CHEST

Original Research

CARDIOVASCULAR DISEASE

The Impact of COPD on Management and Outcomes of Patients Hospitalized With Acute Myocardial Infarction

A 10-Year Retrospective Observational Study

Mihaela S. Stefan, MD; Raveendhara R. Bannuru, MD; Darleen Lessard, MS; Joel M. Gore, MD; Peter K. Lindenauer, MD; and Robert J. Goldberg, PhD

Background: **There are limited data describing contemporary trends in the management and outcomes of patients with COPD who develop acute myocardial infarction (AMI).**
Methods: **The study population consisted of patients hospitalized with AMI at all greater Worcester, Massachusetts, medical centers between 1997 and 2007.**
Results: **Of the 6,290 patients hospitalized with AMI, 17% had a history of COPD. Patients with COPD were less likely to be treated with β-blockers or lipid-lowering therapy or to have undergone interventional procedures during their index hospitalization than patients without COPD. Patients with COPD were at higher risk for dying during hospitalization (13.5% vs 10.1%) and at 30 days after discharge (18.7% vs 13.2%), and their outcomes did not improve during the decade-long period under study. After multivariable adjustment, the adverse effects of COPD remained on both in-hospital (OR, 1.25; 95% CI, 0.99-1.50) and 30-day all-cause mortality (OR, 1.31; 95% CI, 1.10-1.58). The use of evidence-based therapies for all patients with AMI increased between 1997 and 2007, with a particularly marked increase for patients with COPD.**
Conclusions: **Our results suggest that the gap in medical care between patients with and without COPD hospitalized with AMI narrowed substantially between 1997 and 2007. Patients with COPD, however, remain less aggressively treated and are at increased risk for hospital adverse outcomes than patients without COPD in the setting of AMI. Careful consideration is necessary to ensure that these high-risk complex patients are not denied the benefits of effective cardiac therapies.** ***CHEST 2012; 141(6):1441–1448***

Abbreviations: AMI = acute myocardial infarction; CABG = coronary artery bypass surgery; HF = heart failure; PCI = percutaneous coronary intervention

COPD affects >24 million American adults and results in 600,000 hospitalizations annually.[1,2] Cardiovascular disease is an important cause of hospitalization in patients with COPD and is the leading cause of mortality in these high-risk patients.[3,4] In addition to smoking, patients with COPD have other risk factors for cardiovascular disease due, in part, to their advanced age and reduced levels of physical activity.

Despite the magnitude of and mortality associated with COPD, there is limited information available about the characteristics, management practices, and hospital outcomes of patients with COPD with acute myocardial infarction (AMI). Although prior research has shown that β-blockers and other effective cardiac therapies are underused in patients with AMI with COPD,[5-8] it is less clear to what extent the overall management of AMI differs between patients with and without COPD and how their acute treatment and outcomes may have changed during recent periods. The purpose of this large observational study was to examine differences in the clinical characteristics, hospital outcomes, and use of different treatment approaches in patients with and without COPD hospitalized with AMI over the period of 1997 to 2007.

Materials and Methods

The Worcester (Massachusetts) Heart Attack Study is an ongoing population-based investigation examining long-term trends in the incidence and death rates of greater Worcester (2000 census: 478,000) residents hospitalized with AMI at all metropolitan Worcester medical centers. The methods used in this study have been previously described in detail.[9-11] Data have been collected on a biennial basis since 1975; a total of 6,290 patients hospitalized with independently validated AMI during the 6 study years of 1997, 1999, 2001, 2003, 2005, and 2007 comprised the population for this report, because information about COPD was only collected from 1997 on. In brief, patients with AMI were identified through standardized review of computerized hospital databases by trained study physicians and nurses according to preestablished criteria. At least two of the following three criteria needed to be satisfied for study inclusion: prolonged chest pain not relieved by rest or use of nitrates, biomarkers in excess of the upper limit of normal at each participating hospital, and serial ECG tracings showing changes in the ST segment and Q waves typical of AMI. Abstracted data included demographics, presenting symptoms, medical history, AMI characteristics, laboratory measurements, length of hospital stay, and hospital discharge status. Use of cardiac medications, cardiac catheterization, coronary reperfusion therapies used as primary revascularization (percutaneous coronary intervention [PCI] and coronary artery bypass surgery [CABG]), and development of important complications during hospitalization were determined. COPD was considered to be present if a patient was described in his/her medical record as having clinical or radiographic evidence of COPD. Pulmonary function testing results were not available to confirm the diagnosis or to assess the severity of COPD.

