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30-Day Readmission Rate of Patients with COPD and Its Associated Factors: A Retrospective Cohort Study from a Tertiary Care Hospital

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Purpose: Readmission of chronic obstructive pulmonary disease (COPD) has been used as a measure of performance for COPD care. This study aimed to determine the rate of readmission of COPD in tertiary care hospital in Malaysia and its associated factors.

Patients and Methods: A retrospective cohort study was conducted at a tertiary care hospital in Malaysia from 1st January to 21st May 2019. Seventy admissions for COPD exacerbation involving 58 patients were analyzed.

Results: The majority of the patients were male (89.8%), had a mean age of 71.95 ± 7.24 years and a median smoking history of 40 (IQR = 25) pack-years, 84.5% were in GOLD group D and 91.4% had a mMRC grading of 2 or greater. Approximately 60.3% had upper or lower respiratory tract infection as the cause of exacerbation; one in five patients had uncompensated hypercapnic respiratory failure at presentation, and 27.6% needed mechanical ventilatory support. Approximately 43.1% of patients had a history of exacerbation that required hospitalisation in the past year. The mean blood eosinophil concentration was 0.38 ± 0.46 x10^9 cells/L. The 30-day readmission rate was 20.3%, revisit rate to the emergency room within 30 days after discharge was 3.4%, and in-hospital mortality rate was 1.7%. Among all characteristics, a higher baseline mMRC grade ($p = 0.038$) and history of exacerbation in the past 1 year ($p < 0.001$) were statistically associated with 30-day readmission.

Conclusion: The 30-day readmission rate for COPD exacerbation in a Malaysian tertiary hospital is similar to the rates in high-income countries. Exacerbation in the previous year and a higher baseline mMRC grading were significant risk factors for 30-day readmission in patients with COPD. Strategies of COPD management should concentrate on improvement of symptoms control by optimisation of pharmacotherapy, and early initiation of pulmonary rehabilitation, and structured integrated care programs to reduce readmission rates.

Keywords: COPD, exacerbation, readmission, baseline mMRC, nurse educator

Introduction

Chronic obstructive pulmonary disease (COPD) is a major disease in Asia due to the high prevalence of tobacco smoking and environmental air pollution. Based on the Malaysia National Health and Morbidity Survey conducted in 2019, 21% of Malaysian were cigarette smokers, and the prevalence of COPD for Malaysia was estimated at 4.7%.[1,2] COPD exacerbations are associated with profound morbidity and mortality, with poor quality of life, faster decline in lung function, and burden on healthcare system and economy.[3–5] A systemic review on the studies conducted in countries with widely available COPD treatment showed a decline in the patient-reported Health related quality of life (HRQoL) in individuals with frequent exacerbations and recurrent hospitalisation.[6] Almost half of the working individuals with COPD reported a high percentage of overall work impairment after an exacerbation. These were associated with poor HRQoL work productivity and activity impairment, particularly in patients with severe and very severe disease.[3] Similarly in Malaysia, patients with COPD were reported to have 32% productivity losses at the workplace and 17%

