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Trends in the use of echocardiography and left ventriculography to assess left ventricular ejection fraction in patients hospitalized with acute myocardial infarction

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Abstract

Background—While current guidelines strongly recommend the measurement of ejection fraction (EF) in all patients hospitalized with acute myocardial infarction (AMI), there are little data available describing trends in the use of diagnostic modalities to assess EF in these patients. The purpose of this study was to evaluate trends in the use of ventriculography and echocardiography to measure EF in a community sample of patients hospitalized with AMI.

Methods—The medical records of 5,380 residents of the Worcester (MA) metropolitan area hospitalized with AMI at 11 greater Worcester medical centers between 1997 and 2005 were reviewed.

Results—Between 1997 and 2005, the proportion of patients hospitalized with AMI undergoing measurement of EF by both ventriculography and echocardiography increased from 11% to 18%, while the percentage of patients who did not receive an evaluation of EF by either modality decreased from 37% to 27%. The percentage of patients undergoing measurement of EF by ventriculography alone increased from 14% to 20%, while the percentage of patients undergoing measurement of EF by echocardiography alone remained stable at 37%. In 1997, echocardiography was performed prior to ventriculography in approximately two-thirds of hospitalized patients, while in 2005, ventriculography was performed prior to echocardiography in approximately two-thirds of patients with AMI.

Conclusions—The use of left ventriculography, and the concurrent use of both ventriculography and echocardiography, to assess EF in patients with AMI is increasing. While the proportion of patients who do not have their EF assessed has declined during recent years, many still do not receive a determination of their EF.

Keywords

Acute myocardial infarction; diagnostic testing; population-based study

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Introduction

The diagnosis and management of acute myocardial infarction (AMI) has changed dramatically over the past 30 years, coincident with the development and expanded use of echocardiography, coronary angiography, coronary reperfusion strategies, and evidence-based treatment regimens. These diagnostic and therapeutic modalities have led to significant reductions in the morbidity and mortality associated with AMI.^{1,2} The increasing use of these modalities has, however, significantly contributed to the rising cost of healthcare in the U.S.³

Left ventricular ejection fraction (EF) has been shown to be a powerful predictor of prognosis and a key measure in guiding treatment decisions in the setting of AMI.^{4–7} Accordingly, current guidelines promulgated by the American College of Cardiology and American Heart Association list the evaluation of EF after AMI as a Class I, level of evidence B indication.^{5–7} Determination of EF after AMI is also an indirect performance measure recommended by the American College of Cardiology, American Heart Association, and the Joint Commission on Accreditation of Healthcare Organizations.^{8,9}

Despite these recommendations, prior studies have shown that between one-sixth and one-third of patients hospitalized with an AMI are discharged without an assessment of their EF.^{10–12} In current practice, EF is assessed almost exclusively by 2 modalities, left ventriculography and echocardiography. Guidelines for the evaluation of ST segment elevation MI and unstable angina/non-ST segment elevation MI recommend the use of echocardiography to assess left ventricular function in patients who will not have their EF assessed during coronary angiography.^{6,7} However, in clinical practice, an echocardiogram is often ordered to assess extent of left ventricular dysfunction even though EF may have been previously assessed by ventriculography.

The primary objective of this observational study in residents of a large New England community hospitalized at all area medical centers with AMI was to examine contemporary trends in the use of echocardiography and left ventriculography to measure EF in patients hospitalized with AMI. Secondary goals of this study were to determine the frequency and characteristics of patients who underwent concurrent testing of ventricular function, and to characterize differences in EF testing in patients with ST segment elevation MI compared to patients with non-ST segment elevation MI. Data from the Worcester Heart Attack Study were utilized for purposes of this investigation.^{2,13}

Methods

Study population

The Worcester Heart Attack Study is an ongoing population-based investigation that is examining long-term trends in the hospital incidence rates, clinical complications, management practices, and hospital and long-term case-fatality rates of AMI in residents of the Worcester, MA, metropolitan area.^{2,13} In brief, the medical records of greater Worcester residents hospitalized with possible MI at all 11 metropolitan Worcester medical centers were individually reviewed and validated according to predefined criteria.^{2,13} Demographic (e.g., age, sex), clinical (e.g., prior comorbidities, AMI type), treatment (e.g., cardiac medications), and diagnostic procedure related data were abstracted from hospital medical records by trained nurse and physician reviewers.^{14,15} While data have been collected in this ongoing investigation since 1975 on an approximate biennial basis, data on ventriculographic measurement of EF have only been collected since 1997. Patients hospitalized with confirmed AMI during the years 1997, 1999, 2001, 2003, and 2005 comprised the sample of interest.