Data Analysis

Differences in the demographic and clinical characteristics as well as in the receipt of various treatment practices among patients with AMI with and without a history of COPD were examined using χ^2 tests for discrete variables and Student t test for continuous variables. We examined the association between COPD and in-hospital and 30-day mortality as well as between COPD and significant hospital complications using multivariable logistic regression analyses to control for the influence of potentially confounding prognostic factors. The variables included in the logistic regression models were age, sex, year of hospitalization, history of cardiovascular disease, history of renal failure, ST-elevation MI, and hospital length of stay. In a secondary analysis we also adjusted for current smoking status, in addition to previously mentioned variables. We report the analysis for the 10-year period and for three aggregated periods of time for ease of analysis and interpretation: 1997/1999, 2001/2003, and 2005/2007. To examine changes over the period under study with regard to the use of various hospital treatments and short-term outcomes of patients with AMI with and without COPD, we used χ^2 tests for trends.

All analyses were performed using SAS 9.2 (SAS Institute Inc). This study was approved by the institutional review board at the University of Massachusetts Medical School, Worcester, approval number H-458.

Results

Study Population Characteristics

Of the 6,290 patients hospitalized with AMI within the 10-year period of the study, 17% had COPD. Overall, the average age of this population was 71 years, and 56% were men. Compared with patients without COPD, patients with COPD were, on average, 4 years older and more likely to be current smokers and to have had angina, heart failure (HF), hypertension, diabetes, renal disease, and stroke previously diagnosed. Patients with COPD were more likely to have presented with a non-ST-segment elevation AMI and were less likely to present with chest pain but more likely to present with dyspnea. In comparison with all study patients, patients hospitalized during the 2 most recent years under investigation were older and had a higher prevalence of selected comorbidities (Table 1).

Hospital Treatment Practices

Patients with COPD were less likely to have been treated with anticoagulants, aspirin, thrombolytics, lipid-lowering medication, or β-blockers or to have undergone primary cardiac revascularization procedures, but were more likely to have received calcium channel blockers, during their index hospitalization than patients without COPD (Table 2).

After controlling for a number of potentially confounding factors that may have affected the prescribing of these treatment approaches, patients with COPD had a 56% lower odds to have been treated with β-blockers, 30% for lipid-lowering medication, and 44% lower odds to have undergone cardiac catheterization. They were also less likely to have undergone a PCI (OR, 0.64; 95% CI, 0.54-0.77) and CABG (OR, 0.46; 95% CI, 0.32-0.66) during their index hospitalization, but were more likely to have been prescribed calcium channel blockers, than patients without COPD (Table 3).

In terms of changing treatment trends during the decade-long period under study, there was a marked

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Affiliations: From the Department of General Medicine (Drs Stefan and Lindenauer), Baystate Medical Center, Springfield, MA; the Tufts Clinical and Translational Science Institute (Drs Stefan, Bannuru, and Lindenauer), Tufts University School of Medicine, Boston, MA; and the Department of Medicine (Dr Gore) and Department of Quantitative Health Sciences (Ms Lessard and Dr Goldberg), University of Massachusetts Medical School (Ms Lessard, Drs Gore and Goldberg), Worcester, MA.

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Correspondence to: Mihaela S. Stefan, MD, Baystate Medical Center, 756 Chestnut St, Springfield, MA 01199; e-mail: mihaela.stefan@bhs.org

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Table 1—*Baseline Characteristics of Patients Hospitalized With AMI According to a History of COPD*

Characteristics	Total Study Population		2005/2007 Cohort	
	COPD Present (n = 1,080)	COPD Absent (n = 5,210)	COPD Present (n = 300)	COPD Absent (n = 1,512)
Demographics				
Age, mean, y	74	70[a]	73.5	69.8[a]
Age				
< 65	19.4	34.3	19.0	34.9
65-74	27.1	20.1	27.0	16.8
75-84	35.1	27.6	32.7	27.5
> 85	18.4	18.0	21.3	20.9
Male sex	52.4	57.1[b]	50.8	56.1
Medical history				
Hypertension	72.7	68.8[b]	81.1	74.9[b]
Diabetes mellitus	37.0	32.3[b]	45.2	33.8[c]
Angina	22.3	19.2[b]	15.0	11.8
Heart failure	38.6	21.0[a]	42.9	22.5[c]
Stroke	15.0	11.0[a]	15.3	11.0[b]
Renal disease	22.3	15.6[a]	32.9	21.6[c]
DNR	34.4	22.1[a]	35.2	24.6[c]
Current smoking	27.3	20.4[c]	29.6	20.8[c]
Symptoms				
Chest pain	52.9	67.7[c]	52.2	68.6[c]
Dyspnea	61.5	47.0[c]	62.9	48.0[c]
Initial heart rate	94.4	84.9[c]	93.0	84.4[c]
AMI type				
ST elevation MI	26.7	39.6[a]	24.3	32.9[a]

