

Healthcare utilisation patterns by persons with newly diagnosed Chronic Obstructive Pulmonary Disease (COPD) in Singapore

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Abstract

Chronic Obstructive Pulmonary Disease (COPD) is a highly prevalent chronic condition placing substantial strain on the health system. We aimed to study the utilization patterns of ambulatory care (primary and specialist outpatient services) and emergency/hospital services by newly diagnosed COPD patients in Singapore during their initial year post diagnosis of COPD, and compared that with their pre-diagnosis utilization.

Methods

Utilisation data at ambulatory care services (primary care/specialist outpatient centres) and emergency department and hospitalisations were collected for a retrospective cohort of COPD patients newly diagnosed in 2018-2021. Utilisation rates in the 360 days prior to diagnosis were compared to 360 days post. Tail 180 days analysis (excluding 6months immediately prior and subsequent to diagnosis) was done to exclude potential confounding by the immediate peri-diagnosis investigations and stabilisation.

Results

Among a cohort of 4,967 patients, 72% had positive smoking history. Ambulatory care service utilisation rates remained stable (primary care) or increased (specialist), whether comparing 360 days or the tail 180 days. Emergency and hospitalisation inpatient care showed a decrease when comparing 360 day period, while comparison of the tail 180 days, excluding the 6 months immediately preceding and subsequent to diagnosis showed instead an increase. Smoking history did not significantly impact utilisation pattern changes.

Conclusion

Newly diagnosed COPD patients had a markedly higher usage of specialist ambulatory care with a concomitant higher ED attendance and hospitalisation rate. Further research is essential to understand underlying reasons for this increased usage and to develop effective upstream preventive and downstream mitigating strategies to reduce COPD incidence and health system burden.

Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a chronic and progressive respiratory condition with severe deleterious health effects, including increased cardiovascular risk, respiratory failure, and pulmonary cancer [1]. Risk factors include environmental exposure to pulmonary irritants, including smoking, air pollution, and occupational hazards, pulmonary infections, and genetic diseases such as alpha-1 antitrypsin deficiency [2,3]. COPD is highly prevalent, especially given its long chronicity, with estimates as low as 2% to 5% from the Global Burden of Disease studies [2] or as high as 9% to 12% from other systematic reviews and meta-analyses [4,5]. Number of cases is expected to increase, with studies projecting a relative increase of 23% globally, reaching nearly 600 million by 2050 [6].

Given its negative health effects and growing prevalence, COPD is a major and increasing burden on health systems and society [7,8]. Total direct cost of respiratory diseases in the European Union is estimated to consume 6% of total annual health care allocation, with COPD

contributing over half of that (56%) [7]. In the United States, COPD costs are projected to increase over the next two decades, estimated at near US\$40 billion annually [8].

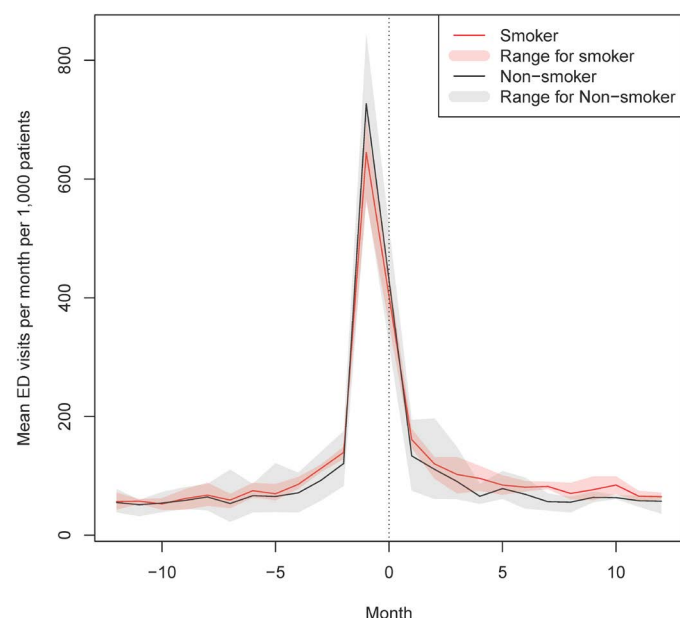
There is a plethora of published studies on healthcare utilization and clinical outcomes of COPD cohorts [9-12]. However, to our knowledge, there appears to be a lack of published evidence comparing these patterns against their pre-diagnosis history. COPD is an ambulatory-care sensitive condition that if ideally managed in the community or outpatient setting, could reduce catastrophic high-cost emergency attendances or hospitalisations [13]. Hence, we aimed

