in our study hospitals. We also assessed predictors of BB prescription.

METHODS

Study Setting

We conducted the study in 5 private teaching hospitals in 2 mid-Michigan, urban communities with bed size ranging from 268 to 495. All the hospitals were staffed with cardiologists, primary care physicians, and resident physicians in training and were all certified to offer cardiac catheterization and cardiac surgery.

Study Population

The MICH Study is a hospital-based study of management and outcomes following AMI. Details of our methods have been described.^{11,12} Trained study research nurses screened the daily computerized list of patients, ward logs, and medical records to identify patients who met the entry criteria. The entry criteria were either: 1) typical symptoms of AMI plus elevated cardiac enzymes, defined as elevation of creatinine kinase isoenzymes (CK-MB) fraction more than 1.2 times the upper limit of normal within 48 hours

Table 1. Characteristics of Ideal Beta-blocker Candidates in the 1994 to 1995 (MICH I) and 1997 (MICH II) Cohorts of Patients with Acute Myocardial Infarction in Five Michigan Community Hospitals

Characteristic	MICH I N = 287 n (%)	MICH II N = 121 n (%)	P Value
Age at MI, y			
<45	48 (16.7)	18 (14.9)	.23
45 to 54	56 (19.5)	29 (24.0)	
55 to 64	64 (22.3)	24 (19.8)	
65 to 74	73 (25.4)	22 (18.2)	
≥75	46 (16.0)	28 (23.1)	
Gender			
Female	103 (35.9)	53 (43.8)	.13
Male	184 (64.1)	68 (56.2)	
Race			
White	234 (81.5)	97 (80.2)	.4
Black	49 (17.1)	20 (16.5)	
Others	4 (1.4)	4 (3.3)	
Primary insurance coverage			
Employer/private	133 (46.3)	56 (46.3)	.9
Medicare	127 (44.3)	51 (42.1)	
Medicaid	12 (4.2)	6 (5.0)	
Self-payment or no insurance	15 (5.2)	8 (6.6)	
More than 10-day stay in hospital	90 (31.4)	27 (22.3)	.06
Comorbid conditions			
Hypertension	151 (52.6)	65 (53.7)	.83
Diabetes mellitus	68 (23.7)	31 (25.6)	.67
Renal disease	4 (1.4)	3 (2.5)	.44
Previous MI	64 (22.3)	25 (20.7)	.71
Treatments and procedures			
Thrombolytic therapy	146 (50.9)	38 (31.4)	<.01
Percutaneous transluminal coronary arteriography	100 (34.8)	44 (36.4)	
Coronary artery bypass graft	51 (17.8)	18 (14.9)	.47
Cardiac catheterization	90 (31.4)	27 (22.3)	.06

MI, myocardial infarction.

of onset of symptoms or acute event or elevation of aspartate aminotransferase or lactate dehydrogenase more than two times the upper limit of normal within 72 hours of onset of symptoms or acute event, or 2) electrocardiographic (ECG) findings of AMI. The typed chart ECG interpretation had to state "acute myocardial infarction." Study cardiologists read the ECGs of patients who did not meet the enzyme criteria to decide eligibility for inclusion. Table 1 lists the demographic characteristics of our ideal BB candidates.

In MICH I, all eligible patients prospectively identified with AMI between January 1994 and April 1995 in our hospitals (N = 814) were enrolled. Another cohort of 500 patients with AMI was enrolled in the same hospitals between February and September 1997 in MICH II. Institutional review boards of Michigan State University and all participating hospitals approved the study, and all subjects provided written informed consent.

For this analysis we focused on a cohort of ideal candidates for BB therapy, who were admitted directly to these hospitals. We determined BB use at 3 points in time: prehospital, in-hospital, and discharge. To determine prehospital BB use, we included only the ideal candidates with a previous history of AMI. This allowed us to evaluate the use of BBs for secondary prevention. The in-hospital cohort consisted of all ideal BB candidates in the study. We determined the number of ideal BB candidates given a BB in hospital. We also determined the prescription of BBs to ideal candidates at discharge.