Data are given as % unless otherwise indicated. AMI = acute myocardial infarction; DNR = do not resuscitate status; MI = myocardial infarction.
[a]$P < .01$ patients with COPD compared with patients without COPD in each cohort.
[b]$P < .05$ patients with COPD compared with patients without COPD in each cohort.
[c]$P < .001$ patients with COPD compared with patients without COPD in each cohort.

increase in the use of β-blockers (64% in 1997, 93% in 2007), anticoagulants (48% in 1997, 93% in 2007), and lipid-lowering therapy (25% in 1997, 76% in 2007), and decrease in the use of calcium channel blockers (42% in 1997, 24% in 2007) in patients with COPD (Fig 1, Table 2). The use of cardiac catheterization (28% to 53% and 44% to 69%) and PCI (11% to 36% and 20% to 52%) increased significantly in patients with and without COPD, respectively, between 1997 and 2007, whereas the use of CABG remained relatively

Table 2—*Hospital Treatment Practices and Outcomes of Patients Hospitalized With AMI According to a History of COPD and Period of Hospitalization*

Therapies/Outcomes	1997/1999		2005/2007	
	COPD Present	COPD Absent	COPD Present	COPD Absent
ACE inhibitors	50.5	50.1	71.4	64.9[a]
Anticoagulants	48.3	57.5[a]	81.7	80.2
Aspirin	89.0	92.2	92	95.6[a]
β-Blockers	64.6	84.6[b]	93.4	95
Calcim channel blockers	42.3	25.2[b]	24.3	20.8
Lipid lowering	25.0	32.4[c]	76.0	79.0
Cardiac catheterization	28.6	44.0[b]	53.2	69.3[b]
PCI	11.0	20.3[b]	36.5	51.8[b]
CABG	3.8	5.8	5.7	5.6
Atrial fibrillation	17.6	13.6	28.2	20.7[c]
Heart failure	46.4	32.2[b]	55.2	36.9[b]
In-hospital mortality	11	12	14.4	8.7[c]
30-d mortality	15	14.7	18.7	12.3[c]

ACE = angiotensin-converting enzyme; CABG = coronary artery bypass surgery; PCI = percutaneous coronary intervention. See Table 1 legend for expansion of other abbreviation.
[a]$P < .05$ patients with COPD compared with patients without COPD in each cohort.
[b]$P < .001$ patients with COPD compared with patients without COPD in each cohort.
[c]$P < .01$ patients with COPD compared with patients without COPD in each cohort.

Table 3—*Outcomes of Patients Hospitalized With AMI According to a History of COPD*

Therapies/Outcomes	Total Study Population: COPD Present, %	Total Study Population: COPD Absent, %	OR (95% CI)
Outcomes			
Atrial fibrillation	24.3	18.2[a]	1.14 (0.97-1.34)
Heart failure	52.5	34.8[b]	1.59 (1.37-1.83)
Cardiogenic shock	5.7	6.0	0.88 (0.66-1.18)
Stroke	1.7	1.7	0.83 (0.49-1.40)
In-hospital death	13.5	10.1[b]	1.25 (0.99-1.50)
30-d mortality	18.7	13.2[a]	1.31 (1.10-1.58)
Therapies			
β-Blockers	78.2	89.6[a]	0.44 (0.35-0.50)
Anticoagulants	69.7	73.1	0.81 (0.69-0.95)
Lipid-lowering agents	52.9	59.2[a]	0.70 (0.60-0.82)
Calcium channel blocker	32.9	23.8[a]	1.31 (1.13-1.52)
Cardiac catheterization	39.0	56.0[a]	0.56 (0.48-0.65)
PCI	23.0	36.0[a]	0.64 (0.54-0.77)
CABG	4.0	6.4[c]	0.46 (0.32-0.66)

Variables included in the model: COPD, age, sex, year of hospitalization, cardiovascular disease history (coronary artery disease, stroke, heart failure, diabetes, hypertension), renal failure, length of stay, ST-elevation MI. See Table 1 and 2 legends for expansion of abbreviations.

