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Effect of Chronic Obstructive Pulmonary Disease on In-Hospital Mortality and Clinical Outcomes after ST-segment Elevation Myocardial Infarction

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Abstract

There is controversy regarding in-hospital mortality, revascularization, and other adverse outcomes in patients with ST-segment elevation (STEMI) and chronic obstructive pulmonary disease (COPD). We queried the 2003–2011 Nationwide Inpatient Sample (NIS) databases to identify patients ≥18 years old with a primary diagnosis of STEMI. Univariate and multivariate analyses were performed to evaluate the association of COPD with in-hospital clinical outcomes. COPD patients comprised 13.2% of 2,120,005 STEMI patients. COPD was associated with older age, Medicare insurance, greater comorbidities, and lower socioeconomic status. When compared with non-COPD patients, COPD patients had higher in-patient mortality even after adjustment for multiple potential other factors (12.5% vs. 8.6%, adjusted odds ratio (AOR) 1.13, 95% confidence

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interval (CI) 1.11 to 1.15, p<0.001). COPD patients were more likely to develop new-onset heart failure (AOR 2.01, 95% CI 1.99 to 2.03), cardiogenic shock (AOR 1.24, 95% CI 1.22 to 1.26) and acute respiratory failure (AOR 2.46, 95% CI 2.43 to 2.50) during their hospital stay. COPD patients were less likely to undergo diagnostic angiographies and any revascularization procedures. The mean length of stay (6.0 vs. 4.6 days; *P*<0.001) was higher in COPD patients, as were hospital average hospital charges ($63,956 vs. $58,536; *P*<0.001). In conclusion, among STEMI patients, COPD is associated with a greater risk of in- hospital mortality, new onset heart failure, acute respiratory failure and cardiogenic shock.

Keywords

COPD; STEMI; mortality; clinical outcomes; revascularization

Chronic obstructive pulmonary disease (COPD) affects more than 11 million patients and is the third leading cause of death in United States.[1] A significant proportion of COPD patients suffer from myocardial infarction (MI) and the prevalence of COPD in MI patients ranges from 10 to 17%.[2–7] Although studies have reported higher, long-term mortality in COPD patients post-MI, there is controversy regarding in-hospital mortality.[8–13] While some clinical studies have reported higher in-hospital mortality post MI in COPD, others found no significant difference.[9–13] Importantly, there is limited information regarding in-hospital adverse clinical outcomes in STEMI patients with COPD. A previous study found COPD to be an independent predictor of in-hospital mortality among non-STEMI patients, but not in STEMI patients.[11] Therefore, we examined the Nationwide Inpatient Sample (NIS) database (2003 to 2011) to investigate the impact of COPD on revascularization, morbidity and mortality in 2,120,005 STEMI patients.

Methods

Our study population involved a population-based sample of STEMI patients from 2003–2011 whose admission and discharge data were included in the NIS of the Healthcare Cost and Utilization Project (HCUP).[14] Patients with the primary diagnosis of STEMI were identified according to the International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM] codes. Patients with a history of COPD were identified using ICD-9 codes, mentioned anywhere except primary diagnosis column. This approach has been utilized previously using the NIS database to accurately identify COPD patients.[15] The STEMI and COPD ICD-9 codes used are listed in e-Table 1. In addition, the following baseline patient characteristics were examined: demographics (age, sex, race, primary expected payer, median household income for patient's ZIP code, weekday versus weekend admission), all Elixhauser comorbidities (except chronic pulmonary disease)- acquired immune deficiency syndrome, alcohol abuse, deficiency anemia, rheumatoid arthritis/collagen vascular diseases, chronic blood loss anemia, heart failure (HF), chronic renal failure, coagulopathy, depression, diabetes [uncomplicated], diabetes [with chronic complications], drug abuse, hypertension, hypothyroidism, liver disease, lymphoma, fluid and electrolyte disorders, metastatic cancer, other neurologic disorders, obesity, paralysis, peripheral vascular disease, psychosis, pulmonary circulation disorders, solid tumor without

metastasis, valvular heart disease, and weight loss.[14, 16] Other clinically relevant comorbidities were also examined including smoking, dyslipidemia, prior MI, prior percutaneous coronary intervention (PCI), prior coronary artery bypass grafting (CABG), atrial fibrillation, carotid artery disease, family history of coronary artery disease, history of cerebrovascular accident and type of coronary intervention (diagnostic coronary angiography, PCI, and CABG). We also included hospital variables such as hospital region (Northeast, Midwest, South, and West), bed size (small, medium, and large), location (rural, urban), and teaching status in our analysis.