Data analysis

Patients were classified into 4 mutually exclusive categories based on the EF tests they received during their index hospitalization: echocardiography only, left ventriculography only, neither, or both. Nuclear tests were not included in this analysis since only a relatively small number of patients (<2.5%) had their EF assessed by a nuclear test during hospitalization for AMI. Differences in the characteristics of greater Worcester residents hospitalized with AMI undergoing both left ventriculography and echocardiography as compared to those not undergoing both of these tests were examined through the use of chi-square tests of statistical significance for discrete variables and ANOVA for continuous variables. A multivariable logistic regression analysis was used to examine demographic and clinical factors associated with each of the testing profiles. Multivariable adjusted odds ratios (OR) and accompanying 95% confidence intervals (CI's) were calculated in a standard manner.

Since the use of these testing procedures may partially depend on a patient's clinical status, we carried out a subgroup analysis based on whether the patient's clinical course was complicated or uncomplicated. Patients were considered to have a complicated AMI if heart failure, cardiogenic shock, recurrent angina, or atrial fibrillation were diagnosed during the patient's index hospitalization. Patients were considered to have an uncomplicated AMI if none of these conditions was diagnosed during hospitalization.

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Results

Study Sample Characteristics

The study population consisted of 5,380 residents of the Worcester metropolitan area who experienced a documented AMI during the 5 study years. The average age of the study sample was 71 years, 56% were male, and 93% were Caucasian. Approximately two-thirds of the study population had a history of hypertension, one-third had a history of a percutaneous coronary intervention (PCI), and 6% had previously undergone coronary artery bypass graft (CABG) surgery (Table I). Of the echocardiograms conducted, 98.8% were conventional transthoracic studies; only 0.9% were transesophageal studies and 0.3% were stress echocardiograms.

Trends in the Evaluation of EF During Hospitalization for AMI

The percentage of patients undergoing an EF determination only by echocardiography ranged between 35% and 39% during the years under study (Figure 1). The percentage of patients undergoing an EF determination only by left ventriculography increased from 14% in 1997 to 20% in 2005. The percentage of patients who did not receive an evaluation of EF by either testing modality declined consistently from 37% to 27%, while the percentage of patients who received a determination of EF by both diagnostic modalities increased from 11% in 1997 to 18% in 2005.

The percentage of patients with a complicated AMI who underwent concurrent evaluation of their left ventricular function by both echocardiography and ventriculography increased from 12% in 1997 to 18% in 2005, while the percentage of patients with an uncomplicated AMI who underwent determination of their EF by echocardiography and ventriculography increased from 9% in 1997 to 19% in 2005. After excluding all hospital associated deaths, as well as early hospital deaths (within 48 hours of hospital admission), trends similar to those observed in the overall study population were noted.

Characteristics of Patients Undergoing Determination of EF by both Echocardiography and Ventriculography

Compared to all study patients, patients undergoing determination of their EF by both echocardiography and left ventriculography were more likely to be younger and male, to present with more typical symptoms of AMI, to present with an initial MI, ST segment elevation MI or Q-wave MI, and to have a lower heart rate, EF findings, and serum glucose levels during their hospitalization for AMI. On the other hand, these patients had higher blood pressures, serum hemoglobin levels, and better renal function (Table I). These patients were also more likely to have developed important clinical complications during hospitalization, to have previously undergone a PCI or CABG surgery, and to have been treated with effective cardiac medications during their hospitalization. Patients undergoing concurrent determination of their EF by both echocardiography and left ventriculography were more likely to have been evaluated at a teaching hospital and to be overweight. These patients were less likely to have a history of angina, heart failure, or renal disease, were less likely to have a do not resuscitate order in place at the time of hospital admission, and were less likely to have died during hospitalization.

In examining factors independently associated with the determination of a patient's EF by both echocardiography and ventriculography, patients undergoing determination of their EF by both testing modalities were significantly more likely to have been admitted to a teaching hospital, to present with an initial MI or an ST segment elevation MI, to have an EF<50%, normal kidney function, to have previously undergone a PCI or CABG surgery, to present with chest pain, and to have developed significant clinical complications during their hospitalization (Table II). These patients were also younger and were less likely to have a history of heart failure and a do not resuscitate order in their hospital records.