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activity limitation.[7] In addition, study had shown that the lung function of patients with COPD, particularly those with moderate to severe disease, who had frequent exacerbations will have a faster decline in their FEV_1 (40.1 ml/year) as compared to the infrequent exacerbators (32.1 ml/year).[4] Admissions for exacerbations account for most of the costs associated with COPD treatment.[8] In Malaysia, 42% of the cost of COPD management was related to admission for exacerbation, with the mean annual costs per patient of US$297.79.[7] Hospitalisation for COPD exacerbations are associated with a high mortality rate with 5% of patients admitted to hospital died while they were in the hospital.[9] In many countries, readmission within 30 days of a COPD hospitalisation is a common measure of performance for COPD care. Large-scale studies in the United States (US) and the United Kingdom (UK) have shown that 10–20% of COPD patients are readmitted within 30 days after discharge.[10,11] In the US, data have shown that a younger age (40–64 years) has a higher risk of readmission than older patients (>65 years).[12] In a systemic review on 46 studies involving COPD readmission, the pooled readmission rate was 11%, with male sex, number of hospitalisations in the previous year, length of stay (LOS), and comorbidities such as heart failure, tumor or cancer, and diabetes were identified as potential risk factors for COPD readmission.[13] Among the many contributing factors for an acute exacerbation of COPD, infection is still a major trigger.[14] It is well known that a previous history of hospital admission for COPD exacerbation predicts future readmissions and with each exacerbation the severity of future exacerbations and mortality risk increases.[15–17] These findings suggest that early active interventions can reduce the risk of exacerbation and thus prevent readmission.[6] Interventions such as optimisation of pharmacotherapy, smoking cessation, vaccination, pulmonary rehabilitation, and self-management interventional programs are important strategies for prevention of exacerbation.[18] Pulmonary rehabilitation after an acute exacerbation had been proven to lower the rate of readmission to the hospital (odds ratio 0.22, $p = 0.002$)[19] In addition, the role of respiratory therapist in prevention of COPD readmission was studied with positive outcome on significantly fewer readmissions for COPD exacerbations, shorter duration of hospitalisation, and fewer total in-patient and ICU days over 6 months of follow-up.[20] Based on our best knowledge, there are no published data on COPD readmissions in Malaysia. Understanding the characteristics of COPD readmissions is important for quality improvement strategies and the development of local clinical practice guidelines that focus on COPD.

Methods

Study Design and Population

This retrospective cohort study was conducted at a tertiary-care hospital in Kuala Lumpur, Malaysia. All records of patients admitted to the hospital with a diagnosis of acute COPD exacerbation (International Classification of Diseases Tenth Revision (ICD-10) code J44.1) from 1st January to 21 May 2019 were reviewed. Patient demographics, smoking history, and relevant investigation results were retrieved from electronic medical records. Patient records were reviewed from the admission date to 30 days after admission to determine the disease outcomes. This study was approved by the Medical Research Ethics Committee (MREC approval number 202093-9037, NMRR.ID:57360). The informed consent was not obtained from the patients. The requirement for consent was waived by the Universiti Malaya Medical Centre ethics committee as this was a retrospective analysis of anonymized patient's record with no interventional treatment tested. The study complies with the Declaration of Helsinki.

Outcomes

The primary outcome was the readmission rate 30 days after the index admission for COPD exacerbation. The secondary outcome was unscheduled visit(s) to the Emergency Department (ED) within 30 days of COPD exacerbation after index admission.

Data Analysis

The data were analysed using the IBM Statistical Package for the Social Sciences (SPSS) software (version 23.0; SSPS Inc., Chicago, IL, USA). All the quantitative data were tested for normality. Results are expressed as mean and standard deviation if normally distributed and as median and interquartile range if otherwise. Categorical variables are presented as frequencies and percentages. The patients' clinical outcomes are described in terms of rates. Pearson's chi-square test,

Fisher's exact test, and Mann-Whitney test were used to determine the significance of baseline characteristics associated with 30-day readmission.

Results

Seventy admissions for COPD exacerbation were recorded during the study period, involving 58 patients, and their records were retrieved and analysed. One patient died during the admission. Table 1 shows the baseline patient characteristics. Most patients were male (89.7%), with a mean age of 71.95 ± 7.24 years and a median smoking history of 40 (IQR = 25) pack-years. Approximately 37.9% of the patients did not undergo spirometry assessment before index admission. The majority (84.5%) were classified into GOLD group D and 91.4% had a baseline mMRC grade of 2 or

Table 1 Baseline Characteristics of Patients Admitted with COPD Exacerbation

Patient's Characteristics	**Mean ± SD**
Age (year)	71.95 ± 7.24
	n (%)
Sex	
Male	52 (89.7)
Female	6 (10.3)
Race	
Malay	22 (37.9)
Chinese	20 (34.5)
Indian	15 (25.9)
Other	1 (1.7)
Smoking history [median (interquartile range)] (pack-year)	40 (25.0)
Current smoker	15 (25.9)
Ex-smoker	42 (72.4)
Unknown	1 (1.7)
Severity of airflow limitation (FEV_1% of predicted normal value)	
GOLD 1 (≥ 80%)	3 (3.2)
GOLD 2 (50% to <80%)	12 (20.7)
GOLD 3 (30% to <50%)	13 (22.4)
GOLD 4 (<30%)	8 (13.8)
Unknown	22 (37.9)
GOLD (2021) grouping at diagnosis	
A	0 (0)
B	2 (3.4)
C	7 (12.1)
D	49 (84.5)
mMRC dyspnea scale	
0	0 (0)
1	5 (8.6)
2	20 (34.5)
3	21 (36.2)
4	12 (20.7)
History of exacerbation in the past one year	
Yes	25 (43.1)
No	33 (56.9)

(*Continued*)

Table 1 (Continued).