The principal outcome measure was in-hospital mortality, labeled as "died" in the database. Secondary outcomes included new-onset HF (defined as patients without a past history of HF but with HF at the time of discharge), cardiogenic shock and acute respiratory failure. Use of diagnostic coronary angiographies, PCI and CABG was also studied and compared. All ICD-9-CM codes used in our study were extracted from official website of Center for Medicare and Medicaid Services. Comorbidities were classified using the HCUP Comorbidity Software.[14] ICD-9-CM codes and Clinical Classification Software codes used to identify baseline characteristics are provided in e-Table 1.

Categorical variables are expressed as percentages and continuous variables as mean ± SD. We initially compared the baseline patient and hospital characteristics between the two groups (non-COPD and COPD) using the Pearson chi -square test for categorical variables and Student t-test for continuous variables to identify significant univariate associations, defined as a two-tailed $p<0.05$. Multivariate unconditional logistic regression was then used to compare in-hospital outcomes (in-hospital mortality, new-onset HF, acute respiratory failure and cardiogenic shock) between patients with COPD and without COPD. Adjusted odds ratios (AOR) and 95% CI were used to report the results of logistic regression. The regression models were adjusted for patient demographics, hospital characteristics, all Elixhauser comorbidities (except chronic pulmonary disease), other clinically relevant comorbidities and use of intervention (diagnostic coronary angiography, PCI and CABG). Statistical analysis was performed using IBM SPSS Statistics 23.0 (IBM). All analyses were weighted using NIS provided weights to create national estimates. This study was deemed exempt by the University of Tennessee Health Science Center Institutional Review Board because the HCUP-NIS is a publicly available database containing de-identified patient information.

Results

Of 2,120,005 nationally estimated STEMI patients, there were 279,488 (13.2%) patients with a history of COPD and 1,840,517 (86.8%) non-COPD patients. COPD patients were older, more likely to be female, Caucasian and have Medicare insurance than patients without COPD (all $p <0.001$). A past history of smoking, diabetes mellitus, atrial fibrillation, HF, peripheral vascular disease, alcohol abuse, cerebrovascular accident, renal failure or prior PCI/CABG/MI was more prevalent in patients with COPD. (Table 1) The COPD patients were less likely to have diagnostic coronary angiographies and coronary revascularization procedures during the hospital stay when compared with patients without COPD. (Table 2)

Univariate analysis revealed that COPD patients had significantly higher inpatient mortality (12.5% vs. 8.7%) compared to patients without COPD. After adjustment for demographics, hospital characteristics, comorbidities and cardiac interventions, patients with COPD had higher in-patient mortality compared to those without COPD (AOR for COPD 1.13, 95% CI 1.11 to 1.15; Table 3). They had a higher incidence of new-onset HF (39.4% vs. 21.3%), cardiogenic shock (10.6% vs. 7.8%) and acute respiratory failure (20.6% vs. 8.7%) when compared with non-COPD patients. (Table 3) Also COPD patients had a longer average length of stay and higher average total hospital charges than patients without COPD. (Table 3)

Discussion

This is the largest study to examine the impact of COPD on in-hospital mortality and clinical outcomes in patients presenting with a primary diagnosis of STEMI. COPD was relatively common among STEMI patients (13.2 %) and was associated with higher in-hospital mortality, more frequent adverse clinical outcomes and longer average length of stay than patients without COPD.

Prior studies have reported conflicting results for in-hospital mortality in COPD patients after STEMI.[8–13] Similar to our findings, a smaller single center study by Wakabayashi et al. reported COPD to be an independent predictor for inpatient mortality or cardiogenic shock post-STEMI when they compared 365 COPD patients with 2884 non-COPD patients.[10] In contrast, other smaller sample studies by Sung et al. and Lazzeri et al., reported no significant in-hospital mortality difference in STEMI patients with and without COPD.[12,13] In a large registry-based study comparing 6,395 STEMI patients with COPD and 56,911 STEMI patients without COPD, a higher unadjusted rate of death (9.2% vs. 5.5%) was found, but no difference in risk-adjusted mortality (AOR 1.05, 95% CI 0.95–1.17) was noted.[11] Still, the AOR for mortality in that study is similar to our study (1.05 vs. 1.13), thus the failure to find a significant difference in the former studies may have been due to lower statistical power from a smaller sample size.[11–13] It is notable that our patient population was older and less likely to be privately insured than in previous report.[11] Age, socioeconomic status and insurance status strongly impact cardiovascular disease mortality.[17,18] Nevertheless, after adjustment for these variables and others, COPD patients with STEMI still had an increased adjusted risk for in-patient mortality.