Similar regression analyses were carried out in greater Worcester residents hospitalized with AMI at all area medical centers during 2005 for purposes of providing a contemporary perspective into factors associated with the receipt of both diagnostic testing modalities as well as in patients with a complicated or uncomplicated MI. Factors significantly associated with receiving an EF determination by both testing modalities in 2005, and in those with a complicated or uncomplicated MI, were similar to those observed in the total study sample (Table II).

Trends in the Timing of EF Measurements by Echocardiography and Ventriculography

In 1997, approximately two-thirds of patients who underwent both diagnostic tests received an echocardiogram first, 25% were initially catheterized, and 8% had both procedures performed on the same hospital day (Figure 2). In 2005, 61% initially underwent cardiac catheterization, 16% had an echocardiogram first, and 23% received both tests on the same hospital day.

Since the EF testing pathway that patients follow currently is often based on whether they are determined to have a ST segment elevation MI or a non-ST segment elevation MI at the time of hospital presentation, we carried out an analysis restricted to patients hospitalized at all greater Worcester hospitals in 2005 to provide contemporary insights into the use of rapid invasive assessment (catheterization first) as compared to an initially conservative management approach (echocardiogram first).

Among patients hospitalized in 2005 with ST segment elevation MI, 78% underwent cardiac catheterization initially, 15% received an echocardiogram first, and 7% received neither test (Figure 3). Of the patients who were initially catheterized, 72% received an assessment of their EF by ventriculography; of these, 46% received a subsequent assessment of EF by

echocardiography. Of the patients who received an echocardiogram first, 95% had an EF assessment based on the echocardiogram; 32% of the patients with an EF measurement were then catheterized, and 54% of these patients subsequently received an assessment of their EF by ventriculography.

Among patients hospitalized with an non-ST segment elevation MI in 2005, 44% underwent cardiac catheterization initially, 36% received an echocardiogram first, and 20% received neither testing modality (Figure 4). Of the patients who were initially catheterized, 55% received an assessment of their EF by ventriculogram; of these, 28% received a subsequent assessment of EF by echocardiography. Of the patients who received an echocardiogram first, 96% had an EF assessment based on the echocardiogram. Thirty percent of the patients with an EF measurement subsequently underwent cardiac catheterization, and 37% of these patients received an assessment of their EF by ventriculography.

In 2005, 28% of patients with ST segment elevation MI and 11% of patients with non-ST segment elevation MI received an assessment of their ventricular function by both echocardiography and ventriculography during their acute hospitalization.

For patients who had their EF assessed by both modalities, the elapsed time between tests was similar regardless of which EF test was conducted first. When ventriculography was performed first, an average of 2.9 days elapsed between tests and 80% of EF determinations were conducted within 3 days. When echocardiography was the initial test, an average of 3.1 days between tests was observed, and 73% of tests were conducted within 3 days.

Discussion

The results of this study demonstrate changing trends in the use and timing of tests to evaluate EF in residents of the Worcester metropolitan area hospitalized with AMI. Our data show an increase in the proportion of patients who had their EF measured by both echocardiography and ventriculography, as well as an increase in the proportion of patients who had their EF measured by left ventriculography alone. The proportion of patients who did not receive an assessment of their EF by either testing modality during their hospitalization declined appreciably over time; however, approximately one-quarter of patients who were hospitalized with AMI in 2005 failed to receive an assessment of their EF by either testing modality. In 1997, the first test to measure EF in patients hospitalized for AMI was most often an echocardiogram whereas in 2005 the first test to measure a patient's EF was typically a ventriculogram. The tendency for ventriculography to be the first test for assessment of EF was most pronounced in patients who presented with an ST segment elevation MI. We also found that an increasing proportion of patients with AMI are having both diagnostic tests performed, often on the same hospital day. Furthermore, concurrent diagnostic testing was becoming increasingly more commonplace in those with an otherwise uncomplicated AMI.

Our observed trends in EF measurement appear to be closely linked to a broad national pattern of an increasingly more aggressive approach to the management of patients presenting with AMI.^{14–16} While our data demonstrate increased adherence to ACC/AHA guidelines, they also highlight specific situations in which tests of EF may be either over or under-utilized in the current environment.

The broad trend of increasing utilization of cardiac catheterization in patients hospitalized with AMI has been shown in several prior investigations.^{16,17} In a study of Medicare patients, the rate of cardiac catheterization increased from 22 to 37 (per 1000 beneficiaries) between 1993 and 2001.¹⁶ A prior analysis from the Worcester Heart Attack Study also demonstrated that the utilization of cardiac catheterization increased more than three fold between 1986 and

2003.¹⁸ These findings demonstrate the widespread increase in the use of cardiac invasive procedures, many of which are associated with an EF measurement by ventriculography.