Definition of Indisputable Ideal Candidates

Our list of contraindications to BB use in AMI contained all possible contraindications indicated in the literature: chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF; chest X-ray evidence of CHF, pulmonary vascular congestion, cephalization, pulmonary edema, or Kerley B lines), left ventricular ejection fraction (LVEF) <35% by radionuclide scan or echocardiogram, complete heart block, pulse <60 beats per minute at any time during this hospitalization, and use of an intra-aortic balloon pump or pressors for hypotension. Studies have subsequently shown that BBs improve outcomes in patients after AMI who have left ventricular dysfunction.¹³ Because this was not common knowledge at the time of our study, we excluded patients with evidence of CHF from our analysis. Similarly, we used COPD as a contraindication to BB use, because many physicians at the time of our study believed (probably incorrectly) that COPD was a contraindication, and we wanted to limit our population to those BB candidates who all readers would agree should have been treated. Patients were therefore designated ideal BB candidates if they had no contraindication to the use of a BB. Tables 2 and 3 list the number of patients who had each of the contraindications and the number of patients with one or more contraindications.

Table 2. Exclusion Criteria for Beta-blocker Use in MICH I and MICH II Study Patients*

Exclusion Characteristic	MICH I N = 814 n (%)	MICH II N = 500 n (%)	P Value
Congestive heart failure [†]	257 (31.6)	258 (51.6)	<.01
Developed hypotension requiring intervention	242 (29.7)	165 (33.0)	.21
Pulse rate less than 60	157 (19.3)	51 (10.2)	<.01
History of COPD	90 (11.1)	95 (19.0)	<.01
Needed intra-aortic balloon pump	41 (5.0)	41 (8.2)	.02
Complete heart block	37 (4.5)	24 (4.8)	.8
Left ventricular ejection fraction less than 35%	84 (10.3)	45 (9.0)	.44

* Several patients had more than one contraindication.

[†] Includes patients with X-ray evidence of congestive heart failure. COPD, chronic obstructive pulmonary disease.

Table 3. Patients with Exact Number of Exclusion Characteristics

Number of Exclusion Characteristics	MICH I N = 814 n (%)	MICH II N = 500 n (%)	P Value
1	265 (32.6)	190 (38.0)	.04
2	172 (21.1)	108 (21.6)	.8
3	66 (8.1)	55 (11.0)	.07
4	19 (2.3)	23 (4.6)	.02
5+	5 (0.6)	3 (0.6)	.7

Chart Abstraction

Trained research assistants reviewed the charts of all patients enrolled in the study. The data collected included date of the AMI, demographic characteristics, symptoms, results of diagnostic ECGs, relevant laboratory values, diagnostic tests, treatments, and date of discharge or death.

Each patient's medical record, including discharge summary and discharge instructions, was also searched for prehospital, in-hospital, and discharge medications. All medications recorded were later reviewed to determine whether a BB had been prescribed.

Intrarater and interrater reliability were determined by reabstracting medication use in 85 charts. Abstraction/reabstraction agreement for prehospital, in-hospital, and discharge was 94% ($\kappa = .636$).

Statistical Analysis

Analysis was performed with the Statistical Package for Social Sciences (SPSS version 11, SPSS, Inc., Chicago, Ill). All summary descriptive statistics are expressed as proportions or means with standard deviations, as appropriate. The proportions of patients prescribed BBs prehospital, in hospital, and at discharge are reported as percentages. Logistic regression analysis was performed to determine whether the age of the patient at the time of AMI, phase of the study (MICH I/MICH II), gender, race, diabetes mellitus, or hypertension were associated with BB use. The relation of each variable to BB use, controlling for the presence of other variables, was examined with logistic regression modeling. The strength of the associations was reported as odds ratios along with the 95% confidence interval. The rates of BB use prehospital, in hospital, and at discharge during the MICH II study was compared to their use in the MICH I study.

RESULTS

The MICH I cohort (1994 to 1995) enrolled 814 patients with AMI, while the MICH II cohort (1997) enrolled 500 individuals from the same hospitals. Because of one or more contraindications to BB therapy, 527 patients were excluded from the MICH I cohort. This left 287 ideal candidates for BB therapy. In MICH II, 379 patients were excluded for the same reasons. This left 121 ideal BB candidates in MICH II.

In MICH I and MICH II, 35.3% versus 24.8% were ideal BB candidates, respectively ($P < .05$). The difference between MICH I and MICH II was not due to differences in accuracy of documentation of contraindications, because we had the same trained chart abstractors for both studies. Compared to the MICH I cohort, the MICH II cohort had more patients with CHF and COPD, and more patients needing an intra-aortic balloon pump (see Table 2). These patients were excluded from our analysis.