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Received: May 17, 2024; **Accepted:** June 06, 2024; **Published:** June 10, 2024

Table 1. Patient demographics

	Overall		Positive smoking history		Negative smoking history	
Cohort size	4967		3562	72%	1405	28%
Age						
mean, SD	69.1	12.9	68.6	12.2	70.3	14.4
≤ 60 yrs	1106	22%	820	23%	286	20%
61 to 70 yrs	1479	30%	1133	32%	346	25%
70 to 80 yrs	1428	29%	1004	28%	424	30%
> 80 yrs	954	19%	605	17%	329	25%
Gender (n, %)						
Males	3897	78%	3231	91%	666	47%
Race (n, %)						
Chinese	3588	72%	2504	70%	1084	77%
Malay	677	14%	527	15%	150	11%
Indian	430	9%	325	9%	105	7%
Others	272	5%	206	6%	66	5%

**Figure 1.** Emergency department attendances by COPD patients prior to and post diagnosis

to study the utilization patterns of ambulatory care (primary and specialist outpatient services) and emergency/hospital services by newly diagnosed COPD patients in Singapore during their initial year post diagnosis of COPD, and compared that with the pre-diagnosis utilization. We also compared the utilization patterns of smokers (current and ex-smokers) against non-smokers.

Methods

COPD patients diagnosed between 1st January 2018 and 31st December 2021 were identified using the National Healthcare Group's (NHG) Chronic Disease Management System (CDMS) [14]. CDMS is a chronic disease registry that collects data on adults with chronic diseases such as diabetes mellitus, dyslipidaemia, hypertension, asthma, COPD, heart failure and chronic kidney disease.

Health service utilization data at the National Healthcare Group's institutions (one of the three national healthcare clusters with two large hospital sites, two specialty centres, and eight primary care polyclinics) were identified from a central cluster electronic record database. It covered ambulatory care: all-cause polyclinic primary care visits and

all-cause Specialist Outpatient Clinic (SOC) visits, and hospital care: all-cause Emergency Department (ED) attendances, and all-cause admissions (days spent hospitalized) for these COPD patients 360 days prior and 360 days post diagnosis of COPD.

ED attendances, polyclinic primary care visits, SOC visits, and days spent hospitalized by COPD patients in the 360 days prior to diagnosis of COPD were compared against the 360 days post diagnosis, using the unpaired t-test. Further comparison using the tail 180 days (excluding 6 months immediately prior to and post diagnosis) was done to exclude the immediate surge in utilisation post diagnosis. A difference-in-difference comparison between COPD patients with a positive smoking history and those without was conducted to assess whether smoking status impacted utilization patterns. Data were analysed using R version 4.2.0 (The R Foundation for Statistical Computing).

Results

There were a total of 4,967 newly diagnosed COPD patients in 2018 to 2021. Average age at the time of diagnosis was 69.1 years (SD = 12.9). Majority were of male gender (78%) and of Chinese ethnicity (72%). Within this cohort, 3,562 (72%) had positive smoking history. These tended to be younger (68.6, SD 12.2 vs 70.3, SD 14.4 years) and predominantly male (91% vs 47%), as shown in Table 1.

Emergency Department attendances and hospitalisation

There was a significant decrease in ED attendances and days spent hospitalized in the 360 days post diagnosis as compared to the same period immediately prior to diagnosis (Figure 1 and 2). The mean ED attendances per month per 1,000 COPD patients decreased from 1,486 to 1,040 (mean difference 445.3; 95%CI 323.4 to 567.3; $p < 0.001$). The average number of days hospitalised per month per 1,000 COPD patients decreased from 12,893 to 10,265 days (mean difference 2,628; 95%CI 1,575 to 3,681; $p < 0.001$).

