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Who is missing from the measures? Trends in the proportion and treatment of patients potentially excluded from publicly-reported quality measures

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Abstract

Background—The Centers for Medicare and Medicaid Services (CMS) provides public reporting on the quality of hospital care for patients with acute myocardial infarction (AMI). CMS Core Measures allow discretion in excluding patients because of relative contraindications to aspirin, beta-blockers and angiotensin converting enzyme inhibitors. We describe trends in the proportion of AMI patients with contraindications that could lead to discretionary exclusion from public reporting.

Methods—We completed cross-sectional analyses of three nationally-representative data cohorts of AMI admissions among Medicare patients in 1994–5 (n=170,928), 1998–9 (n=27,432), and 2000–2001 (n=27,300) from the national Medicare quality improvement projects. Patients were categorized as ineligible (e.g. transfer patients), automatically excluded (specified absolute medical contraindications), discretionarily excluded (potentially excluded based on relative contraindications), or 'ideal' for treatment for each measure.

Results—For 4 of 5 measures the percentage of discretionarily excluded patients increased over the three time periods (admission aspirin 15.8% to 16.9% and admission beta-blocker 14.3% to 18.3%, discharge aspirin 10.3% to 12.3%, and ACE-I 2.8% to 3.9%, p<.001). Of patients potentially included in measures (those who were not ineligible or automatically excluded), the discretionarily excluded represented 25.5 % to 69.2% in 2000–01. Treatment rates among patients with discretionary exclusions also increased for 4 of 5 measures (all except ACE-I).

Conclusions—A sizeable and growing proportion of AMI patients have relative contraindications to treatments that may result in discretionary exclusion from publicly-reported quality measures. These patients represent a large population for which there is insufficient evidence as to whether measure exclusion or inclusion and treatment represents best care.

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Background

The Centers for Medicare and Medicaid Services (CMS), in collaboration with the Hospital Quality Alliance, collects and disseminates quality measures for over 4000 US hospitals as a part of required reporting by hospitals for payment updates.[1–3] Through use of the Hospital Compare Web site, which provides public access to CMS Core Measures data, one may judge an individual hospital's performance on numerous quality metrics or directly compare institutions. Reported rates of compliance with the processes of care measured by CMS have improved over the past several years coinciding with public reporting of the measures.[4–6] Furthermore, given the continued and growing interest of payers and policymakers in linking healthcare payment to measures of quality, performance on Core Measures will likely become ever more critical to hospitals.[7]

Many Core Measures do not, however, assess care for all patients. Measures of processes of care for acute myocardial infarction (AMI), including the use of aspirin and beta-blockers at admission and at discharge and angiotensin converting enzyme inhibitors (ACE-I) or angiotensin receptor blockers (ARBs) for patients with low left ventricular systolic function, allow physicians considerable discretion in excluding patients from reported metrics in order to account for potential contraindications to measured treatments.[8] Prior work has shown that the overall prevalence of contraindications to AMI treatments is substantial and increasing over time.[6, 9] However, the only patients uniformly excluded from process of care measures are those with specified absolute contraindications to AMI treatments (e.g. medication allergies). Most potential contraindications do not lead to automatic exclusion from a measure; instead process of care measures allow for individualized discretionary exclusions based on documentation of the medical team's decision not to give the treatment, such as not giving a beta-blocker to an AMI patient with chronic obstructive pulmonary disease.[8] Differential use of these discretionary exclusions across hospitals may undermine the utility of these metrics for comparing quality of care across institutions. Despite this concern, the prevalence and trends in the proportion of patients with relative contraindications resulting in discretionary exclusion has not been characterized, because prior studies have not differentiated between the absolute contraindications that automatically result in exclusion versus the relative contraindications that may result in discretionary exclusions.

In order to assess the extent to which rates of relative contraindications and their resultant discretionary exclusions may affect interpretation of quality metrics, we determined trends in the proportion of patients with AMI in several time periods between 1994–2001 with characteristics that would lead to their inclusion, or potential exclusion from current publicly-reported quality measures, as well as trends in the treatment of these patients. Using chart-review data from three national Medicare quality improvement projects, we sought to describe trends in the proportion of Medicare patients presenting with AMI with a) specific exclusions to a given drug therapy ("automatic exclusions" group) b) those with relative medical contraindications ("discretionary exclusions" group), and c) those with no contraindications ("ideal candidates"), and to describe trends in the rates of treatment for each of these groups.

Methods

Data Source and Study Sample

The data for this study were from three Centers for Medicaid and Medicaid Services (CMS) quality improvement projects. The first, the Cooperative Cardiovascular Project (CCP), collected chart-reviewed data on all fee-for-service Medicare patients admitted with a diagnosis of AMI (based on ICD-9 codes) between February 1994 and July 1995

(n=234796).[10] The subsequent projects, the National Heart Care Project (NHC) and National Heart Care Remeasurement (NHC-R) collected data from April 1998 – March 1999 and October 2000 – June 2001 respectively. For the NHC and NHC-R, a systematic sample from each state based on age, race and hospital was used to obtain up to 850 representative discharges for AMI per state (n=35,713 for NHC and 35,407 for NHC-R). Details of these studies have been reported elsewhere.[10–15]

Patient characteristics and performance measurement were obtained from medical records reviewed by trained data abstractors using standardized software, with data quality assessed via random record review. Variable definitions relevant to this analysis were consistent across the three studies. All charts had the same data fields abstracted regardless of treatment decisions. The abstractors had high level of agreement on abstracted data.[11]

Patients with AMI were identified based on principal discharge ICD-9 codes for AMI (410.X0 or 410.x1). In each of the AMI quality improvement projects, the diagnosis of myocardial infarction was confirmed using a combination of laboratory and electrocardiographic data. We excluded patients whose AMI was not confirmed (31186 (13.3%) for CCP, 4255 (11.9%) for NHC, 3647 (10.3%) for NHC-R), patients less than 65 years old (17593 (7.5%) for CCP, 3009 (8.4%) for NHC, 3038 (8.5%) for NHC-R), and later AMI admissions for the same patient within the time period of data collection (27498 (11.7%) for CCP, 2125 (6.0%) for NHC, 2068 (5.8%) for NHC-R), as well as those patients for whom vital status or correct state code was undetermined (4 for CCP, 21 for NHC, 423 (1.2%) for NHC-R). 50,229 patients met one or more of the above criteria, leaving a final cohort of 255,660 patients (170,928 from CCP, 27,432 from NHC, and 27,300 from NHC-R).