Patient's Characteristics	Mean ± SD
Baseline medication	
SAMA/SABA	2 (3.4)
LABA/ICS	11 (19.0)
LAMA	10 (17.2)
LAMA/LABA	20 (34.5)
LAMA/LABA/ICS	15 (25.9)

Abbreviations: FEV1, forced expiratory volume in 1 s; mMRC, modified Medical Research Council; GOLD, Global Initiative for Chronic Obstructive Lung Disease; SAMA, short-acting muscarinic antagonist; SABA, short-acting beta-2 agonist; LAMA, long-acting muscarinic antagonist; LABA, long-acting beta-2 agonist; ICS, inhaled corticosteroid; SD, standard deviation.

above. Almost half of the patients (43.1%) had exacerbations that required admission within the past year. Most patients (60.4%) had at least two long-acting bronchodilators as their baseline maintenance therapy, and 44.9% were on inhaled corticosteroids as maintenance therapy.

Table 2 presents clinical parameters and patient outcomes. The mean blood eosinophil concentration was 0.38 ± 0.46 $x10^9$/L. A quarter of the patients (24.1%) had lung consolidation on chest radiographs taken at presentation. Upper or lower respiratory tract infection was identified as the main trigger for exacerbation in 60.3% of the patients. The other identified triggers for exacerbation were smoking (6.9%), non-adherence to medication (5.2%), and poor inhaler technique (5.2%). Thirteen patients did not have an identifiable trigger. On arrival, one-fifth of the patients had uncompensated hypercapnic respiratory failure, and 27.6% eventually required mechanical ventilatory support during

Table 2 Clinical Parameters and Outcome of COPD Patients Admitted with Acute Exacerbation

Clinical Parameters and Outcome	Mean ± SD
Total white blood cell count ($x10^9$/L)	11.36 ± 4.27
Blood eosinophil concentration [median (interquartile range)] ($x10^9$/L)	0.38 ± 0.46
	n (%)
Blood pH on arrival,	
≥7.35	38 (65.5)
7.25–7.34	7 (12.1)
<7.25	4 (6.9)
Unknown	9 (15.5)
pCO_2 level on admission (mmHg)	
<35	15 (25.8)
35–45	16 (27.6)
>45	18 (31)
Unknown	9 (15.5)
Presence of consolidation in chest radiograph	
Yes	14 (24.1)
No	44 (75.9)
Ventilatory support	
Did not require supplemental oxygen therapy	12 (20.7)
Required controlled supplemental oxygen therapy	30 (51.7)
Required NIV	13 (22.4)
Required IMV	3 (5.2)

(*Continued*)

Table 2 (Continued).

Clinical Parameters and Outcome	Mean ± SD
Main trigger of COPD exacerbation	
Upper respiratory tract infection	18 (31)
Lower respiratory tract infection	17 (29.3)
Smoking	4 (6.9)
Non-adherence to medication	3 (5.2)
Poor inhaler technique	3 (5.2)
Unidentified triggers	13 (22.4)
Outcome within 30 days of hospital discharge	
Readmission	12 (20.7)
ED visit	2 (3.4)
No readmission or ED visit	43 (74.1)
Death	1 (1.7)
	Median (IQR)
Length of hospital stay (day)	3.0 (5.0)

Abbreviations: NIV, non-invasive mechanical ventilation; IMV, invasive mechanical ventilation; ED, emergency department; SD, standard deviation.

the index admission. The median length of stay was 3.0 (IQR = 5.0) days. The 30-day readmission rate was 20.7%, revisit rate to the emergency department (ED) without the need for admission within 30 days after discharge was 3.4%, and in-hospital mortality rate was 1.7%.