Characteristics of Patients Undergoing Determination of EF by both Echocardiography and Ventriculography

The characteristics of patients most likely to receive concurrent assessment of their EF by both echocardiography and ventriculography were similar to the characteristics of patients most likely to receive an invasive management strategy for AMI. These characteristics include being younger, male, and overweight or obese. Data from the multinational Global Registry of Acute Coronary Events showed that younger patients presenting with an acute coronary syndrome were more likely to receive evidence-based management practices than elderly patients.¹⁹ Data from the National Registry of Myocardial Infarction demonstrated that men were more likely than women to receive cardiac interventions after an AMI.¹⁰ In the Worcester Heart Attack Study, the likelihood of receiving a cardiac catheterization was nearly 50% higher in men than women.²⁰ A study of Medicare patients with AMI in the mid-1990's showed that overweight patients were more likely to undergo cardiac procedures than patients with a normal body mass index.²¹

Patients who had their EF measured by both echocardiography and cardiac catheterization were more likely to have experienced several clinically important complications during hospitalization. These data suggest that patients with a complicated hospital course are more likely to receive additional cardiovascular testing in comparison to patients with an uncomplicated MI. Presumably, the development of complications during hospitalization for AMI triggered another assessment of left ventricular function. Additional reasons for further EF testing during hospitalization would include a specific indication, such as suspected valvular or pericardial disease or changes in cardiac performance, possibly associated with a new ischemic event. These indications notwithstanding, nearly 20% of patients with an uncomplicated AMI underwent EF testing by both diagnostic modalities during their acute hospitalization in 2005.

Changing Trends in the Timing of EF Assessment

The increased use of early coronary angiography likely explains why an increasing proportion of patients in our study had a left ventriculogram performed before an echocardiogram. However, in agreement with current guidelines, patients with non-ST segment elevation MI who receive an initial conservative management approach typically receive an assessment of their EF by echocardiography as the initial test. The guidelines suggest that an EF found to be <40% by echocardiography testing may be a criterion for coronary angiography. Thus, patients with a non-ST segment elevation AMI who had their EF initially assessed by echocardiography, and were found to have left ventricular dysfunction, may have proceeded to be managed invasively and received a second, and possibly duplicative, EF assessment by ventriculography.

Declining Proportion of Patients With AMI Who Do Not Have Their EF Measured

Between 1997 and 2005, the proportion of patients hospitalized with AMI who did not have their EF measured by any method declined by nearly one third. These findings are in agreement with the results of prior studies.^{11,12,22} In the VALIANT study registry, approximately 1 in 6 patients hospitalized with an AMI were discharged without an EF assessment between 1999 and 2001.¹¹ Approximately 1 in 5 residents of Olmsted County, MN, hospitalized with AMI between 1988 and 1998 did not have their EF measured within 10 days of hospital admission.¹²

Recent ACC/AHA guidelines strongly recommend that patients with AMI have an assessment of their EF performed.^{19,20} Therefore, the declining percentage of patients who did not have their EF measured in our study likely reflects improved patient management practices. However, it is still unclear why approximately one-quarter of patients who presented with an AMI were discharged without an assessment of their ventricular function. Possible reasons include a specific contraindication, patient denial of testing, or assessment of their EF either shortly before or shortly after the index hospitalization.

Study Strengths and Limitations

The strengths of the present study include its multi-hospital population-based perspective and the large number of patients with independently validated AMI who were studied. The study has several limitations, however, which must be kept in mind in interpreting the present study results. Since EF was only evaluated in the inpatient setting, we could not account for outpatient testing. In some cases, EF assessment during hospitalization may have been attempted, but not successfully accomplished, due to imaging or patient associated limitations. It is also possible that some of the patients who did not have an EF measured refused testing. We did not have information about the presence of valvular disease or changes in cardiac performance that would constitute a specific indication for concurrent testing. Our study was conducted in a single metropolitan area in New England and our results may not be generalizable to patients hospitalized with AMI in other geographic areas.