Definition of candidacy for Performance Measures

We examined trends for 5 AMI quality measures: use of aspirin at admission, use of beta-blocker at admission, prescription of ACE-I at discharge for patients with left ventricular systolic dysfunction, prescription of aspirin at discharge, and prescription of beta-blocker at discharge. Drawing from the current CMS/Joint Commission (CMS/JC) quality measure definitions, patients were categorized as ineligible, automatic exclusions, discretionary exclusions, or ideal candidates for treatment (See Figure 1), although these measures were not publicly reported at the time of initial data collection. We defined ineligible patients (our terminology) as cases who would be ineligible and therefore excluded from current measures for non-medical reasons that either preclude assessment of quality of care or appropriate assignation of the responsible hospital, such being transferred out on the day of admission. Patients were categorized as automatic exclusions for a quality measure if they had a medical contraindication (i.e. medication allergy) for the therapy as defined by current CMS/JC measure specifications. Patients categorized as ineligible or automatically excluded are those who would uniformly be left out of the denominator in calculating rates of treatment for publicly reported data.

We defined the discretionary exclusions group as those patients who may or may not be included in quality measures under current specifications, due to relative contraindications to treatment. To identify potential contraindications to categorize this group we compiled a list of the relative contraindications used by CMS prior to the current public reporting era.[16] These are patients who could be excluded from a measure based on the CMS criteria allowing any patient to be excluded from a measure for "other reasons documented by a physician, nurse practitioner or physician assistant for not prescribing" the given treatment. (A complete list of comparing current CMS/JC measure specifications and the criteria used to categorize patients for this study can be found in Appendix Table 1). Finally, patients who

did not fit into any of the above categories were considered ideal candidates for therapy (no contraindications).

Outcome variables

Treatment with measured processes of care was based on chart-reviewed data from each of the cohorts.

Statistical Analysis

We compared the clinical characteristics of patients from each of the three cohorts and then determined the distribution of patients classified as excluded, ineligible, discretionary, or ideal candidates for each of the five quality indicators. We also calculated the number of patients ideal for 0, 1, 2, 3, 4 or 5 of the drug therapies for each cohort.

We compared rates of use of medical therapies for patients in the excluded, discretionary, and ideal group. Patients classified as ineligible were not assessed because their exclusion from process of care measures is most often related to logistics of their admission and not medical reasons to withhold a particular therapy.

All comparisons between groups were done using survey data analysis methods with chi-squares test in cross table analyses for dichotomous variables and F-test in ANOVA model analyses for continuous variables. All analyses were done with SAS Version 9.1 (SAS institute, Inc. Cary, NC). Analysis of the CCP, NHC, and NHC-R databases was approved by the Yale University School of Medicine Human Investigation Committee. Dr. Bernheim was supported by a training grant from the National Institute on Aging (T32AG1934) when initially working on this study. Saif Rathore is supported by Agency for Healthcare Research and Quality dissertation grant (1R36HS018283-01). The authors are solely responsible for the design and conduct of this study, all study analyses and drafting and editing of the paper.

Results

Characteristics of study samples

The mean age of the 3 cohorts increased significantly over time, ranging from 76.3 years (1994–1995 cohort) to 78.0 years (2000–2001 cohort, $p<0.001$). Each cohort had high rates of comorbidities with significant increases over time, including hypertension, prior heart failure, and previous cardiac interventions. By contrast, measures of clinical severity at admission, such as rates of ST-segment elevation MI, cardiac arrest, shock, and pulmonary edema at admission, decreased over time (Table I).

Trends in candidacy for drug-therapy

A large proportion of the patients in all three cohorts were ineligible for inclusion for each of the five quality of care measures (Table II). For admission use of aspirin and beta-blocker, 20–33% were ineligible, largely because they were transferred in or out, discharged on the day of admission, or died. Up to 85% of patients were ineligible for treatment with ACE-I because their left ventricular systolic function was not assessed or measured as greater than 40% ejection fraction. The proportion of ineligible candidates increased significantly over time for the admission measures (20% in 1994–5, 28% in 2000–1), while it decreased slightly for the discharge measures.

The proportion of patients with medical contraindications that would lead to automatic exclusion from the measures also increased slightly for most measures from 1994–5 to

2000–1, with the largest increase for the measure of beta-blocker at discharge (27% vs. 35%) and a slight decrease for beta-blocker at admission.

In the 2000–01 cohort, 41% of patients (admission aspirin) to 85% (ACE-I) would be uniformly excluded from any given measure denominator because they were either ineligible or had a medical contraindication leading to automatic exclusion. The proportion of patients that were either ineligible or had an automatic exclusion significantly increased for three of five measures over time, aspirin at admission (30.9% either ineligible or excluded for aspirin in 1994–95 vs. 40.5% in 2000–2001), beta-blocker at admission (56.7% 1994–1995 vs. 60.8% in 2000–2001) and beta-blocker at discharge (60.2% 1994–95 vs. 67.1% 2000–2001).

For all measures, except beta-blocker at discharge, the proportion of patients in the discretionary group, i.e., those with relative contraindications that are not automatic exclusions but which could lead to an individualized discretionary exclusion, increased significantly over time. The proportion of candidates in the discretionary group for aspirin on admission increased from 15.8% in 1994–1995 to 16.9% in 2000–2001. For beta-blocker on admission, the increase was greater (14.3% in 1994–1995, 18.3% in 2000–2001.) Moreover, when the proportion of patients that could be discretionarily excluded was calculated as a proportion of measure-eligible patients, i.e., patients who are not automatically excluded or ineligible, the patients with potential discretionary exclusions represented 25.5% of eligible patients for ACE-I, and 69.2% for discharge beta-blocker in 2000–2001. The percentage of discretionary exclusion patients among measure-eligible patients increased over time for all measures.

The combined increases in ineligible, automatically excluded and discretionary patients led to a decrease in the proportion of ideal candidates for each measure except ACE-I at discharge. In turn, the proportion of patients who are ideal for no measures (ineligible, excluded or discretionary for all groups) increased from 29.8% in 1994–5 to 37.1% in 2000–2001, and the proportion of patients who were ideal for all measures was less than 1% in all cohorts. (Table III)

Trends in Drug Therapy

Use of all five drug therapies increased for automatically excluded, discretionary and ideal candidates, except for ACE-I use in automatically excluded and discretionary patients (Table IV) The use of aspirin and beta-blocker at admission and discharge was substantial and increased significantly for both automatically excluded and discretionary patients, that is to say, patients with potential medical contraindications to treatment. For example, admission use of aspirin went from 83% to 89% ($p<0.001$) among the discretionary patients and 60% to 73% use among excluded patients. Beta-blocker use at discharge among patients excluded from measures and among discretionary patients increased dramatically over this time period (excluded 40% in 1994–5 to 71% in 2000–2001, discretionary: 26% to 61%).