Table 3 summarises the analysis comparing the baseline characteristics of the readmitted and non-readmitted patients. Among all the characteristics, baseline mMRC grading ($p = 0.038$) and history of exacerbation in the past 1 year ($p < 0.001$) are statistically associated with 30-day readmission in COPD patients.

Table 3 Comparison of Characteristics at Index Admission Between Those with and without 30-Day COPD Readmission

Variable	30-Day Readmission to hospital		p-value
	Yes	No	
	Median (IQR)	Median (IQR)	
Age	72.0 (7.5)	72.5 (11.3)	0.773[a]
	n (%)	n (%)	
Sex			0.594[b]
Male	10 (83.3)	42 (91.3)	
Female	2 (16.7)	4 (8.7)	
Race			0.285[b]
Malay	4 (33.3)	18 (39.1)	
Chinese	5 (41.7)	15 (32.6)	
Indian	2 (16.7)	13 (28.3)	
Others	1 (8.3)	0 (0.0)	
Smoking History			0.393[c]
Current	2 (16.7)	13 (28.9)	
Ex-smoker	10 (83.3)	32 (71.1)	

(*Continued*)

Table 3 (Continued).

Variable	30-Day Readmission to hospital		p-value
	Yes	No	
	Median (IQR)	Median (IQR)	
Severity of airflow limitation			0.166[b]
GOLD 1	1 (9.1)	2 (8.0)	
GOLD 2	2 (18.2)	10 (40.0)	
GOLD 3	3 (27.3)	10 (40.0)	
GOLD 4	5 (45.5)	3 (12.0)	
GOLD at diagnosis			0.449[b]
A	0 (0.0)	0 (0.0)	
B	0 (0.0)	2 (4.3)	
C	0 (0.0)	7 (15.2)	
D	12 (100.0)	37 (80.4)	
Baseline mMRC grading			**0.038[b]**
0	0 (0.0)	0 (0.0)	
1	0 (0.0)	4 (10.9)	
2	4 (33.3)	13 (34.8)	
3	2 (16.7)	18 (41.3)	
4	5 (50.0)	6 (13.0)	
History of exacerbation in the past one year			**<0.001[c]**
Yes	11 (91.7)	14 (30.4)	
No	1 (8.3)	32 (69.6)	
Medication			0.182[b]
SAMA/SABA	0 (0.0)	2 (4.3)	
LABA/ICS	1 (8.3)	10 (21.7)	
LAMA	0 (0.0)	10 (21.7)	
LAMA/LABA	6 (50.0)	14 (30.4)	
LAMA/LABA/ICS	5 (41.7)	10 (31.7)	

Notes: The bold underlined text showing the significant p-value. [a]Mann-Whitney U test. [b]Fisher's exact test. [c]Pearson's chi-square test.

Abbreviations: FEV_1, forced expiratory volume in 1 s; mMRC, modified Medical Research Council; GOLD, Global Initiative for Chronic Obstructive Lung Disease; SAMA, short-acting muscarinic antagonist; SABA, short-acting beta-2 agonist; LAMA, long-acting muscarinic antagonist; LABA, long-acting beta-2 agonist; ICS, inhaled corticosteroid; SD, standard deviation; IQR, interquartile range.

Discussion

From our findings, history of exacerbation in the previous year is consistently associated with COPD readmission, which was similar to several cohort studies and systematic reviews.[21–23] History of exacerbation in the previous year was stated as the main risk factor for COPD readmission by Njoku et al.[23] In addition, our findings showed a higher baseline mMRC grading is statistically associated with 30-day readmission, but it was not significant in Alqahtani et al.[22] The reason behind was Alqahtani et al looked at the patients' mMRC grading on admission and before discharge, which usually will be higher as compared to their baseline mMRC grading. Patients who are more symptomatic (CAT score ≥ 20) at baseline will be at higher risk of exacerbation, which was found in the post hoc analysis of patients with COPD in the IMPACT trial, during the 1-year treatment period.[24] In our study, mMRC grading was used instead of CAT score as mMRC grading is much easier, common, and likelier to be use by the physician in assessment of COPD patient presenting to the acute care. CAT and mMRC have equal effectiveness in evaluating patients with regular medical treatment, however mMRC grading is more favorable for COPD emergency room visit and hospitalisation.[25] Robust evidence had shown that previous exacerbation in the past 1 year increases the risk of subsequent exacerbations.[17] Treatment strategy should emphasize on delaying the second severe exacerbation and

