

Emergency department management of acute exacerbations of chronic obstructive pulmonary disease: factors predicting readmission

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I. INTRODUCTION

Acute exacerbations of chronic obstructive pulmonary disease (AECOPD) is defined as an acute worsening of respiratory symptoms beyond baseline level including dyspnea, cough, and sputum production that require a change in medication in mild cases

Numerous factors have been associated with readmissions following AECOPD, however, readmission rates in patients seen in the ED for AECOPD and directly sent home are understudied, particularly the factors that predict readmissions in this population.

This study was designed to:

- Compare the readmission rates and patient population demographics of patients visiting the ED for AECOPD and discharged directly from the ED, to patients visiting the ED and who are then hospitalized for AECOPD.
- Determine the factors that predict readmission of the patients directly discharged from the ED with the primary diagnosis of AECOPD.

The primary outcome measure was the total all-cause and COPD-related readmissions at 30 and 90 days post-index visit/admission for COPD.

The secondary outcomes were patient factors (disease and social factors) and system factors (ED management) or variables associated with readmission.

II. METHODS

Patient population:

-retrospective study

-All patients were seen and managed in the ED and either directly sent home after stabilization or admitted to hospital for further management.

Study design:

- The in-hospital management of AECOPD in all patients was guided by a standardized hospital-wide admission protocol for the management of AECOPD based on the GOLD strategic document.
- The AECOPD in the ED group was managed by the attending emergency physician. As there is no standardized protocol for ED management of AECOPD, specific data regarding patient assessment (investigations such as imaging, laboratory tests, and other diagnostics), patient treatment (medication given and prescribed on discharge), and patient follow-up (referrals for further testing and interventions such as pulmonary rehabilitation or follow-up by the patient's family physician or respirologist) were collected.

III. RESULTS

The ED index admission group compared with the hospitalized index admission group was significantly younger by about 10 years ($p,0.001$), with milder COPD severity (as indicated by higher FEV1; $p=0.001$).

There were 26% more current smokers ($p,0.001$), 13% more ever smokers ($p=0.001$), and 30% more substance abusers ($p,0.001$) in the ED group versus hospital group.

The ED group had a higher mean number of comorbidities ($p,0.001$) and had 20% more mental health comorbidities ($p,0.001$) than the hospitalized group. The ED group had a high proportion of patients living without a partner (88.8%) and high prevalence of cardiovascular comorbidity (43.8%).

Table 1 Demographic data

	ED group (n=240)	Hospitalized group (n=271)	p-value
Age (mean, SD) years	61.57 (11.67)	70.84 (13.18)	<0.001***
Male	65.0%	64.6%	0.920
FEV ₁ (mean, SD)	54.54 (25.21)	45.65 (20.17)	0.001
BMI (mean, SD)	26.87 (8.08)	26.52 (7.65)	0.872
Current smoker	62.9%	36.5%	<0.001
Ever smoker	82.5%	70.1%	0.001
Pack-years (mean, SD)	43.51 (22.67)	39.52 (36.52)	0.013
Substance abuse	51.7%	22.1%	<0.001
Number of comorbidities (mean, SD)	5.28 (3.48)	3.74 (1.98)	<0.001
Mental health comorbidities	50.0%	29.9%	<0.001

Notes: *** $p < 0.001$. FEV₁ data available for 65% of ED group and 69% of hospitalized group; BMI available for 65% of ED group and 66% of hospitalized group; pack-years available for 60% of ED group and 71% of hospitalized group.

Abbreviations: ED, emergency department; FEV₁, forced expiratory volume in 1 second; BMI, body mass index; pack-years, 1 pack of 20 cigarettes for 1 year.

Readmissions of ED versus hospitalized patients (primary outcome) :

Readmission rates of the two groups are shown in Table 2.

- The 90-day ED readmissions (1.29 vs 0.51, $p,0.001$) and 30-day ED readmissions (0.54 vs 0.20, $p,0.001$) were significantly higher in the ED group.
- The 30- and 90-day hospital readmissions were not significantly different between the two groups. In the ED group, 31% of the 90-day readmissions were COPD related and 33% of the 30-day readmissions were COPD related.
- Time to the first all-cause readmission was significantly shorter in the ED group compared with the hospitalized group (24.21 vs 31.85 days, $p,0.01$)

Table 2 Readmission rates between ED- and hospital-managed AECOPD

	ED group (n=240)		Hospitalized group (n=271)		p-value
	Mean	SD	Mean	SD	
30-day ED readmissions	0.5417	1.1600	0.1956	0.6225	<0.001
90-day ED readmissions	1.2875	2.3207	0.5055	1.2409	<0.001
30-day hospital readmissions	0.1875	0.4600	0.2103	0.4831	0.578
90-day hospital readmissions	0.4250	0.8646	0.4871	0.8021	0.126
Time to readmission (days to first all-cause)	24.2101	22.1041	31.8450	27.8128	0.050

Notes: 30- and 90-day hospital admissions were not different between groups.