Discussion

Our results demonstrate that an increasing proportion of older patients with AMI have medical conditions that could lead to their exclusion from publicly-reported process of care measures. Indeed, of the patients that could be included in a given quality measure (that is, of those that are not uniformly excluded) up to 69% were in the discretionary category based on chart-abstracted data in 2000–01; they did not have a specified contraindication that would automatically lead to their exclusion from the measure, nor were they ideal for the given treatment. We found, additionally, that rates of treatment with medications for which these patients had potential contraindications also increased. These results highlight the

uncertainties surrounding the best care for older patients with relative contraindications to treatment: it is unclear whether inclusion and treatment or discretionary exclusion represents the better care.

Our results build upon prior work that described the growing proportion of older AMI patients with coexisting conditions and potential contraindications to treatment for AMI.[6, 9] A study by Masoudi et. al. indicated, for example, that the proportion of patients ideal for aspirin at admission dropped from 67% to 47% over 10 years, with similar drops found for other measured drug therapies. In our study, less than 1% of Medicare patients were ideal candidates for all 5 process of care measures in 2001, which is to say that for nearly every Medicare beneficiary presenting with an AMI, a complex decision has to be made about whether to provide at least one standard medical treatment.

These findings echo concerns about the evidence-base for current quality measures for older patient groups.[17, 18] Although the CMS process measures for AMI are based upon substantial clinical evidence, older and sicker patients are rarely included in clinical trials that established standards of care. A number of observational studies have supported the use of aspirin, beta-blocker and ACE-I in older patient populations,[19–21] but these generally have also excluded patients with potential contraindications to care. Without the inclusion of such patients in treatment studies it is difficult to judge what treatment decisions are in the patients' best interest, thus leaving clinicians with challenging medical decisions.

Our findings also raise questions about how best to account for patients with relative contraindications when measuring quality of care. An earlier approach delineated a comprehensive list of potential contraindications for each therapy and excluded all such patients, whether or not they received treatment.[9] In more recent efforts, CMS and the Joint Commission, recognizing the potential overriding benefit of treatment for many patients with relative contraindications, now specify a much narrower set of absolute exclusion criteria. This approach supports more individualized decision-making about care, but the allowance for discretionary exclusions complicates interpretation of publicly reported data. First, the use of discretionary exclusions are invisible to the health care consumer, so the public can not discern to what extent the quality measures are representative of the full population of patients seen at the hospital. Second, use of discretionary exclusions may vary greatly between hospitals and thus limit the comparability of measures. Furthermore, the combined factors of 1) discretion about whether to include patients with contraindications and 2) the lack of evidence about what is best for such patients create a situation that may give hospitals an incentive to treat patients despite relative contraindications, and thus hospitals could seemingly receive credit for care whether or not it is in the patient's best interest. Indeed, we found rates of treatment for patients with potential contraindications have increased over time.

Finally, the exclusion of large numbers of patients from quality indicators raises broader questions about quality measurement. If a substantial proportion of patients are not represented in quality measures, because they are excluded or ineligible, we cannot provide any definitive assurances regarding the care they receive. This is particularly disconcerting because exclusion and ineligibility for process of care measures cluster in older, sicker patients who are more medically vulnerable and are being missed by quality of care measurement. This also has implications for our ability to ascertain quality at institutions when a notable proportion of patients, typically a sicker cohort, are not included in their overall assessment of quality.

There are a number of potential implications of our work. The first, as described, is the need for more evidence upon which to base treatment decisions for older patient groups with

multiple coexisting conditions. Second, quality reporting for older patients may be improved by reporting outcomes or quality of life, as opposed to processes of care. Clinical outcomes could include all patients after risk-adjustment for clinical differences between populations and may be more meaningful to patients. Finally, more detailed information on the portion and characteristics of included patients should be reported for currently reported process measures.

A number of factors must be taken into consideration when interpreting of our work. First, we examined older data and cannot determine what course the observed trends in treatment have taken in more recent years. However, these data permitted detailed analysis of coexisting illnesses and treatment. We know of no other nationally representative source of chart-review data on AMI care. Second, we cannot be sure that all of the increases in discretionary exclusions are due to changes in the AMI population; it is possible that some of these changes represent changes in documentation. However, data collection was done prior to the era of public reporting and we know of no national effort to better document relative contraindications to care at that time. Third, our study is based on applying current measure criteria to patient populations prior to the era of public reporting. Thus, although we illuminate important changes in the populations of AMI patients that could be excluded from the measures, we do not know how this would translate into actual practice. The goal of this work was to highlight the growing population of AMI patients that could be excluded and the lack of transparency around these exclusions. Finally, our categorizations of patients were based on variables selected for prior quality improvement projects and do not precisely match current CMS/Joint Commission criteria. However, it is unlikely that this would dramatically change the trends described.

Important progress has been made in the last decade toward making care provided by hospitals to AMI patients more transparent. Most indications suggest that there has been simultaneous improvement in the quality of care provided to AMI patients. Our work identifies ongoing challenges with performance measurement in this population by revealing potential limitations of process measurements that incorporate discretionary exclusion of patients. Despite allowing for patient-specific decision-making, discretionary exclusion may lead to variability in patient populations included in measures across hospitals. Public quality reports, by failing to indicate who is excluded from measures, do not reflect the care provided to a large group of older patients whose inclusion or discretionary exclusion is invisible to the healthcare consumer.

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Appendix

Appendix Table 1

Comparison of CMS measure specification with study cohort specifications for patients identified as ineligible, excluded or discretionary

CMS MEASURE SPECIFICATIONS	STUDY COHORT SPECIFICATIONS
ADMISSION MEASURES	
Excluded for all admission measures	**Ineligible for all Admission Measures**
<18 years of age	[Cohort includes >65 y.o only]