Conclusions

The results of this large observational study demonstrate an increasing use of ventriculography, and combined use of both ventriculography and echocardiography, over time to assess EF in patients hospitalized with AMI. The proportion of patients who were discharged without an assessment of EF has declined significantly during the years under study, reflecting improved adherence to published guidelines. Clinicians should attempt to assess EF in all patients hospitalized with AMI unless there is a specific contraindication. On the other hand, clinicians should seek to minimize concurrent testing of EF in the absence of a specific indication. In cases where EF is assessed initially by a ventriculogram, and no complication or specific indication for an echocardiogram exists, a second assessment of a patient's EF could be considered duplicative. Similarly, in cases where EF is initially assessed by echocardiography, another determination of EF during angiography may be considered duplicative without a significant change in clinical status. The present results are important because they suggest that approximately 1 in 5 patients hospitalized with an uncomplicated AMI receive concurrent, and possibly unnecessary, assessment of their EF with attendant cost and resource implications.

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Figure 1.
Changing Trends in the Measurement of Ejection Fraction in Patients Hospitalized with Acute Myocardial Infarction

Figure 2.
Changing Trends in the Relative Timing of Echocardiography and Ventriculography in Patients Hospitalized with Acute Myocardial Infarction

Figure 3.
Ejection Fraction Evaluation Flow Chart for Patients Hospitalized With ST Segment Elevation
Acute Myocardial Infarction in 2005

Figure 4.
Ejection Fraction Evaluation Flow Chart for Patients Hospitalized With Non-ST Segment Elevation Acute Myocardial Infarction in 2005

Table 1
Characteristics of Patients With Acute Myocardial Infarction (AMI) According to Testing Profile

Characteristic	Neither Testing Approach	Catheterization Only	Echocardiography Only	Both Diagnostic Modalities		P Value
	(n=1,729)	(n=917)	(n=1,994)	(n=740)		
<u>Demographics</u>						
Age (mean, years)	73.9	62.8	73.9	66.5		<.001
Length of hospital stay (mean, days)	4.6	5.3	6.6	8.8		<.001
Male (%)	52.1	68.5	52.2	61.1		0.10
Caucasian (%)	92.7	91.9	93.5	90.6		0.16
Do not resuscitate order in hospital records (%)	36.5	5.9	28.9	9.8		<.001
<u>Presenting symptoms (%)</u>						
Chest pain	67.2	89.5	65.6	82.7		<.005
Dizziness	10.9	16.6	13.6	15.8		<.005
Nausea	28.0	37.1	30.2	35.4		<.01
Sweating	30.5	47.8	35.4	48.4		<.001
Shortness of breath	56.5	52.7	60.4	60.7		<.005
<u>Medical History (%)</u>						
Angina	24.6	23.9	18.7	19.1		<.001
Hypertension	71.0	63.8	69.2	66.8		0.12
Heart failure	34.9	9.2	25.8	12.6		<.001
Diabetes	35.6	27.7	32.7	32.6		0.15
Stroke	13.8	6.4	13.7	8.8		0.09
Renal disease	20.6	6.4	17.7	8.5		<.001
<u>AMI Associated Characteristics (%)</u>						
Initial	57.0	68.8	66.9	73.1		<.001
Q wave MI	18.3	28.5	25.2	36.4		<.001
STEMI	29.2	46.1	37.5	53.1		<.005
<u>Clinical Complications (%)</u>						
Heart failure	36.5	16.4	46.1	40.1		<.001
Cardiogenic shock	4.8	2.6	6.4	10.7		<.001
Atrial fibrillation	17.2	10.1	22.5	23.8		<.001

Characteristic	Neither Testing Approach		Catheterization Only		Echocardiography Only		Both Diagnostic Modalities		P Value
	(n=1,729)		(n=917)		(n=1,994)		(n=740)		
Demographics									
Recurrent Angina	20.3		28.3		19.5		32.0		<.005
Death	17.4		3.6		10.3		5.7		<.001
Uncomplicated*	40.9		53.9		33.2		31.5		<.001
Complicated*	59.1		46.1		66.8		68.5		<.001
Physiologic Data (mean)									
Heart rate (bpm)	88		79		89		87		<.001
Systolic blood pressure (mmHg)	140		147		142		144		<.001
Diastolic blood pressure (mmHg)	75		82		76		79		<.001
Hemoglobin (mg/dl)	13.1		14.4		13.3		13.9		<.001
Blood urea nitrogen (mg/dl)	31.4		18.7		28.7		20.5		<.001
Glucose (mg/dl)	193		166		184		183		<.001
Body mass index	26.7		28.5		27.0		28.3		<.001
Ejection fraction (%)	---		50.0		45.5		44.9		<.001
Glomerular filtration rate (ml/min/1.73m ²)	54.8		71.6		55.7		68.3		<.001
Therapies (%)									
ACE inhibitors	44.4		63.5		61.3		77.3		<.001
Aspirin	85.7		97.2		91.8		96.5		<.001
Beta blockers	79.1		94.3		86.3		94.1		<.001
Lipid lowering agents	42.5		69.1		49.3		65.2		<.001
Thrombolytics	8.7		12.1		11.8		13.4		<.005
PCI	21.2		52.2		24.4		50.2		<.001
CABG	1.4		14.4		1.9		16.6		<.001