[a]$P < .001$.

[b]$P < .01$.

[c]$P = .051$.

steady in both groups over time (4% to 6% in both groups).

Outcomes

In comparison with patients without COPD, patients with COPD were more likely to have died during their acute hospitalization (13.5% vs 10.1%) and during the 30-day period after (18.7% vs 13.2%). The occurrence of atrial fibrillation (24.3% vs 18.2%) and heart failure (52.5% vs 34.8%) were significantly higher in patients with COPD (Table 3). Median hospital length of stay was 5 days for patients with COPD and 4 days for patients without COPD.

After adjusting for potential confounding factors of prognostic importance, patients with COPD had a 25% increased risk for dying in the hospital and a 31% higher risk of dying at 30 days after discharge (Table 3). Patients with COPD had a 59% increased risk for developing HF during hospitalization even after controlling for multiple potentially confounding variables.

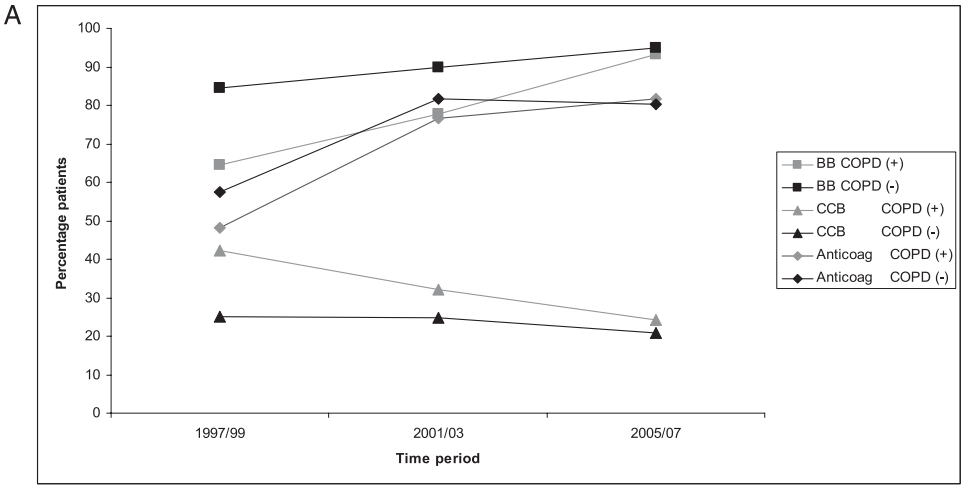
Although in-hospital mortality rates steadily declined during the years under study for patients with AMI without COPD, there was no improvement over time in hospital and 30-day survival for patients with COPD. In both patient groups, the risk of atrial fibrillation and HF increased, whereas the risk of cardiogenic shock and stroke decreased, during the years under study. (Fig 2, Table 2) In a sensitivity analysis, we adjusted for current smoking status, but our main results did not change meaningfully.

Discussion

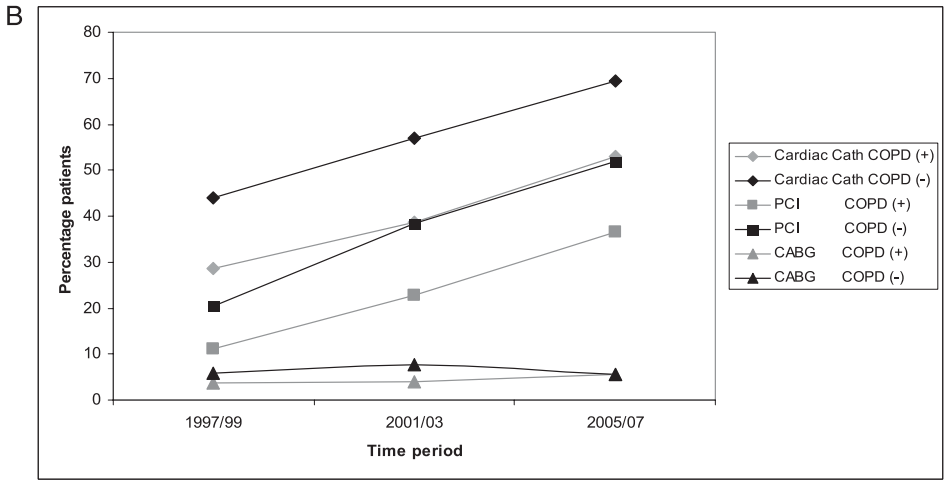
The results of this large observational study among residents of central Massachusetts hospitalized with AMI between 1997 and 2007 demonstrate significant differences among patients with and without COPD with regard to clinical presentation, treatments received, and hospital outcomes. Patients with COPD were more likely to have an atypical clinical presentation, were less likely to have been prescribed evidence-based cardiac therapies and interventional procedures during their hospitalization for AMI, and were more likely to have experienced complications. During the decade-long period under study, there was an overall improvement in the use of effective cardiac therapies in patients with and without COPD, with a particularly marked increase in the use of β-blockers and cardiac catheterization in patients with COPD. Although short-term mortality decreased for patients with AMI without COPD, there was no improvement over time in the survival of patients with COPD.