CMS MEASURE SPECIFICATIONS	STUDY COHORT SPECIFICATIONS
Patient transferred to another acute care hospital or federal hospital on day of or day after arrival	Transferred out on the day or the day after admission
Patient discharged on day of arrival	Discharged on the day or the day after admission
Patient expired on day of or day after arrival	Expired on the day or the day after admission
Patients who left AMA on day of or day after arrival	Left AMA on day of or day after admission
Patients with comfort measures only documented by a physician, APRN or PA	Patients with terminal illness
Patients received in transfer from another hospital or ER	Patient received in transfer or admission source unknown
ASPIRIN ON ADMISSION	
Additional exclusions for ASA on admit	**Absolute Contraindications**
Aspirin allergy	Aspirin allergy
Active bleeding on arrival or within 24 hours after arrival	Bleeding on arrival or within 48 hours prior to arrival
Coumadin as pre-arrival medication	Coumadin prior to admission
Any other reason documented by PA/MD for not giving ASA on admission	**Relative Contraindications**
	Bleeding risk
	History of internal bleeding
	History of bleeding disorder
	Chronic liver disease
	First platelet count drawn within 24 hours of arrival < 100×109/L
	Anemia
	History of peptic ulcer disease
	Renal insufficiency on admission
BETA-BLOCKER ON ADMISSION	
Additional exclusions for Beta-blocker on admission	**Absolute Contraindications**
Beta-blocker allergy	Beta blocker allergy
Bradycardia (HR < 60) on arrival or within 24 hours after arrival while not on a beta-blocker	Bradycardia on admission without taking a beta blocker
Heart failure on arrival or within 24 hours after arrival	Heart failure at admission
	CHF/pulmonary edema on admission
	Pulmonary edema on chest x-ray within 24 hours of arrival
	CHF on chest x-ray within 24 hours of arrival
Shock on arrival or within 24 hours after arrival	Shock on admission
2nd or 3rd degree heart block on ECG on arrival or within 24 hours after arrival and does not have a pacemaker	Heart block
	2nd or 3rd degree heart block
	first degree PR interval > 240 milliseconds on arrival EKG
	Right bundle block and left fascicular block on arrival EKG
	ICD-9-CM heart block codes

CMS MEASURE SPECIFICATIONS	STUDY COHORT SPECIFICATIONS
Any other reason documented by PA/MD for not giving Beta-blocker on admission	**Relative Contraindications**
	Heart failure at admission
	History of HF
	Previous LVEF < 50 and LVEF not equal to missing
	COPD
	History of COPD
	ICD-9-CM COPD codes
	Asthma
	Peripheral vascular disease
	Hypotension
	Renal insufficiency
DISCHARGE MEASURES	
CMS Exclusions for all discharge measures	**Ineligible for all discharge measures**
< 18 years of age*	[Cohort includes >65 y.o only]
Patients who left AMA *	Patients who left AMA
Patients discharged to hospice*	Terminal Illness
Patients with comfort measures only documented by a physician, APRN or PA*	Terminal Illness
Patients transferred to another acute care hospital or federal hospital	Patient transferred out of the hospital
Patients who expired	Patient dead at discharge or discharge status unknown
ASPIRIN ON DISCHARGE	
Additional exclusions for ASA at discharge	**Absolute Contraindications**
Aspirin allergy	History of allergy to ASA or reaction to ASA during hospitalization
Active bleeding on arrival	Bleeding on admission
Active bleeding during hospital stay	Bleeding during hospitalization
Coumadin prescribed at discharge	Warfarin prescribed at discharge
Any other reason documented by PA/MD for not giving ASA on discharge	**Relative Contraindications**
	Bleeding risk
	History of internal bleeding
	History of bleeding disorder
	Chronic liver disease
	Low platelet count
	Anemia
	History of peptic ulcer disease
	Acute UGI disorder during index admission
	Renal insufficiency
BETA-BLOCKER AT DISCHARGE	
Additional exclusions for BB at discharge	**Absolute Contraindications**

CMS MEASURE SPECIFICATIONS	STUDY COHORT SPECIFICATIONS
Beta-blocker allergy	History of allergy to beta blockers or reaction to beta blockers during hospitalization
Second or third degree heart block on ECG on arrival or during hospital stay and does not have a pacemaker	Heart block
	2nd or 3rd degree heart block
	first degree PR interval > 240 milliseconds on arrival EKG
	Right bundle block and left fascicular block on arrival EKG
	Heart block second or third degree on any EKG during hospital stay
	Right bundle block and left fascicular block during hospital
	ICD-9-CM heart block codes
Bradycardia (<60bpm) on day of discharge or day prior to discharge while not on beta blocker	Bradycardia
	Bradycardia during hospital stay
	Last pulse documented < 60 and did not take beta blocker on discharge
Any other reason documented by PA/MD for not giving beta-blocker on discharge	**Relative Contraindications**
	Heart failure and (LVEF<50 or unknown)
	Heart failure on admission
	CHF on chest x-ray within 24 hours of arrival
	Heart failure during stay
	ICD-9-CM heart failure codes
	LVEF unknown or less than 50
	LVEF less than 30
	Shock
	Shock on arrival
	Shock during stay
	ICD-9-CM shock codes
	Hypotension
	Hypotension during stay
	Last systolic BP < 100mm Hg and did not take beta blocker on discharge
	COPD
	History of COPD
	ICD-9-CM COPD codes
	Asthma
	Peripheral vascular disease
ACE-I USE AT DISCHARGE	
Additional Exclusions for ACE-I at Discharge	**Ineligible**
Chart documentation of an LVEF < 40% or a narrative description of LVS function consistent with moderate or severe systolic dysfunction	LVEF not between 0 and 40

CMS MEASURE SPECIFICATIONS	STUDY COHORT SPECIFICATIONS
	Absolute Contraindications
ACE-I allergy	History of allergy to ACE or reaction to ACE during hospitalization
Moderate or severe aortic stenosis	Aortic stenosis
	Aortic stenosis
	Cardiac cath aortic stenosis
	ICD-9-CM aortic stenosis codes
Any other reason documented by PA/MD for not giving ACE-I on discharge	**Relative Contraindications**
	Creatinine > 2 on admission or during hospitalization
	Hypotension at discharge and did not have ACE at discharge