Table 1 presents selected characteristics of ideal BB candidates for both MICH I and MICH II. In age and gender, our patients were typical of AMI patients seen in other studies. MICH II had more women (43.8% vs 35.9%), while MICH I had more blacks (17.1% vs 16.5%). Neither of these differences was statistically significant. The racial distribution broadly reflected that of the underlying population of the two communities as enumerated in the 1990 Census.

Beta-blocker Use

In MICH I, among the 287 ideal BB candidates, 64 had a history of a previous AMI. Of these, 8 (12.5%) were on a BB at the time of arrival (Table 4). During hospitalization, 135 (47.0%) of the 287 were prescribed a BB. Two ideal BB candidates died during the hospitalization. At discharge, only 97 (34.0%) of the 285 ideal candidates were prescribed a BB. The proportion of patients prescribed a BB in hospital and at discharge differed by 13%.

In MICH II, among the 121 ideal candidates, 25 had a history of a previous AMI. Of these, 9 (36.0%) were on a BB at the time of arrival (Table 4). This showed a 23.5% improvement in use of BBs for secondary prevention in MICH II ($P = .01$). During hospitalization, 92 (76.0%) of the 121 were prescribed a BB. This represents a 29.0% improvement in MICH II ($P < .01$). Three ideal BB candidates died during hospitalization in the MICH II study. At discharge, 73 (61.9%) of the 118 ideal candidates were prescribed a BB. This again represents a significant improvement

Table 4. Comparison of Proportions of Patients Receiving Beta-blocker Medication at Various Stages During Their Hospital Stay

Stage of Hospital Stay	Patients on Beta-blocker		P Value
	MICH I	MICH II	
Already on beta-blocker at arrival (with a previous myocardial infarction) (%)	8/64 (12.5)	9/25 (36.0)	.01
During the hospital stay (%)	135/287 (47.0)	92/121 (76.0)	<.01
Discharged on a beta-blocker (%) (Excludes hospital deaths)	97/285 (34.0)	73/118 (61.9)	<.01

Table 5. Odds Ratios for Receipt of Beta-blocker Therapy from Logistic Model

Characteristics	Adjusted Odds Ratio	95% Confidence Interval
At arrival in hospital		
Age 55 years or less	0.82	0.19 to 3.59
Phase 2	4.61	1.24 to 17.09
White race	0.55	0.105 to 2.96
Female gender	0.97	0.28 to 3.35
Diabetes mellitus	1.42	0.31 to 6.36
Hypertension	0.44	0.11 to 1.73
During the hospital stay		
Age 55 years or less	1.53	0.98 to 2.38
Phase 2	3.40	2.09 to 5.52
White race	1.44	0.82 to 2.53
Female gender	1.30	0.83 to 2.01
Diabetes mellitus	0.90	0.54 to 1.48
Hypertension	1.32	0.86 to 2.03
At discharge from the hospital		
Age 55 years or less	2.07	1.32 to 3.23
Phase 2	2.97	1.87 to 4.71
White race	1.22	0.69 to 2.17
Female gender	1.23	0.79 to 1.93
Diabetes mellitus	0.84	0.50 to 1.41
Hypertension	1.67	1.07 to 2.60

(27.9%) from the MICH I study ($P < .01$). The proportion of patients prescribed a BB in hospital and at discharge in MICH II differed by 14.1% (Table 4). Our studies showed that ideal candidates were more likely than other study patients with at least one contraindication to be prescribed a BB during hospitalization and at discharge in MICH I (47% vs 35.1%; 34.0% vs 22.1%; $P < .01$, respectively) and MICH II (76.0% vs 55.7%; 61.9% vs 38.6%; $P < .01$).

Using multivariable logistic regression analysis, we looked for possible associations between various patient characteristics and the use of BBs (Table 5). On arrival, no significant association was found between the use of BBs and age, race, gender, diabetes mellitus, or hypertension among patients with previous AMI (Table 5). The findings were similar during hospitalization. At discharge, no significant association was found between the use of BBs and gender, race, or diabetes mellitus. However, hypertensive patients were more likely to be prescribed a BB (odds ratio [OR], 1.67; 95% confidence interval [CI], 1.07 to 2.60), while older age had an inverse relation with the prescription of BBs at the time of discharge. Among ideal BB candidates, patients prescribed a BB at discharge were more likely to be younger (≤ 55 years old; OR, 2.07; 95% CI, 1.32 to 3.23). Analysis further revealed that being a MICH II candidate was associated with increased odds of being prescribed a BB at arrival in hospital, during hospitalization, and at discharge (Table 5).