Abbreviations: ED, emergency department; AECOPD, acute exacerbations of chronic obstructive pulmonary disease.

Factors predicting readmissions in ED-managed patients (secondary outcome)

- Mental health and cardiovascular comorbidities were the strongest variables associated with both 30- and 90-day readmissions in the ED group (Table 3).
- Thirty-day readmissions were associated with younger age ($IRR = 0.98, p, 0.01$), *lack of a partner/spouse* ($IRR = 0.37, p = 0.010$ or $p, 0.01$), *mental illness* ($IRR = 1.76, p, 0.01$), *cardiovascular comorbidities* ($IRR = 1.42, p, 0.05$), and *an increase in total number of comorbidities* ($IRR = 1.05, p, 0.05$) (Table 3).
- Ninety-day readmission rates were associated with *substance abuse disorder* ($IRR = 1.53, p, 0.001$), *mental illness* ($IRR = 1.53, p, 0.001$), *cardiovascular comorbidities* ($IRR = 1.62, p, 0.001$), and *the number of comorbidities* ($IRR = 1.09, p, 0.001$)

Table 3 Factors predicting all-cause readmission in the ED group

Predictor	Total 90-day all-cause (n=240)				Total 30-day all-cause (n=240)			
	B	IRR-e ^b	SE	p-value	B	IRR-e ^b	SE	p-value
Intercept	0.0501	1.0514	0.3529	0.8870	0.4031	1.4964	0.4614	0.3824
Age	-0.0105	0.9895	0.0055	0.0562	-0.0223	0.9779	0.0079	0.005**
Female				NS				NS
Living with partner				NS	-0.9944	0.3699	0.3868	0.010*
Current smoker				NS				NS
Past smoker	-0.7279	0.4829	0.1657	<0.001***				NS
Substance abuse	0.4265	1.5318	0.1224	<0.001***				NS
Mental comorbidity	0.4285	1.5349	0.1162	<0.001***	0.5645	1.7585	0.1751	0.001**
Pulmonary comorbidity				NS	-0.3219	0.7248	0.1696	0.058
Cardiovascular comorbidity	0.4849	1.6239	0.1136	<0.001***	0.3530	1.4233	0.1740	0.043*
Number of comorbidities	0.0821	1.0856	0.0153	<0.001***	0.0518	1.0532	0.0248	0.036*

Notes: *p<0.05, **p<0.01, ***p<0.001. The incidence rate ratio (IRR-e^b) shows the expected difference in the outcome (readmission rates) for one unit change in the predictor variable.

Abbreviations: ED, emergency department; NS, not significant; SE, standard error.

Table 4 summarizes the risk factors associated with COPD-specific admissions. Factors with the strongest association with COPD readmissions in the ED-managed group were younger age, cardiovascular comorbidities, and FEV1.

Table 4 Factors predicting COPD readmission in ED-managed patients

Predictor	Total 90-day COPD (n=157)				Total 30-day COPD (n=157)			
	B	IRR-e ^b	SE	p-value	B	IRR-e ^b	SE	p-value
Intercept	1.9966	7.3638	0.6467	0.002	2.1739	8.7927	0.9224	0.018
Age	-0.0310	0.9694	0.0109	0.004	-0.0435	0.0957	0.0156	0.005
Female				NS				NS
Living with partner				NS	-1.1229	0.3253	0.7217	0.120
Current smoker				NS				NS
Past smoker	-0.8200	0.4404	0.2872	0.004				NS
SUD				NS				NS
Mental comorbidity				NS				NS
Pulmonary comorbidity	-0.3717	0.6896	0.2088	0.075				NS
Cardiovascular comorbidity	0.4961	1.6424	0.2097	0.018	0.5826	1.7907	0.2899	0.044
Number of comorbidities	0.1042	1.1098	0.0284	<0.001				NS
FEV ₁	-0.0212	0.9790	0.0046	<0.001	-0.0174	0.9828	0.0063	0.006

Notes: FEV₁; 157 patients had recent documented spirometry measurements available; IRR-e^b, expected difference in the outcome (readmission rates) for one unit change in the predictor variable.