Appendix Table 2

Number and proportion of patients with given contraindications

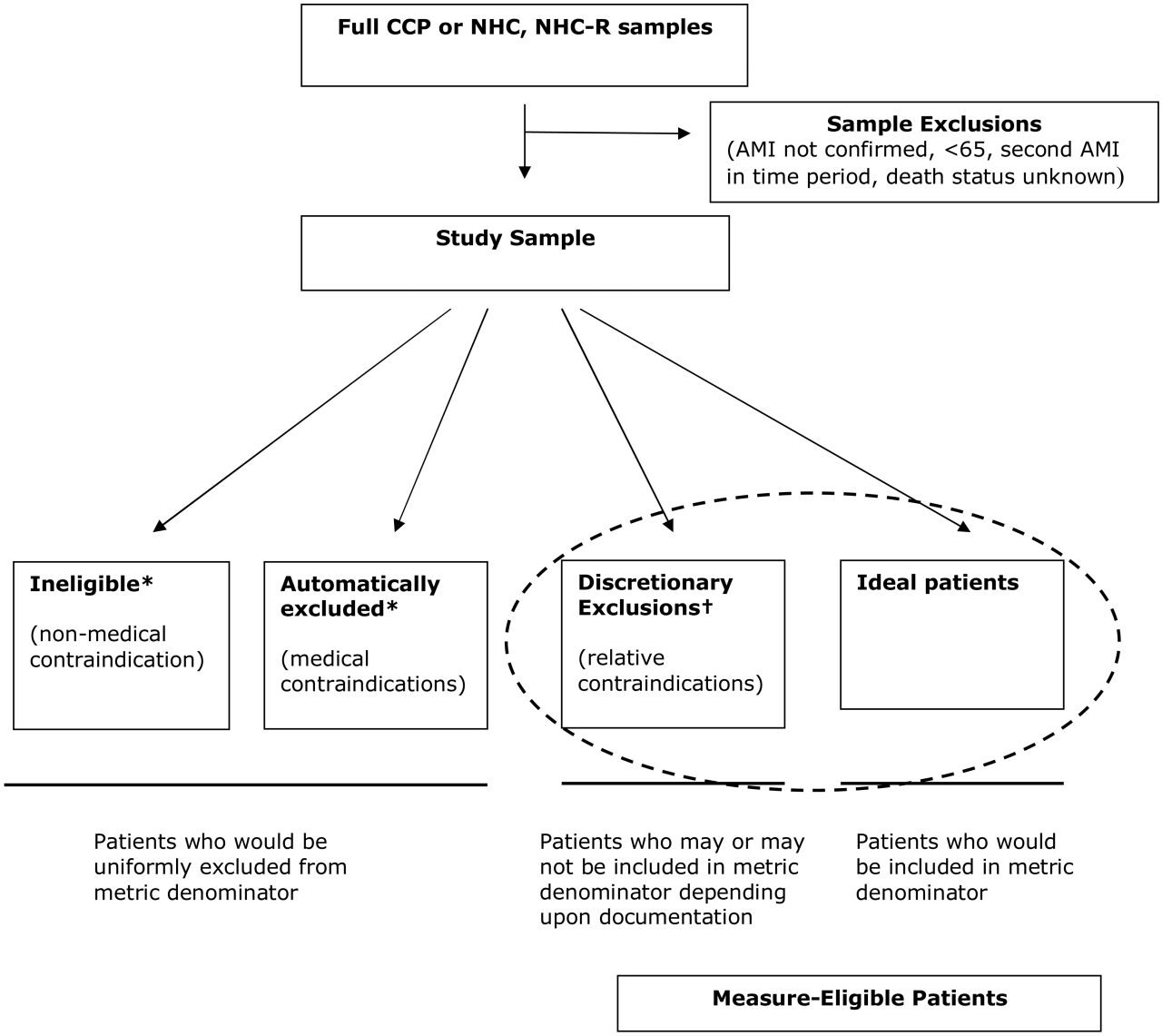
Characteristics	Total		1994–1995		1998–1999		2000–2001		Overall P
	#	%	#	%	#	%	#	%	
ASA at Admission									
Ineligible									
Discharged/left AMA/transferred out/died on admission day or day after	23849	11.05	16975	9.93	3279	11.27	3595	12.13	<0.001
Terminal illness	726	0.24	624	0.37	64	0.22	38	0.13	<0.001
Transferred in	27316	14.05	18005	10.53	4411	15.51	4900	16.73	<0.001
Excluded (medical contraindication)									
Aspirin allergy	9827	6.96	7398	4.33	1199	10.79	1230	10.43	<0.001
Active bleeding on arrival or within 48 hours	7332	3.64	5251	3.07	1030	3.85	1051	4.11	<0.001
Coumadin/Warfarin as pre-arrival medication	16226	8.42	11411	6.68	2344	9.26	2471	9.82	<0.001
Discretionary (Relative contraindication)									
Bleeding risk	24035	12.12	16673	9.75	3505	12.89	3857	14.11	<0.001
History of internal bleeding	20327	10.17	14147	8.28	2870	10.39	3310	12.13	<0.001
History of bleeding disorder	1423	0.77	905	0.53	263	0.99	255	0.84	<0.001
Chronic liver disease	791	0.31	649	0.38	69	0.26	73	0.28	0.0031
First platelet count drawn within 24 hours of arrival < 100×109/L	2585	1.44	1701	1.00	468	1.87	416	1.55	<0.001
Anemia	13704	7.51	9388	5.49	1952	7.79	2364	9.55	<0.001
History of peptic ulcer disease	29976	12.93	22961	13.43	3557	12.77	3458	12.49	<0.001
Renal insufficiency on admission	8388	4.37	5843	3.42	1187	4.56	1358	5.28	<0.001
Beta-blocker on admission									
Ineligible									

Characteristics	Total		1994–1995		1998–1999		2000–2001		Overall P
	#	%	#	%	#	%	#	%	
Discharged/left against AMA/transferred out/died on the admission day or the day after	23849	11.05	16975	9.93	3279	11.27	3595	12.13	<0.001
Terminal illness	726	0.24	624	0.37	64	0.22	38	0.13	<0.001
Transferred in	27316	14.05	18005	10.53	4411	15.51	4900	16.73	<0.001
Excluded (medical contraindication)									
Beta-blocker allergy	1332	1.10	846	0.49	193	1.57	293	2.26	<0.001
Bradycardia (heart rate less than 60 bpm) on arrival or within 24 hours after arrival while not on beta-blocker	15020	6.03	11717	6.85	1732	5.86	1571	5.25	<0.001
Heart failure on arrival or within 24 hours after arrival	79745	35.44	61221	35.82	9536	36.11	8988	34.43	0.0018
CHF/pulmonary edema on admission	59724	24.73	48025	28.10	6136	23.71	5563	21.84	<0.001
Pulmonary edema on chest x-ray within 24 hours of arrival	25841	13.29	19654	12.75	3424	15.30	2763	12.15	<0.001
CHF on chest x-ray within 24 hours of arrival	51710	26.48	39457	25.60	6213	27.34	6040	26.76	<0.001
Second or third degree heart block on ECG on arrival or within 24 hours after arrival and does not have a pacemaker	16050	7.52	11576	6.77	2222	7.91	2252	8.01	<0.001
2nd or 3rd degree heart block	2845	1.18	2295	1.44	282	1.05	268	0.99	<0.001
first degree PR interval > 240 milliseconds on arrival EKG	1670	3.14			782	2.95	888	3.31	
Right bundle block and left fascicular block on arrival EKG	5055	2.38	3753	2.20	637	2.53	665	2.47	0.0052
ICD-9-CM heart block codes	8509	3.15	6961	4.07	850	2.83	698	2.39	<0.001
Shock on arrival or within 24 hours after arrival	5190	1.87	4364	2.55	513	1.81	313	1.15	<0.001
Discretionary (Relative contraindication)									
Heart failure at admission	56411	29.34	39350	23.02	8067	31.14	8994	34.87	<0.001
History of HF	50703	26.17	35603	20.83	7125	27.55	7975	30.98	<0.001
Previous LVEF < 50 and LVEF not equal to missing	14473	8.83	8820	5.16	2525	9.75	3128	12.15	<0.001
COPD	53789	25.53	39408	23.06	6973	26.18	7408	27.76	<0.001
History of COPD	47462	22.49	34756	20.33	6097	22.85	6609	24.62	<0.001
ICD-9-CM COPD codes	35613	16.86	26341	15.41	4535	17.24	4737	18.16	<0.001
Asthma	4158	2.06	2868	1.68	619	2.15	671	2.40	<0.001
Peripheral vascular disease	160	0.09	111	0.06	22	0.08	27	0.14	0.0613
Hypotension	16847	7.67	12520	7.32	2097	7.51	2230	8.20	<0.001
Aspirin on discharge									
Ineligible									
Patients transferred to another acute care hospital or federal hospital	41191	17.90	31265	18.29	5049	17.96	4877	17.41	0.0795
Patients who died	31239	13.27	24596	14.39	3322	12.53	3321	12.65	<0.001
Patients who left AMA	314	0.23	181	0.11	67	0.31	66	0.29	<0.001