In the present study, approximately one in every six patients hospitalized with AMI had a history of COPD. Prior studies have reported considerable variation in the prevalence of COPD in patients with acute coronary syndromes, ranging from as low as 5%[8] to as high as 20%.[7,12,13] These wide variations in COPD prevalence likely reflect differences in the characteristics of patients studied and working definitions of COPD. Our observation that patients with COPD were older and had a worse cardiovascular profile than patients without COPD is consistent with the results of other investigations.[8,14-16] Patients with COPD were more likely to have presented with dyspnea than with chest pain (62% vs 47%). Shortness of breath is a common symptom of COPD, and it may be interpreted as part of an acute exacerbation; as such, the diagnosis of an AMI can be missed. These findings support the results of a study of 900 patients admitted with an exacerbation of COPD, which showed a high percentage of undiagnosed myocardial infarction.[17]

The results of the current study suggest that patients with a history of COPD were less likely to receive therapies of proven benefit for patients with AMI. As expected, the use of all evidence-based therapies for patients with AMI increased between 1997 and 2007, but more significantly so for patients with COPD. As a result of these changing trends, differences in the hospital use of several effective cardiac



Abbreviations: BB = beta-blockers, CCB = calcium channel blockers, Anticoag= anticoagulation
COPD (+) = COPD present, COPD (-) = COPD absent

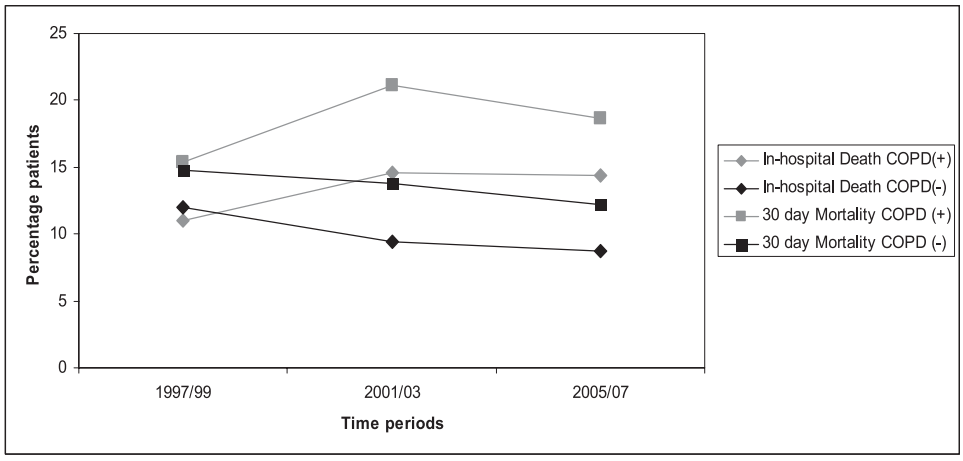


Abbreviations: Cardiac cath = cardiac catheterization, PCI = percutaneous coronary intervention, CABG =coronary artery bypass graft
COPD (+) = COPD present, COPD (-) = COPD absent

FIGURE 1. Hospital treatment practices of patients hospitalized with acute myocardial infarction (AMI) according to a history of COPD, 1997-2007. A, Use of cardiac medications according to a history of COPD and to time period of hospitalization. B, Use of cardiac procedures and coronary reperfusion therapy according to a history of COPD and to time period of hospitalization.

therapies between patients with and without COPD were relatively modest in the most recent years of our study (2005-2007). During the earlier years of this population-based study, patients with COPD were less likely to have been prescribed β-blocker therapy than patients without COPD, a finding that is consistent with the results of several previous studies.[5,7,8,18] Physicians may be reluctant to use β-blockers in patients with COPD because of concerns with aggravating bronchospastic symptoms, but current evidence suggests that cardioselective β-blockers are generally well tolerated.[19,20] In our analysis, the use of β-blockers was higher than has been reported in previously published studies. The increase in β-blocker prescribing over time was greater for patients with COPD, and by 2007 the gap between patients with and without COPD had narrowed considerably. This marked increase in the use of β-blockers between 1997 and 2007 is very encouraging and suggests that the results of systematic reviews and clinical trials have been increasingly incorporated into the care of patients with AMI and COPD.