A key question is why the outcomes of STEMI patients with COPD are worse than those without COPD. COPD patients may have poorer clinical outcomes due to impaired lung function and oxygenation, higher inflammatory state, more cardiovascular risk factors and a more extensive atherosclerotic disease.[19,20] Another factor that may contribute to the enhanced mortality and adverse outcomes in COPD patients is that these patients were less likely to receive life-saving interventions such as beta- blocker therapy, diagnostic angiography or PCI at the time of initial presentation or during hospitalization.[5,6,8,11–13] The use of prior or in-hospital beta- blocker therapy in STEMI patients is associated with lower incidence of in-hospital adverse cardiac events and death.[21–23] Although coronary artery bypass was more frequent in COPD patients in this study, overall these patients were less likely to be revascularized. Since COPD patients may present with atypical anginal

equivalents (dyspnea, palpitations, atypical chest pain), there may be delays in the initial recognition and reperfusion as shown previously.[5,6,11,24] COPD patients were more likely to have lower median household income and Medicare insurance, which may affect health-care delivery systems and performance of emergency services, leading to delays from symptom onset to first medical contact that may lead to differences in outcomes. Differences in reperfusion protocols or timing can affect mortality in these critically sick patients.[5,8,25,26] Although variables such as door to balloon time, symptom-onset to balloon time etc. are unavailable in our study, COPD remained associated with poor clinical outcomes after adjustment for differences in the use of invasive coronary interventions, median household income and insurance type.

Previous studies have also found that STEMI patients with COPD have a higher risk for development of adverse clinical outcomes such as new-onset HF and cardiogenic shock.[5,10,11] It is notable that these events in MI patients are associated with significant increase of in-hospital mortality.[27,28] As expected, COPD patients had more acute respiratory failure events than patients without COPD. COPD patients may have less ability to overcome physiological stressors like hypoxemia and pulmonary edema, that are commonly seen during myocardial infarction.[29] Hence these patients are at lower threshold for worsening of airway status than in non-COPD patients that may also enhance coronary ischemia in the setting of STEMI.[30] In addition to increased mortality in COPD-STEMI patients, these complications could have contributed to longer length of stay and higher hospital charges also.

There are certain limitations to this study related to the nature of the NIS database, which lacks variables such as spirometry, medications, cause of death or angiography details. The NIS dataset has the potential for errors in procedure coding and inaccurate differentiation of comorbidities from complications. Nevertheless, the prevalence of COPD in our study is similar to that of previous work.[5–11] The NIS data with a nationally estimated large patient sample size provided an unequaled statistical power to examine the relationship between COPD and in-patient mortality and complications in STEMI patients. Further research is warranted to determine whether the inferior outcomes of COPD patients with STEMI are related to remediable deficiencies in medications, coronary angiography and revascularization or other factors.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Baseline Demographics, Hospital Characteristics, and Comorbidities of patients admitted with ST-Elevation myocardial infarction

Variable	Overall	COPD		*P*-value
	(n=2,120,005)	NO (n=1,840,517)	YES (n=279,488)	
Age, mean ± SD (years)	65.1 ± 14.7	64.5 ± 14.9	69.0 ± 12.5	<0.001
Women	35.6%	35.0%	39.6%	<0.001
White	79.3%	78.2%	86.4%	
Black	7.6%	8.0%	5.2%	
Hispanic	7.2%	7.6%	4.6%	
Asian or Pacific Islander	2.2%	2.3%	1.1%	
Native American	0.5%	0.5%	0.4%	
Other	3.3%	3.5%	2.3%	
Payer status				
Primary expected payer				<0.001
Medicare	48.7%	46.4%	64.2%	
Medicaid	5.6%	5.5%	6.1%	
Private insurance	34.8%	36.8%	21.5%	
Self-pay	7.1%	7.4%	4.9%	
No charge	0.6%	0.7%	0.4%	
Other	3.2%	3.2%	2.9%	
Median household income (percentile)				<0.001
0 to 25th	27.2%	26.5%	32.1%	
26th to 50th	27.6%	27.2%	29.9%	
51st to 75th	24.4%	24.6%	22.6%	
76th to 100th	20.8%	21.6%	15.4%	
US Region				<0.001
Northeast	16.9%	17.3%	14.7%	
Midwest	24.6%	24.4%	25.7%	
South	39.7%	39.2%	43.0%	
West	18.9%	19.2%	16.6%	
Hospital Bed size				<0.001
Small	9.8%	9.6%	10.9%	
Medium	22.9%	22.8%	23.3%	
Large	67.3%	67.6%	65.8%	
Urban location	87.8%	88.4%	83.6%	<0.001
Teaching Hospital	45.4%	46.4%	38.7%	<0.001
Weekend admission	26.8%	26.9%	26.1%	<0.001
Comorbiditie[*]				
Smoker	34.9%	33.2%	46.0%	<0.001
Diabetes mellitus (uncomplicated)	23.2%	23.3%	23.1%	0.06
Diabetes mellitus (complicated)	3.3%	3.2%	3.7%	<0.001