Characteristics	Total		1994–1995		1998–1999		2000–2001		Overall P
	#	%	#	%	#	%	#	%	
Patients with unknown discharge status	676	0.67	148	0.09	173	0.61	355	1.38	<0.001
Terminal illness	726	0.24	624	0.37	64	0.22	38	0.13	<0.001
Excluded (medical contraindication)									
History of allergy to ASA or reaction to ASA during hospitalization	10019	4.58	7537	4.41	1217	4.65	1265	4.72	0.0955
Active bleeding on arrival or during hospital stay									
Bleeding on admission	7332	3.64	5251	3.07	1030	3.85	1051	4.11	<0.001
Bleeding during hospitalization	39807	18.79	29215	17.09	4914	18.34	5678	21.12	<0.001
Coumadin/Warfarin prescribed at discharge	24609	11.41	19169	11.21	2826	12.13	2614	11.05	0.0045
Discretionary (Relative contraindication)									
Bleeding risk	24035	12.12	16673	9.75	3505	12.89	3857	14.11	<0.001
History of internal bleeding	20327	10.17	14147	8.28	2870	10.39	3310	12.13	<0.001
History of bleeding disorder	1423	0.77	905	0.53	263	0.99	255	0.84	<0.001
Chronic liver disease	791	0.31	649	0.38	69	0.26	73	0.28	0.0031
Low platelet count	2585	1.44	1701	1.00	468	1.87	416	1.55	<0.001
Anemia	13704	7.51	9388	5.49	1952	7.79	2364	9.55	<0.001
History of peptic ulcer disease	29976	12.93	22961	13.43	3557	12.77	3458	12.49	<0.001
Acute UGI disorder during index admission	910	0.47	668	0.39	108	0.49	134	0.54	0.0214
Renal insufficiency	16476	8.25	11791	6.90	2226	8.52	2459	9.56	<0.001
Beta-blocker on discharge									
Ineligible									
Patients transferred to another acute care hospital or federal hospital	41191	17.90	31265	18.29	5049	17.96	4877	17.41	0.0795
Patients who died	31239	13.27	24596	14.39	3322	12.53	3321	12.65	<0.001
Patients who left AMA	314	0.23	181	0.11	67	0.31	66	0.29	<0.001
Patients with unknown discharge status	676	0.67	148	0.09	173	0.61	355	1.38	<0.001
Terminal illness	726	0.24	624	0.37	64	0.22	38	0.13	<0.001
Excluded (medical contraindication)									
Beta-blocker allergy	2267	1.11	1505	0.88	307	0.98	455	1.48	<0.001
Bradycardia (heart rate less than 60 on day of discharge or day prior to discharge while not on a beta-blocker)	93199	44.84	66604	38.97	12431	45.11	14164	51.24	<0.001
Bradycardia during hospital stay	88839	43.60	62574	36.61	12216	44.37	14049	50.82	<0.001
Last pulse documented < 60 and did not take beta blocker on discharge	14818	4.87	12930	7.56	1028	3.55	860	2.98	<0.001
Second or third degree heart block on ECG on arrival or during hospital stay and does not have a pacemaker	24809	11.21	18547	10.85	3064	11.13	3198	11.68	0.0050
2nd or 3rd degree heart block	2845	1.18	2295	1.44	282	1.05	268	0.99	<0.001
first degree PR interval > 240 milliseconds on arrival EKG	1670	3.14			782	2.95	888	3.31	

Characteristics	Total		1994–1995		1998–1999		2000–2001		Overall P
	#	%	#	%	#	%	#	%	
Right bundle block and left fascicular block on arrival EKG	5055	2.38	3753	2.20	637	2.53	665	2.47	0.0052
Heart block second or third degree on any EKG during hospital stay	8950	3.38	7372	4.31	769	2.78	809	2.84	<0.001
Right bundle block and left fascicular block during hospital	11317	5.12	8638	5.05	1287	5.06	1392	5.24	0.6213
ICD-9-CM heart block codes	8509	3.15	6961	4.07	850	2.83	698	2.39	0.0000
Discretionary (Relative contraindication)									
Heart failure and (LVEF<50 or unknown)	93241	42.19	70710	41.37	11265	42.40	11266	42.95	<0.001
Heart failure on admission	59724	24.73	48025	28.10	6136	23.71	5563	21.84	<0.001
CHF on chest x-ray within 24 hours of arrival	63042	28.37	48026	28.10	7705	29.28	7311	27.87	0.0056
Heart failure during stay	96159	43.91	72744	42.56	11434	43.49	11981	45.80	<0.001
ICD-9-CM heart failure codes	89659	40.72	68159	39.88	10771	41.02	10729	41.40	0.0003
LVEF unknown or less than 50	162509	71.25	124160	72.64	19528	71.30	18821	69.63	<0.001
LVEF less than 30	21299	10.63	15499	9.07	2842	11.23	2958	11.85	<0.001
Shock	18424	7.87	14387	8.42	2084	7.73	1953	7.37	<0.001
Shock on arrival	5190	1.87	4364	2.55	513	1.81	313	1.15	<0.001
Shock during stay	16370	12.71	12683	7.42	1857	24.88	1830	22.36	<0.001
ICD-9-CM shock codes	11538	4.98	8988	5.26	1280	4.75	1270	4.86	0.0040
Hypotension	66620	30.15	49529	28.98	8264	29.44	8827	32.11	<0.001
Hypotension during stay	57708	27.48	41424	24.23	7803	27.84	8481	30.82	<0.001
Last systolic BP < 100mm Hg and did not take beta blocker on discharge	21714	6.30	19936	11.66	955	3.26	823	2.93	<0.001
COPD	53789	25.53	39408	23.06	6973	26.18	7408	27.76	<0.001
History of COPD	47462	22.49	34756	20.33	6097	22.85	6609	24.62	<0.001
ICD-9-CM COPD codes	35613	16.86	26341	15.41	4535	17.24	4737	18.16	<0.001
Asthma	4158	2.06	2868	1.68	619	2.15	671	2.40	<0.001
Peripheral vascular disease	160	0.09	111	0.06	22	0.08	27	0.14	0.0613
ACE-I at discharge									
Ineligible									
Patients transferred to another acute care hospital or federal hospital	41191	17.90	31265	18.29	5049	17.96	4877	17.41	0.0795
Patients who died	31239	13.27	24596	14.39	3322	12.53	3321	12.65	<0.001
Patients who left AMA	314	0.23	181	0.11	67	0.31	66	0.29	<0.001
Terminal illness	676	0.67	148	0.09	173	0.61	355	1.38	<0.001
Patients with unknown discharge status	726	0.24	624	0.37	64	0.22	38	0.13	<0.001
LVEF not between 0 and 40	177111	76.74	134930	78.94	21245	75.71	20936	75.17	<0.001
Excluded (medical contraindication)									
History of allergy to ACE or reaction to ACE during hospitalization	2344	1.20	1474	0.86	365	1.26	505	1.52	<0.001
Aortic stenosis	15049	6.91	11339	6.63	1871	7.27	1839	6.92	0.0225