When comparing the tail 6-months, there was instead an increase in utilization. Mean ED attendances increased by 352.9 to 420.7 per month per 1,000 patients (mean difference 67.8, 95%CI 12.7 to 123.0; $p = 0.016$), while average days hospitalized per month per 1,000 patients

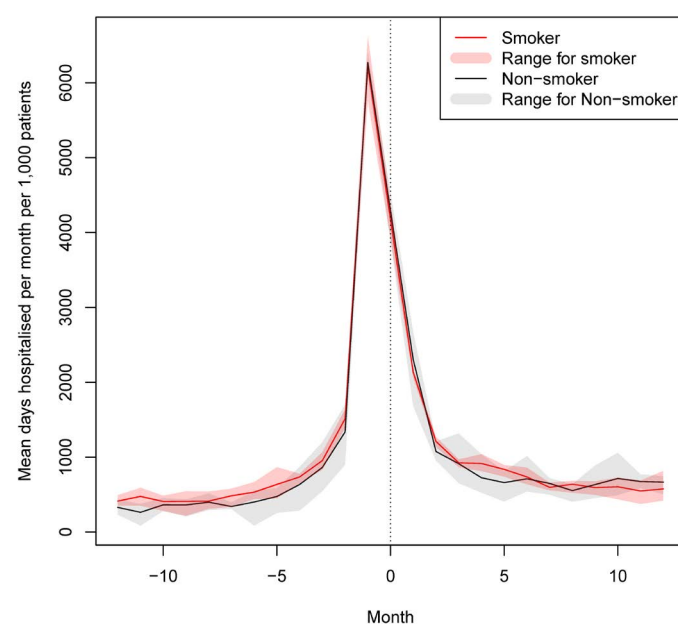
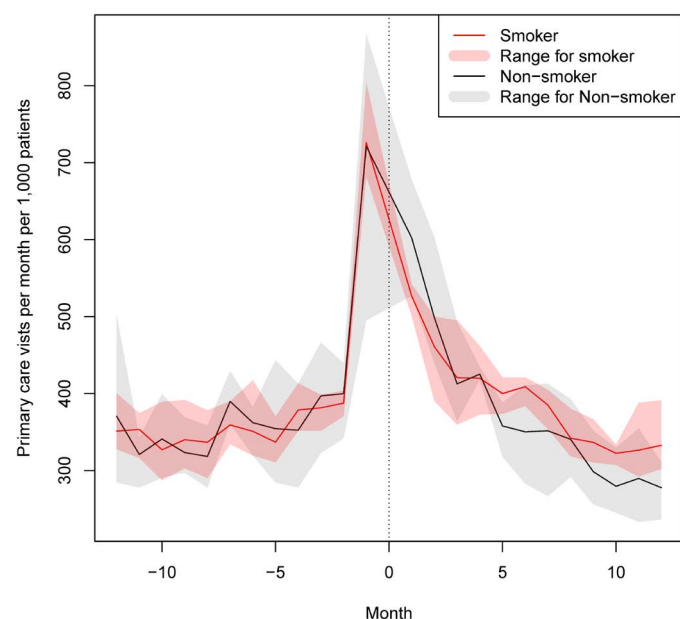
**Figure 2.** Days spent hospitalised by COPD patients prior to and post diagnosis

Table 2. Change in utilisation rates (per month per 1,000 patients) prior to and after diagnosis, according to smoking history

	Positive smoking history	Negative smoking history	p-value
360 day comparison			
Emergency department attendances	-392.48	-579.36	0.031
Polyclinic primary care visits	67.94	-193.59	0.435
Specialist outpatient clinic visits	2260.53	1760.14	0.089
Days spent hospitalised	-2917.18	-1895.37	0.260
Tail 180 day comparison			
Emergency department attendances	88.71	14.95	0.186
Polyclinic primary care visits	-14.32	-234.88	0.175
Specialist outpatient clinic visits	862.44	549.47	0.056
Days spent hospitalised	935.15	1782.21	0.085

**Figure 3.** Polyclinic primary care visits by COPD patients prior to and post diagnosis

increased from 2,457 to 3,632 (mean difference 1,174; 95%CI 662 to 1,686; $p < 0.001$).

Stratification according to smoking history did not show any statistical difference in utilisation between those with positive and negative smoking history, as shown in Table 2.

Ambulatory care: polyclinic primary care and specialist outpatient clinic (SOC) visits

Primary care visits did not show any significant change when comparing the 360 days prior to and post diagnosis (prior = 4,640 visits per month per 1,000 patients vs post = 4,634; mean difference 6.04, 95%CI -362 to 374; $p = 0.97$). SOC visits per month per 1,000 patients showed an increase (prior = 5,616 visits per month per 1,000 patients vs post = 7,735; mean difference 2,119; 95%CI 1,762 to 2,476; $p < 0.001$), as shown in Figures 3 and 4.