Variable	Overall	COPD		*P*-value
	(n=2,120,005)	NO (n=1,840,517)	YES (n=279,488)	
Hypertension	56.7%	56.8%	55.4%	<0.001
Dyslipidemia	47.5%	48.7%	39.5%	<0.001
Obesity [+]	8.8%	8.9%	8.3%	<0.001
Prior myocardial infarction	7.1%	6.9%	8.6%	<0.001
Prior percutaneous coronary intervention	8.1%	8.1%	8.1%	0.55
Prior coronary artery bypass grafting	4.2%	4.0%	5.1%	<0.001
Prior cerebrovascular vascular accident	2.9%	2.8%	3.4%	<0.001
Atrial fibrillation	13.5%	12.7%	18.8%	<0.001
Heart failure	0.6%	0.5%	0.9%	<0.001
Peripheral vascular disease	7.3%	6.3%	13.3%	<0.001
Renal Failure	8.3%	7.8%	11.6%	<0.001

COPD= chronic obstructive pulmonary disease; US= united states; SD= standard deviation.

[*] Co-morbidities were extracted using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) and Clinical Classifications Software (CCS) Codes. A complete list and details of comorbidities is available in e-Table 2.

[+] Obesity defined as pre-specified by ICD-9 codes in the database.[14]

Table 2

In-hospital coronary interventions

Cardiac Invasive Procedure	Overall	COPD	
		NO	YES
Diagnostic Coronary Angiography	69.8%	71.2%	60.3%
Unadjusted OR (95% CI)	—	Reference	0.61 (0.61 to 0.62)
Adjusted OR * (95% CI)	—	Reference	0.76 (0.75 to 0.77)
Percutaneous Coronary Intervention	56.8%	58.9%	43.3%
Unadjusted OR (95% CI)	—	Reference	0.53 (0.53 to 0.54)
Adjusted OR * (95% CI)	—	Reference	0.67 (0.66 to 0.67)
Coronary Artery Bypass Grafting	8.4%	7.9%	11.7%
Unadjusted OR (95% CI)	—	Reference	1.56 (1.54 to 1.58)
Adjusted OR * (95% CI)	—	Reference	1.56 (1.54 to 1.59)
Any revascularization (PCI or CABG)	63.5%	65.1%	52.9%
Unadjusted OR (95% CI)	—	Reference	0.60 (0.60 to 0.61)
Adjusted OR * (95% CI)	—	Reference	0.75 (0.74 to 0.76)

* Adjusted for demographics, hospital characteristics and comorbidities

COPD= chronic obstructive pulmonary disease; PCI= percutaneous coronary intervention; CABG= coronary artery bypass grafting; OR= odds ratio; CI= confidence interval

Table 3

In-hospital mortality, complications, procedures, length of stay and cost of hospitalization for patients with ST-Elevation myocardial infarction.

In-Hospital Outcomes	Overall	COPD	
		NO	YES
Number of cases (weighted)	2,120,005	1,840,517	279,488
In-hospital mortality %	9.2	8.7	12.5
Unadjusted OR (95% CI)	—	Reference	1.50 (1.48 to 1.52)
Adjusted OR * (95% CI)	—	Reference	1.13 (1.11 to 1.15)
New-onset AHF %	23.7%	21.3%	39.4%
Unadjusted OR (95% CI)	—	Reference	2.40 (2.38 to2.42)
Adjusted OR * (95% CI)	—	Reference	2.01(1.99 to 2.03)
Acute respiratory failure %	10.3%	8.7%	20.6%
Unadjusted OR (95% CI)	—	Reference	2.70 (2.67 to2.73)
Adjusted OR * (95% CI)	—	Reference	2.46 (2.43 to 2.50)
Cardiogenic shock %	8.1	7.8	10.6
Unadjusted OR (95% CI)	—	Reference	1.40 (1.38 to 1.42)
Adjusted OR * (95% CI)	—	Reference	1.24 (1.22 to 1.26)
Mean length of stay (days)	4.75±5.90	4.56±5.73	6.00±6.72
Average hospital charges ($)	59,258±68,321	58,536±66,937	63,956±76,579

COPD= chronic obstructive pulmonary disease; AHF= Acute Heart Failure; CI= confidence interval; OR, odds ratio.

* Adjusted for demographics, hospital characteristics, comorbidities and coronary intervention (coronary angiography, percutaneous coronary intervention, coronary artery bypass grafting)