Characteristics	Total		1994–1995		1998–1999		2000–2001		Overall P
	#	%	#	%	#	%	#	%	
Aortic stenosis	5845	5.10	4246	4.44	794	5.63	805	5.38	<0.001
Cardiac cath aortic stenosis	2522	2.29	2198	3.88	169	1.71	155	1.33	<0.001
ICD-9-CM aortic stenosis codes	10454	5.09	7550	4.42	1449	5.49	1455	5.51	<0.001
Discretionary (Relative Contraindications)									
Creatinine > 2 on admission or during hospitalization	38490	18.82	27878	16.31	4968	18.94	5644	21.54	<0.001
Hypotension at discharge and did not have ACE at discharge	22156	6.62	20095	11.76	1036	3.50	1025	3.57	<0.001



*Ineligible and Automatically excluded categories defined by presence of contraindications named as exclusions in current measure specifications
† Discretionary exclusions defined by presence of relative contraindication
For full listing comparing CMS measure specification criteria and study criteria for categorizing patients see Appendix 1.

Figure 1.
Schematic of Sample and Patient Categories

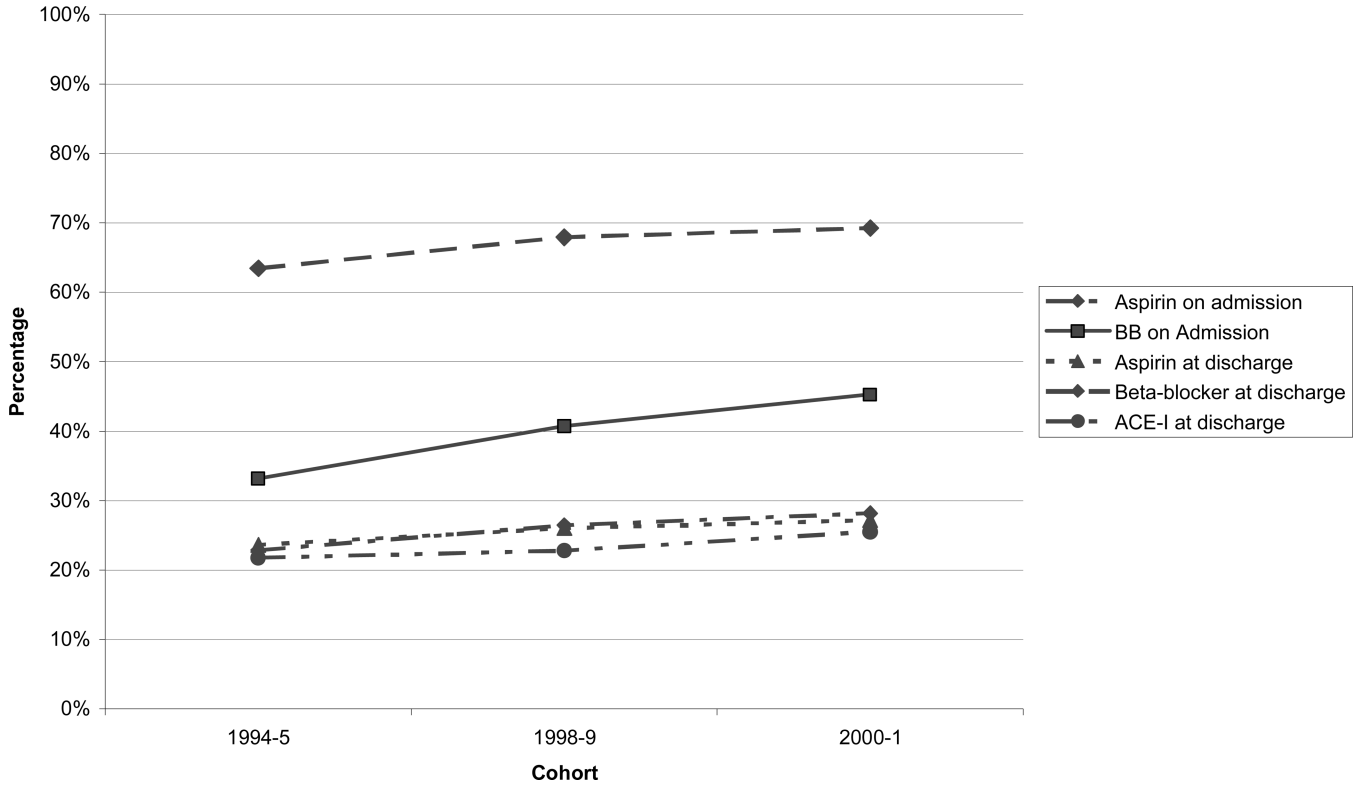


Figure 2.
Percentage of patients with discretionary exclusions among measure eligible patients