When comparing tail 6-months, this pattern remained. Polyclinic primary care visits did not show any statistically significant difference (prior = 2,067 visits per month per 1,000 patients vs post = 1,990; mean difference 76.7, 95%CI -103 to 257; $p = 0.403$) while SOC visits increased (prior = 2,443 visits per month per 1,000 patients vs post = 3,217; mean difference 773.9; 95%CI 594.0 to 953.8; $p < 0.001$). Stratification

according to smoking history did not show any statistical difference in utilisation between those with positive and negative smoking history.

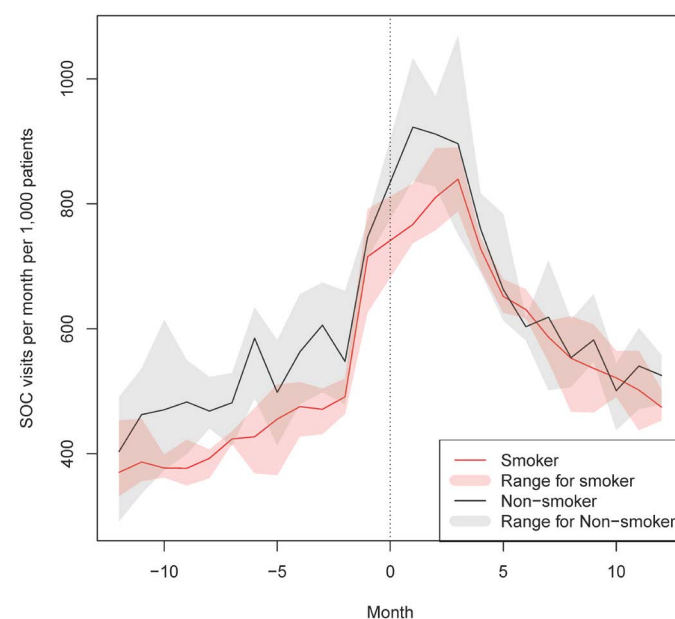
Discussion

We found a significant change in utilisation patterns pre and post diagnosis of COPD. Ambulatory care services remained either stable or increased, whether comparing 360 days or the tail 180 days. Emergency and hospitalisation inpatient care showed a decrease when comparing 360 day period, while comparison of the tail 180 days, excluding the 6 months immediately preceding and subsequent to diagnosis showed instead an increase. The presence of smoking history had little impact on the utilisation patterns.

The patterns of ambulatory care service utilisation are not unexpected, given the diagnosis of COPD. COPD is a chronic condition with episodic flares necessitating regular follow-up and medication if required. Therefore, any increase post diagnosis is logical and in keeping with the diagnosis of any chronic condition. In fact, this chain of events is the underlying premise of health maintenance and disease prevention.

It is interesting that primary care visits rate remained stable while specialist care increased. This increase in SOC visits remained even after exclusion of the 6 months immediate pre and post diagnosis. We postulated that 6 months would be sufficient for stabilisation of the COPD condition. Therefore after 6 months, COPD patients would no longer require tertiary level specialist care and could be managed by primary care providers. Our findings were contrary to this hypothesis, where instead we find COPD patients are receiving increased SOC care without increased primary care visits. This is alongside an increased emergency department attendances and days spent in hospital.

Reasons for this could be disease-related, provider-related, or patient-related. Disease factors include patients being diagnosed at the late stage where there is higher risk of pulmonary infections and other complications, with lesser room for improvement. Other reasons include continued disease progression despite treatment possibly due to continued trigger exposure, especially given the high recidivism rate

**Figure 4.** Specialist outpatient clinic visits by COPD patients prior to and post diagnosis

for smoking [15]. COPD is a progressive condition and would lead to increased healthcare utilisation at tertiary centres (i.e., SOC, ED attendances and hospitalisations) as patients approach end stage lung disease. This conjuncture is consistent with the data collected. However, we lack disease severity measures (eg. GOLD scoring, spirometry results), preventing further confirmation of this hypothesis. We also noted that our findings were consistent between those with positive smoking history and those without, indicating that despite the different aetiologies (tobacco exposure vs other causes), the trajectories and utilisations are similar.

Patient-related factors involve their ideas, concerns and expectations. They may deem primary care as less effective compared to specialist care due to a variety of reasons such as past experiences or availability of services. Patients may also utilise the ED and hospitalisation as their 'care provider' as the billing model is fixed-cost for the former, and claimable from health insurance.