In the current study, the rates of cardiac catheterization were only 39% in patients with COPD, lower than current national estimates.[21] The use of PCI and CABG was also lower in patients with AMI and COPD than in patients without COPD, which suggests that clinicians are less likely to perform interventional procedures in this group of patients. There are conflicting findings in the published literature



COPD (+) = COPD present, COPD (-) = COPD absent

FIGURE 2. Outcomes of patients hospitalized with AMI according to a history of COPD and to time period of hospitalization. See Figure 1 legend for expansion of abbreviation.

with regard to the outcomes of patients with AMI and COPD after undergoing PCI and CABG, with one study reporting a higher in-hospital death[22] and another study not finding any differences in in-hospital death and major adverse outcomes between patients with COPD and without COPD.[15]

The older age, higher number of comorbidities, and overlap between the respiratory and cardiac symptoms in patients with AMI and associated COPD have important implications for the management of these complex patients. Physicians may consider patients with COPD at high risk for complications and they may be hesitant to recommend cardiac catheterization and PCI, although these patients may equally benefit from the receipt of these more aggressive but evidence-based interventions.

In our study, patients with AMI and COPD had a 59% increased risk for developing HF during their index hospitalization compared with those without COPD. The use of medications that stimulate the cardiovascular system, including sympathomimetic and anticholinergic drugs, together with persistent right ventricle strain, may predispose patients with COPD to develop HF post MI.

In the present study, patients with COPD and AMI had substantially higher hospital and 30-day mortality than patients without COPD, and the association between COPD and mortality remained significant after controlling for a variety of potentially confounding prognostic factors. The current results are in contrast with the findings from the Gulf Registry of Acute Coronary Events (Gulf RACE) study in Middle Eastern residents, which concluded that patients with AMI and COPD are at greater risk for developing HF but not at increased risk for dying during hospitalization.[8] However, our results confirm and extend the findings from two other studies done in the United States that assessed long-term mortality post MI and showed that patients with COPD have approximate twofold greater 1-year mortality than patients without COPD.[12,23]

Despite significant improvements in the overall quality of care for patients hospitalized with AMI and COPD, their clinical outcomes did not improve significantly between 1997 and 2007. Sustained improvement and refinement in the appropriate use of novel treatment strategies in this increasingly prevalent and unique subgroup of patients may be necessary to achieve better survival and lower their risk of AMI-associated complications. Educational efforts for both specialists and general internists may improve the outcomes of these patients if, at the time of diagnosis of COPD, health-care professionals assess patients' cardiovascular risk and aggressively target their risk factors. Further studies exploring their optimal management will contribute to additional improvement in their hospital and long-term outcomes.

Study Strengths and Limitations

The Worcester Heart Attack Study is a large population-based investigation that reflects community practice patterns and short-term outcomes of patients with and without COPD in a large Massachusetts population. A limitation of our study was that we did not have information about pulmonary function testing. However, previous studies of the interaction between COPD and AMI have used similar criteria to define COPD,[8,12] and our results should be generalizable to patients who report a history of COPD.

CONCLUSIONS

In summary, patients with AMI and COPD were less likely to receive evidence-based therapies during

hospitalization, and they had a higher risk of dying during hospitalization and at 30 days after discharge. Although the use of therapies recommended per current guidelines increased in all patients hospitalized with AMI during the 10 years under study, and the gap in care quality between patients with and without COPD closed substantially, differences in treatment persist, and the outcomes of patients with AMI and underlying COPD did not improve. Therefore, it is essential to educate providers to consider cardiovascular comorbidities in patients with COPD and not focus on the pulmonary disease in isolation. Careful consideration is necessary to treat established cardiovascular risk factors and optimize cardiac therapies in patients with COPD.

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Ms Lessard: contributed to data analysis and interpretation and drafting and revising the manuscript.
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