Table I

Patient Characteristics and Outcomes* by Time Period

Description	1994–1995		1998–1999		2000–2001		Overall P
	#	%	#	%	#	%	
All	170928	100.00	27432	100.00	27300	100.00	
Demographics							
Age: mean (SD)	76.30	7.34	77.40	16.83	77.99	18.25	<0.001
Female	82741	48.41	13446	50.31	13470	50.17	<0.001
Non-white	16529	9.67	4103	13.54	4591	14.84	<0.001
Medical history							
Prior MI	49477	28.95	9436	35.04	9947	37.17	<0.001
Prior HF	35603	20.83	7125	27.55	7975	30.98	<0.001
Prior PTCA	11564	6.77	3204	11.48	3756	14.14	<0.001
Prior CABG	21254	12.43	4418	16.63	4691	17.66	<0.001
Prior CVA	23612	13.81	4625	17.32	5152	19.56	<0.001
COPD	34756	20.33	6097	22.85	6609	24.62	<0.001
Diabetes	52167	30.52	8704	32.58	9112	34.38	<0.001
Clinical Presentation							
Shock	4364	2.55	513	1.81	313	1.15	<0.001
Hemorrhage	5251	3.07	1030	3.85	1051	4.11	<0.001
CHF/Pulmonary edema	48025	28.10	6136	23.71	5563	21.84	<0.001
Heart rate: mean (SD)	87.43	24.50	88.57	54.38	88.70	58.15	<0.001
Systolic blood pressure: mean (SD)	143.55	32.76	142.78	71.78	141.97	76.63	<0.001
Respiratory rate: mean (SD)	22.23	6.58	22.06	14.16	21.85	14.95	<0.001
Creatinine: mean (SD)	1.38	0.96	1.45	4.02	1.49	2.62	<0.001
ST-elevation	54608	31.95	8412	30.15	6905	24.47	<0.001
Assessment of LVEF							
Without the measure	60845	35.60	9017	30.69	7989	27.69	<0.001
With the measure							<0.001
Normal	46667	42.39	7914	41.37	8494	42.04	

Am Heart J. Author manuscript; available in PMC 2012 April 4.

Description	1994–1995		1998–1999		2000–2001		Overall P
	#	%	#	%	#	%	
Mild/mild moderate/decreased	27517	25.00	4327	23.62	4476	23.73	
Moderate/moderate severe/low	20438	18.57	3325	18.78	3372	17.79	
Severe/very severe/very low/poor	15461	14.04	2849	16.24	2969	16.44	
Outcomes							
Length of stay: mean (SD.)	8.36	7.22	7.24	13.90	7.11	15.15	<0.001
30-Day mortality from discharge	8843	5.17	1733	6.46	1756	6.73	<0.001
One-year mortality from discharge	29782	17.42	5524	20.75	5688	22.19	<0.001

* Results from survey analysis for % and P value are shown here.

Table II

Performance Measures by Time Period

Description	1994–1995		1998–1999		2000–2001		Overall P
	#	%	#	%	#	%	
All	170928	100.00	27432	100.00	27300	100.00	
Medication on admission							
Aspirin							<0.001
Ineligible	34441	20.15	7458	25.97	8190	27.75	
Excluded	18540	10.85	3327	12.55	3290	12.73	
Discretionary	26964	15.78	4402	16.49	4457	16.94	
Ideal	90983	53.23	12245	44.98	11363	42.58	
BB							<0.001
Ineligible	34441	20.15	7458	25.97	8190	27.75	
Excluded	62620	36.64	9318	35.19	8584	33.03	
Discretionary	24518	14.34	4339	16.06	4764	18.31	
Ideal	49349	28.87	6317	22.78	5762	20.91	
Medication at discharge							
Aspirin							<0.001
Ineligible	56570	33.10	8645	31.51	8640	31.81	
Excluded	39558	23.14	6301	22.82	6486	23.72	
Discretionary	17669	10.34	3248	11.97	3306	12.25	
Ideal	57131	33.42	9238	33.71	8868	32.22	
BB							<0.001
Ineligible	56570	33.10	8645	31.51	8640	31.81	
Excluded	46298	27.09	8906	31.87	9860	35.34	
Discretionary	43167	25.25	6710	25.06	6092	22.88	
Ideal	24893	14.56	3171	11.56	2708	9.97	
ACEI							<0.001
Ineligible	146212	85.54	23098	82.97	22778	82.68	

Description	1994–1995		1998–1999		2000–2001		Overall P
	#	%	#	%	#	%	
Excluded	2535	1.48	456	1.95	473	1.71	
Discretionary	4824	2.82	883	3.44	1032	3.93	
Ideal	17357	10.15	2995	11.64	3017	11.68	

* Results from survey analysis for % and P value are shown here.

Table III

Number of Ideal Performance Measures by Time Period

Description	1994–1995		1998–1999		2000–2001		Overall P
	#	%	#	%	#	%	
N (%)	170928	100.00	27432	100.00	27300	100.00	
Number of Ideal Performance Measures							<0.001
0	50891	29.77	9772	35.35	10284	37.08	
1	43242	25.30	6828	24.98	7112	26.42	
2	45683	26.73	6663	23.99	6176	22.69	
3	19934	11.66	2933	11.24	2701	9.87	
4	10587	6.19	1167	4.20	984	3.77	
5	591	0.35	69	0.23	43	0.17	

* Results from survey analysis for % and P value are shown here.

Table IV

Use of Medications Among the Corresponding Performance Measures by Time Period

Description	1994–1995		1998–1999		2000–2001		Overall P
	#	%	#	%	#	%	
Medication on admission or during hospital							
Aspirin	140774	82.36	24338	88.09	24429	88.81	<0.001
Excluded	11169	60.24	2385	70.97	2434	72.79	<0.001
Discretionary	22252	82.52	3992	90.23	4033	89.21	<0.001
Ideal	80961	88.98	11593	94.20	10793	94.66	<0.001
BB	84353	49.35	18337	66.81	20993	77.41	<0.001
Excluded	25331	40.45	5582	59.74	6397	74.77	<0.001
Discretionary	11127	45.38	2844	65.57	3581	75.70	<0.001
Ideal	32535	65.93	5212	82.97	5067	88.24	<0.001
Medication at discharge							
Aspirin	87200	51.02	16569	58.86	17316	61.16	<0.001
Excluded	20931	52.91	3870	58.48	4267	63.10	<0.001
Discretionary	11946	67.61	2509	74.49	2612	76.78	<0.001
Ideal	43627	76.36	7748	83.13	7625	84.42	<0.001
BB	49345	28.87	12638	45.93	15383	55.75	<0.001
Excluded	18555	40.08	5390	60.73	7014	71.19	<0.001
Discretionary	11382	26.37	3061	45.66	3702	60.62	<0.001
Ideal	12503	50.23	2267	71.18	2157	78.87	<0.001
ACEI	43298	25.33	9617	34.93	10815	38.97	<0.001
Excluded	1279	50.45	238	51.00	227	47.77	0.695
Discretionary	1886	39.10	371	39.49	387	35.87	0.260
Ideal	10761	62.00	2092	70.07	2213	71.48	<0.001

* Results from survey analysis for % and P value are shown here.