DISCUSSION

Despite overwhelming evidence from several randomized controlled trials that BB therapy for AMI decreases

both early and late cardiovascular mortality and reinfarction and increases survival by 20% to 40%, studies have repeatedly demonstrated wide variations and underuse of BBs.^{1,9,14-22} As seen in previous studies by other investigators,²³⁻²⁷ our group, the Michigan State University Inter-Institutional Collaborative Heart (MICH) Study Group, from January 1994 to April 1995, found underutilization of BBs in patients following AMI in 5 mid-Michigan community hospitals.¹⁰ The results of our MICH II study (February to September 1997) showed a 23.5% improvement in use of BBs among patients with a previous history of AMI on arrival at the hospital (12.5% vs 36.0%; $P = .01$), a 29.0% increase in the prescription of BBs to ideal patients with AMI in hospital (47.0% vs 76.0%; $P < .01$), and a 27.9% increase at discharge (34.0% vs 61.9%; $P < .01$), consistent with findings by some other investigators.^{27,28} Having more female patients in MICH II is unlikely to account for increase in use of BBs, because this group has consistently been found to be undertreated.

The increase in prescription of BBs prehospital, in hospital, and at discharge is most likely the result of many quality improvement measures that occurred between the study periods. Regional and national quality improvement initiatives were directed at improving the quality of care and the use of appropriate evidence-based treatment of AMI in these hospitals. The Michigan Peer Review Organization (MPRO) continued its focus on improving the quality of health care for Medicare beneficiaries with AMI and other cardiovascular illnesses between the study periods. Data abstraction and data feedback were part of AMI and heart failure projects for those hospitals collaborating with the MPRO. All 5 hospitals that participated in our studies participated in MPRO quality improvement feedback before and during the MICH II study period. The MPRO provided feedback to each of the hospitals on these data between the dates of MICH I and MICH II. The hospitals probably gave their physicians feedback on this aggregate data. The MPRO study was part of a national study looking at quality of care for Medicare patients with AMI, which was published in *JAMA* in 1995.¹⁶ In addition, following the MICH I study period, the MICH investigators presented the results showing gross underutilization of BBs to physicians in the participating hospitals who attended a continuing medical education (CME) session. One of the cardiologists in one of the hospitals was a collaborator in the MICH I and MICH II study. Furthermore, the publications of clinical trials and widely disseminated clinical guidelines for management of patients with AMI by the American College of Cardiology/American Heart Association (ACC/AHA) in 1996 recommended increased BB use.²⁹ The use of credible data feedback has been identified as one intervention that has led to greater improvements in BB use over time.²⁸ Although we demonstrated an increase of 23.5% in the use of BBs among patients with a previous history of AMI, 29.0% increase in in-hospital use, and a 27.9% improvement in use at discharge, with our very stringent eligibility criteria, all patients we designated ideal BB candidates, with no single contraindication, should have been on a BB.

Our studies also revealed a decrease in the proportion of patients given BBs in hospital and at discharge. Patients given a BB during hospitalization but not at discharge can potentially be targeted for improved discharge BB prescription. Given the reliability of our chart abstraction it is unlikely that misclassification of discharge BB status could account for the difference. Although there may have been legitimate reasons for discontinuation, such as drug intolerance, it is possible that this was a simple oversight. Systematic measures that ensure the appropriate continuation of medications prescribed during hospitalization may improve discharge utilization rates of this and other important AMI medications.