Abbreviations: ED, emergency department; COPD, chronic obstructive pulmonary disease; FEV₁, forced expiratory volume in 1 second; NS, not significant; SE, standard error; SUD, substance abuse disorder.

ED management :

- Table 5 shows the ED management of AECOPD, demonstrating both the investigation conducted to exclude other potential causes for the patients' symptoms and the treatment provided

Table 5 ED management (investigations and treatment) of AECOPD

Patient assessment – tests conducted	N	%
Chest imaging	223	92.92
• Chest X-ray	221	92.08
• Chest CT scan	10	4.17
Cardiovascular diagnostics (any of troponin, BNP, ECG, D-dimer)	134	55.83
• ECG, troponin, and/or pro-BNP	132	55.00
• D-Dimer (pulmonary embolism)	18	7.50
Infectious diagnostics (any of CBC, CRP, blood and sputum culture)	178	74.17
• CBC	177	73.75
• CRP	3	1.25
• Blood culture	14	5.83
• Sputum culture	12	5.00
Lung function	22	9.17
• ED peak flow or spirometry	19	7.92
• Blood gases	4	1.67
Patient treatment – medication provided	n	%
Appropriate treatment (bronchodilator, antibiotic, steroid)	118	49.17
• Prescribed bronchodilator	211	87.92
• Prescribed antibiotic	153	63.75
• Prescribed steroid	171	71.25
Follow-up – referrals given	n	%
Medical referral	164	68.33
• FP referral/notification	124	51.67
• Respiratory care referral (respirologist, pulmonary rehabilitation, puffer education)	54	22.50

Abbreviations: ED, emergency department; AECOPD, acute exacerbations of chronic obstructive pulmonary disease; CT, computed tomography; BNP, brain natriuretic protein; ECG, electrocardiogram; CBC, complete blood count; CRP, C-reactive protein; FP, family physician.

IV. DISCUSSION

Although the exact reasons for the higher rates of readmissions in the ED-discharged patients are not fully known, there were several important observations in this study that deserve emphasis.

- First, the ED-discharged patients were more likely to be current smokers and have more comorbidities (and especially substance abuse disorders and mental illnesses).
 - Substance abuse disorder has been identified as a strong predictor for readmission following hospitalization.
 - Comorbidities are common in COPD patients and adversely impact disease outcome because of many sharing risk factors and compounding effects on disease severity.
- Cardiovascular comorbidities were present in 44% of the patients in the ED group. In particular, in terms of AECOPD, underlying cardiovascular diseases are associated with a higher risk for exacerbation

Acute exacerbation of COPD may also trigger acute coronary syndrome, myocardial infarction (heart attack), stroke, and sudden cardiac death.

The strong association of underlying cardiovascular comorbidities in the ED group and its association with increased readmission rates suggest that ED management of AECOPD should always include a workup for potential associated cardiovascular events.

- Second, adherence to national and international guidelines for managing AECOPD in the ED was relatively low in the present study, consistent with another study in the USA and Canada.

We found that while nearly

-90% of ED patients were treated with bronchodilators,

- 63% with antibiotics

- 71% with a course of steroids for their AECOPD in the ED

This relative under-treatment of AECOPD may contribute to the high recurrence and readmissions rates.

ED management analysis suggests that the patients with comorbidities (predominantly cardiovascular) and more severe COPD were correctly identified in the ED and given appropriate tests and treatment. Yet the higher readmission rates among these patients indicate that the management plan was not sufficient to prevent future exacerbations or readmissions

Interestingly, the use of bronchodilators in the ED and at home was strongly associated with fewer readmissions (all-cause and COPD readmissions), underlying recent studies that showed the importance of proper use of bronchodilators, specifically long-acting bronchodilators in reducing AECOPD.

The need for systemic steroids to treat AECOPD also predicts future COPD readmissions, and this study suspects that the need for steroids may be just a surrogate marker for the severity of AECOPD.

V. CONCLUSION

- Patients managed in the ED for AECOPD and discharged directly home have a higher 30- and 90-day readmission rate than patients admitted for in-hospital management.
- Factors that contribute to this higher readmission rate are underlying cardiovascular disease, mental illness, and substance abuse disorder.
- We also identify weaknesses in the management of the patients in the ED, specifically as only 50% were given bronchodilators, steroids, and antibiotics inclusively.

Other important interventions such as smoking cessation counseling, providing an action plan and referral to appropriate follow-up services such as pulmonary rehabilitation, or a respiratory specialist, were lacking.

A protocolized management plan for AECOPD in the busy ED could reduce short-term readmissions.

THANK YOU FOR YOUR ATTENTION