improving treatment of severe exacerbations, hence, reducing risk of early mortality. In our study, gender was not a significant factor for readmission in 30 days, as compared to the systemic review done by Ruan et al.[13] This could be due to effect from the small sample size and predominance male in our study. We found that 27.9% of admissions due to COPD exacerbation required mechanical ventilation and one died. This is grave and inevitably poses a heavy burden on the health system and incurs financial costs.

Although the main trigger for COPD exacerbations was respiratory tract infection, almost 40% of the cases from our study were due to modifiable causes such as poor inhaler technique, non-adherence to medications, and exposure to tobacco smoke, which can be targeted and improved with structured education and counselling of the patients.[5] However, educating a patient can be time consuming, and efforts to modify these risks are usually neglected, partly due to the lack of human resources. Sav et al reported that the treatment burden is high in patients with COPD, as the managing physicians not only need to prioritise the accessibility of healthcare to patients with COPD, but also worry about their treatment, prognosis, and medication-related burden.[26] Empowering especially respiratory therapist, Trained nurses and pharmacists as COPD educators and counsellors, as well as handing over to primary care physicians to educate patients about exacerbations and their risks, are some of the solutions to help reduce the burden of managing clinicians.

Evidence had shown that self-management intervention with communication with a health care professional improves health status and decreases hospitalisation and emergency department visit for COPD patients.[5] A trained COPD nurse educator will be able to reduce the burden of the physician by educating patients on the disease, assessing the patient's inhaler technique and compliance to treatment, and referring patients to pulmonary rehabilitation program and smoking cessation program early. Resources should be channeled to train nurse educators to address this issue.

Primary care physicians play a crucial role in COPD management and should not be neglected. Evidence has shown that early diagnosis of COPD with early treatment can prevent acute exacerbation episodes and prevent rapid progression of the disease.[27] Spirometry assessment, which is crucial in the diagnosis of COPD, should be available in all primary care clinics, as this will aid the primary care physicians to diagnose COPD confidently and initiate appropriate treatment according to the severity of the disease. In addition, COPD awareness campaigns should be organised regularly to screen for individuals with undiagnosed COPD.

Patients relate primary care as one of the best places to receive education, information, and initiate the process of quitting smoking, as they had established an ongoing relationship with the patients.[28] However, all parties should work together to distribute the burden in patient's education to solve the issues of lacking support, time, skills, and training.[29–33] Public health doctors should organise smoking cessation campaign regularly to educate the public on the harmful effect of tobacco smoke and guide the smokers on ways to stop smoking, which inevitably prevent development of COPD among them.

This study is limited by its retrospective design. Readmission to other hospitals, visits to other healthcare facilities, and mortality outside the hospital were not recorded, as there were no follow-up telephone calls to determine the outcome of these patients. Therefore, the number of readmissions, ED visits, and mortality rates may have been underestimated in this study. Some patients might have been lost to follow-up or readmitted to other hospitals. Developing a registry for COPD admission at the national level may help identify these patients, and the data can be used to estimate the burden and healthcare costs. Structured integrated care programs for patients may be used to reduce readmission rates. This program should involve trained COPD nurse educators coaching patients on self-management, designing a personalised action plan, and arranging early post-discharge follow-up. The other component of the program is to refer patients for pulmonary rehabilitation as early as during the index admission for COPD exacerbation. Inpatient pharmacist education and inhaler dispensing prior to discharge are crucial, and telemedicine to monitor the patients' status post-discharge may help reduce early readmission.[34]

Conclusion

The 30-day readmission rate for COPD exacerbation in a Malaysian tertiary hospital is similar to the rates in high-income countries. Exacerbation in the previous year and a higher baseline mMRC grading were significant risk factors for 30-day readmission in patients with COPD. Strategies of COPD management should concentrate on improvement of symptoms control by optimisation of pharmacotherapy, and early initiation of pulmonary rehabilitation, and structured integrated care programs to reduce readmission rates.

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