Provider-related factors would entail understanding ground practices and preferences. Specialist physicians may have a high threshold of decanting patients to the primary care sector due to possible disease progression, or concerns over primary care capacity or capability. There may also be other incentives for specialist clinics not to discharge these mild and stable COPD patients, such as departments being held to disease control targets. It is also important to consider that ED attendances and admission is often a complex decision involving psychosocial factors on top of clinical grounds.

Based on our results, we suggest a careful review of COPD disease trajectories, and the current clinical care provided. Currently, care guidelines both local and international do not provide clear information on the frequency of review [16,17]. Given the likelihood of poor disease control (more ED attendances and hospitalisations) up to 1 year post diagnosis, we recommend more frequent reviews and intense therapy in the early period post diagnosis and throughout the initial year.

Clinical care guides also suggest addressing risk factors, especially tobacco exposure, alongside other preventive measures (eg. vaccinations, pulmonary rehabilitation) [16,17]. In our cohort, we noted that nearly 3 in 4 had a positive smoking history. Smoking is known to be a risk factor for not just COPD but other major conditions such as pulmonary malignancies and cardiovascular events. Therefore preventing tobacco initiation and supporting smoking cessation efforts are of high importance [16,17]. Addressing other exposures such as air pollution and occupational exposures are also areas of concern, given that 28% had no smoking history [16,17]. Infection control and personal hygiene measures such as facemask wearing, regular hand washing and social distancing should also be emphasized, given its demonstrated effectiveness in reducing COPD exacerbations during the coronavirus pandemics [18,19].

Alongside upstream preventive efforts, downstream interventions to mitigate the current and future burden on health care services should be considered. Telemedicine and home monitoring are such potential avenues. These are potentially effective strategies for managing chronic respiratory conditions in the community, where patients use ambulatory devices to measure oxygen saturation, lung volumes and other vital signs [20]. This would thereby allow greater patient empowerment in self-care and monitoring of their own condition while also increasing accessibility to healthcare services [21-23]. It also provides the opportunity for early exacerbation detection and timely intervention in the home or at the outpatient setting, thereby avoiding ED attendance or hospitalisations [24].

It may also be worthwhile to consider whether current clinical practice, capacity and capability are able to support management of COPD at the appropriate sector. For example, the primary care providers may lack the necessary supports and skills for management, therefore preventing any right-siting efforts of patients. Similarly, careful consideration on interventions, such as utilisation reduction efforts for certain services (eg. SOC) may result in unintended increases of other services (emergency, inpatient) if poorly designed or implemented. Nevertheless, it is essential to consider novel alternatives and strategies for a more patient-centric and proactive COPD management approach, especially in an era of overburdened health systems.

Conclusion

COPD is a chronic respiratory disease, contributing a substantial burden on health systems both locally and worldwide. We found that newly diagnosed COPD patients had a markedly higher usage of specialist ambulatory care with a concomitant higher ED attendance and hospitalisation rate. Moving forward, further research is essential to understand underlying reasons for this increased usage and to develop effective upstream strategies to reduce COPD incidence, and downstream interventions to mitigate healthcare system burdens such as potentially avoidable ED attendances and hospitalisations. Home monitoring and telemedicine plays an important role in this effort.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Human/Animal Ethics Approval Declaration

Not applicable for this study as only retrospective, de-identified and aggregated data were used. This is in accordance with our cluster's IRB policy.

Clinical Impact

This study demonstrates the changes in COPD health service utilisation before and after the diagnosis of COPD.

The findings underscore the potential avoidable disease burden and healthcare cost in this population.

The study highlights the need of preventive and smoking cessation services in reducing unnecessary health service utilisation in Singapore.

This study explores strategies to reduce the burden of chronic respiratory diseases on the healthcare system in Singapore.

Tweetable Abstract

Chronic obstructive airway diseases persistently increased emergency visits and admissions. Preventive efforts and smoking cessation may help reduce unnecessary utilisation and disease burden.

Authorship and Contributorship

All authors provided substantial contributions to the study's conception and design, the conducting of the study, and the acquisition, analysis and interpretation of the data. All authors were involved in the drafting and critical revision of the manuscript for important intellectual content. All authors were involved in the final approval of the version for publication.

Competing Interests

The author(s) declare that they have no competing interests.

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