The finding of only 12.5% of patients with a history of previous AMI being on a BB on arrival at the hospital in MICH I and 36% in MICH II could be due to sample size, but it also suggests that many patients probably do not continue to use BBs after discharge, although a large proportion were likely to have been discharged on the medication. Perhaps lack of adequate knowledge regarding the benefits of BBs in the secondary prevention of AMI, side effects from the medication, or simple omission of the drug could have contributed to the low percentage of patients on BBs on arrival at the hospital. In addition, failure of the primary care physician to continue to prescribe this medication during outpatient visits could be another important factor. Provider characteristics, such as medical specialty, knowledge, attitudes, and beliefs, are possible predictors of BB use.^{9,30,31} Most initiatives to increase the use of BBs in patients with AMI have concentrated on programs designed for use in hospital and on discharge. Our results suggest that outpatient programs that will ensure the continued use of BBs post-AMI are urgently needed.

To identify predictors of BB use, we examined associations between various patient characteristics and the prescription of BBs. Similar to the findings of another investigator with a similar-sized cohort,¹⁸ logistic regression analysis did not suggest any association with race. But the small number of black patients did not provide adequate power to examine this question. Recent studies that have analyzed large Medicare data sets have documented racial disparities in BB prescription post-AMI at discharge.^{32,33} In our study, there was a trend toward more BB use in hospital and at discharge in white patients than in black patients, but our sample size was too small to show a statistically significant difference (in-hospital OR, 1.44; at discharge, 1.22). Whites with a previous history of AMI were less likely than blacks to be on a BB on admission, although this was not statistically significant (Table 5). The reason for this finding is not known, though a very small number of blacks had a previous history of AMI. No valid comparison can be made with this small cohort.

Our analysis showed that older age had an inverse relation to prescription of BBs at the time of discharge (OR, 2.07; 95% CI, 1.32 to 3.23). A similar trend was shown with in-hospital use (OR, 1.53; CI, 0.98 to 2.38), although this did not achieve statistical significance. Among ideal BB

candidates, those receiving a BB at discharge were more likely to be younger patients (<55 years; OR, 2.07; 95% CI, 1.32 to 3.23). Age was not a factor in BB use prehospital (OR, 0.82; 95% CI, 0.19 to 3.59).

Other studies have also revealed that BBs are underused in elderly AMI survivors, leading to measurable adverse outcomes including a 43% excess risk of 2-year mortality and a 20% increase in rates of rehospitalization for cardiovascular disease.^{9,19} It has been demonstrated that older patients have a greater absolute benefit when treated with a BB. Indeed, even among patients 80 years of age or older, mortality was 32% lower when BBs were prescribed.⁵ It is thus unfortunate that the elderly receive less BB treatment than younger patients. Studies have revealed that underutilization of BBs is attributed, in part, to fear of adverse effects, especially in the elderly and in patients with concomitant disorders such as diabetes mellitus or heart failure. However, studies have shown that such patients are precisely the ones who derive the greatest benefits from beta-blockade.⁵

The rate of use of BBs among patients who had contraindications to BB therapy by our criteria in MICH I (19% on admission, 35.1% in hospital, and 22.1% on discharge) and MICH II (21.5% on admission, 57% in hospital, and 39% on discharge) suggests that many physicians consider the potential benefits of these drugs to outweigh the risks.^{18,27} Benefits to use of BBs in diabetics have been documented.³⁴ Also, BBs has been shown not to worsen intermittent claudications in patients with peripheral vascular disease.³⁵ Furthermore, recent meta-analytic studies have shown that cardio-selective BBs do not produce clinically significant adverse respiratory effects in patients with mild to moderate reactive airway disease.³⁶ With the use of cardio-selective agents and through careful dosing and monitoring, the benefits of BBs after AMI appear to far outweigh the potential risks in most patients.

Limitations and Conclusions

The results of this study must be interpreted within its limitations. Defining the ideal study sample was a challenge. We chose to create an ideal group of BB candidates by using stringent criteria that excluded any patient with any known contraindications. However, this process ensured that all our ideal BB candidates needed to be on a BB without any doubt and boosted confidence in the validity of these data. The most important limitation of this study was its reliance on medical records whose possible inaccuracies and incompleteness may have led to misclassification of BB prescription prior to hospitalization. In addition, our ability to ascertain contraindications to BBs was also limited by the information that is documented in the chart. This limitation was reduced by the use of trained chart abstractors using standardized definitions with high reliability. The impact of these limitations is likely to be small and unlikely to account for underutilization.

Despite these limitations, this collaborative study of BB use in prospectively identified AMI patients in community

hospitals reflects the growing awareness of optimal care of patients with AMI and is likely to be representative of current use of BBs in similar community hospitals.²⁹

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