* Uncomplicated MI defined as absence of heart failure, shock, recurrent angina, and atrial fibrillation during index admission

* Complicated MI defined as the presence of any of the above conditions during index admission

Table II
Factors Associated With Evaluation of Ejection Fraction in Patients With Acute Myocardial Infarction (AMI) by Both Echocardiography and Left Ventriculography

<u>Characteristic</u>	<u>Total Sample</u>	<u>2005</u>	<u>Uncomplicated AMI</u>	<u>Complicated AMI</u>
Age (yrs)				
55–65	1.07 ^o (0.82,1.41)	0.98 ^o (0.53,1.81)	1.18 ^o (0.79,1.77)	0.98 ^o (0.67,1.42)
65–74	0.71 (0.54,0.94)	0.65 (0.34,1.22)	0.72 (0.45,1.13)	0.67 (0.46,0.97)
75–84	0.75 (0.56,1.00)	0.85 (0.44,1.65)	1.19 (0.74,1.91)	0.60 (0.41,0.87)
≥85	0.47 (0.31,0.71)	0.62 (0.27,1.42)	0.71 (0.32,1.61)	0.39 (0.24,0.64)
Female	0.85 (0.70,1.02)	0.73 (0.48,1.11)	0.96 (0.69,1.33)	0.81 (0.64,1.01)
Do not resuscitate order	0.55 (0.40,0.75)	0.78 (0.41,1.50)	0.49 (0.21,1.14)	0.60 (0.42,0.85)
Length of stay	1.04 (1.03,1.06)	1.02 (0.98,1.06)	1.07 (1.03,1.10)	1.04 (1.02,1.05)
Teaching hospital	10.88 (4.43,26.69)	7.58 (0.98,58.44)	11.55 (2.79,47.79)	10.39 (3.26,33.12)
EF <50%	3.69 (3.08,4.43)	3.94 (2.59,5.99)	3.67 (2.70,4.99)	3.82 (3.04,4.80)
GFR >60 ml/min/1.73m ²	1.25 (1.01,1.54)	1.12 (0.68,1.84)	1.04 (0.69,1.58)	1.36 (1.06,1.75)
<u>Medical History</u>				
Angina (+)	0.82 (0.66,1.03)	0.78 (0.43,1.41)	0.64 (0.40,1.00)	0.89 (0.69,1.16)
Heart failure (+)	0.65 (0.50,0.85)	0.55 (0.31,0.97)	0.61 (0.30,1.25)	0.65 (0.48,0.87)
<u>AMI Characteristics</u>				
Initial MI	1.38 (1.12,1.69)	1.81 (1.12,2.91)	1.56 (1.05,2.30)	1.32 (1.04,1.69)
ST segment elevation MI	1.33 (1.09,1.62)	1.44 (0.92,2.25)	1.36 (0.97,1.90)	1.36 (1.06,1.74)
<u>Therapies</u>				
PCI	1.77 (1.46,2.15)	3.09 (1.85,5.15)	1.68 (1.21,2.33)	1.89 (1.48,2.41)
CABG surgery	2.65 (1.98,3.56)	2.23 (0.83,6.01)	1.44 (0.79,2.63)	3.24 (2.29,4.59)
<u>Symptoms</u>				
Any chest pain	1.31 (1.04,1.66)	1.45 (0.83,2.53)	1.49 (0.93,2.39)	1.23 (0.93,1.62)
Complicated MI [*]	1.39 (1.14,1.69)	1.33 (0.84,2.11)		

* Uncomplicated MI defined as absence of heart failure, shock, recurrent angina, and atrial fibrillation during index admission

* Complicated MI defined as the presence of any of the above conditions during index admission

[†] Respective referent categories: age <55 years, male, absence of a do not resuscitate order, nonteaching hospital, EF >50%, GFR <60 ml/min/1.73m², absence of prior angina and heart failure, prior MI, non-ST segment elevation AMI, failure to undergo a PCI or CABG surgery, other acute symptoms, uncomplicated MI.

^o Odds ratios (95% CI's)