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Published in:
Internal Medicine Journal

DOI:
10.1111/imj.15014

Does distance to hospital affect emergency department presentations and hospital length of stay among COPD patients?

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This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process which may lead to differences between this version and the Version of Record. Please cite this article as doi: 10.1111/imj.15014

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Conflict of Interest statement: On behalf of all authors, the corresponding author states that there is no conflict of interest.

Acknowledgements: We thank the data managers at each of the three hospitals for their cooperation in accessing the data used in the study.

Abstract

Background: The primary goal of COPD management is to optimize a patient's functional status and quality of life. By encouraging effective patient self-management within primary health care, unplanned and potentially avoidable COPD admissions to the emergency department can be avoided.

Aim: The aim of this study is to examine whether distance to hospital influences the rate of ED presentation, hospital admission and hospital length of stay for COPD patients.

Methods: The 2016 to 2018 resulted in a total of 5253 patient presentations with a primary medical diagnosis code of J44 (COPD). These were at the main hospitals of three Queensland Hospital and

Health Services: Toowoomba, Ipswich and Gold Coast. To examine the variations in patient characteristics based on distance a one-way ANOVA (Analysis of Variance) test was conducted. The Kruskal-Wallis (KW) test indicated that there were group differences.

Results: This study identified significant variation in COPD-related hospital length of stay and distance to hospital among COPD patients within three hospitals in South East Queensland, Australia. These results confirm that distance plays an important role in determining duration of hospital stay (in number of days) among COPD patients, with clear evidence of the distance 'decay phenomenon'. It appears from the findings of the current study that distance to the hospital is not associated with the greater likelihood of ED presentation but may influence length of stay.

Conclusions: Several distance-specific studies have concluded that lower utilisation of hospital care is associated with distance to hospital.

Keywords: distance, COPD, regional hospital, emergency department, length of stay, Australia

Introduction

The burden of chronic obstructive pulmonary disease (COPD) has increased substantially worldwide over the past few decades. In 2016 the disease claimed three million lives globally (5.7% of all deaths) and was the 3rd leading cause of death[1]. COPD was the underlying cause of 7,889 Australian deaths in 2018 and was the 5th leading cause of deaths in Australia[2]. This progressive life-threatening condition is non-curable; however, appropriate treatment and chronic condition management can significantly alleviate symptoms, improve health trajectories, provide cost savings to the health system, and reduce the mortality rate while improving patient quality of life[3].

The primary care management of COPD patients includes a range of options for patient monitoring to identify changes in symptoms, reduce risk of acute exacerbations, improve patient compliance with prescribed treatment/s, increase participation in non-traditional pulmonary rehabilitation clinics, and to more effectively support patients to adopt healthier lifestyle behaviours (e.g. smoking cessation)[4,5]. Thus, the primary goal is to optimize a patient's functional status and quality of life by preserving best possible lung function, improving symptoms management, and avoiding the recurrence of exacerbations. This is best achieved through effective interventions such as changing smoking habits, prescribing appropriate medications, medication compliance, regular vaccinations, oxygen therapy and pulmonary rehabilitation. Despite that a lack of adherence to clinical guidelines of disease management[6] and inadequate access to and utilisation of primary care services and management action plans[7], individually and cumulatively contribute to unplanned and potentially avoidable COPD related hospital admissions. Australian hospitals had 78,100 admissions of patients with COPD as the primary diagnosis in 2016-17, and over the last 10 years, the hospitalization rate among women had increased (17%) significantly more than men (6% decline)[8]. Furthermore, according to the Organization for Economic Co-operation and Development (OECD) database (2017), Australia's COPD related hospital admission were the 4th highest in 2015 (306.62 vs OECD average of 189.81 per 100 000 population). The health system cost of COPD related treatment was estimated at $976.9 million, which comprised 24% of total disease expenditure on respiratory conditions in Australia[9].

Previous studies have identified several key patient-specific and geographic factors as well as system-level factors that adversely affect COPD related hospital admission rates. Research findings have demonstrated a strong association between sociodemographic factors (e.g. age), health characteristics (e.g. comorbidities) and health behaviours (e.g. smoking) as well as frequency of hospital admissions among COPD patients[5,10,11]. Other studies have examined the impact of remoteness on hospital admission among ambulatory care sensitive chronic conditions such as COPD however, these findings are inconsistent. Eckert et al[12], Ansari[13] and the Australian Institute of Health and Welfare[14] found that hospital admissions were higher in rural areas, and Zielinsk et al[15], LaVela[16] and Escarce et al[17] concluded that geographical distance to hospital inversely influenced the utilisation of hospital care. On the contrary, Purdy et al[4], Paul et al[18] and Henneman et al[19] demonstrated that distance was significantly associated with COPD related hospital admissions and shorter distances were associated with increased probability of emergency department (ED) admission. Furthermore, Agboado[20] found that distance did not influence length of hospital stay among COPD patients.

There is lack of consensus within the existing literature regarding relationships between the distance and hospital/emergency admission and length of stay nexus. Understanding the factors responsible for variations in COPD related hospital length of stay due to distance will critically assist policymakers and health practitioners to improve COPD related health outcomes and reduce avoidable demand for hospital care, especially for emergency department presentations. This is important in large countries such as Australia, Canada and the United States where there may be large distances from home to hospital. There is little data examining this issue within a regional hospital context in Australia for COPD.

The aim of this study is to examine whether distance to hospital influences the rate of hospital admission/ED presentation and hospital length of stay for COPD patients. This study will test the following null hypotheses: a) distance does not influence the duration of hospitalisation per admission among COPD patients, and b) distance does not affect the ED presentation rate among COPD patients. As distance (between home and nearest hospital) is a key determinant that affects healthcare utilization (particularly in a country such as Australia with its vast land area and wide dispersal of the population), the findings of this study will likely inform health policymakers to deliver more effective COPD management and treatment strategies and reduce avoidable hospital admissions/ED presentations. Furthermore, the study will also identify any potential distance-related inequality in the utilisation of hospital care among COPD patients.

Materials and methods

Study design and setting

This causal-comparative non-experimental research design was conducted in three hospitals in regional Queensland, Australia.

Study population

During the study period (late 2016 to late 2018), there were a total of 5253 patient presentations which had a primary medical diagnosis code of J44 (COPD). These presentations were at the main hospitals of three Queensland Hospital and Health Services: Toowoomba Hospital (Darling Downs), Ipswich Hospital (West Moreton) and Gold Coast University Hospital (Gold Coast). Among these patients, 58% had more than one ED presentation over this period. Data on hospital admission (after ED presentation) and length of stay was available for 4914 patients out of which 958, 1648 and 2308 were from Toowoomba, Ipswich and Gold Coast Hospitals, respectively. Approximately, 34% had one or fewer days of hospital length of stay after presenting at ED.

Data collection

We used an automated data set extracted from EDIS and HBSCS system admission data for every COPD emergency department presentation over a 22-month period in the three hospitals.

Variable definition

This analysis uses two dependent variables; a) the hospital length of stay (continuous variable) and b) the number of ED presentations (ordinal variable with three categories). The key independent explanatory variable was the distance to the hospital, which was calculated using the distance from the usual place of residence to the presenting hospital. We converted the value into three categories and assumed that: 0 km – 15 km - short-distance, >15 km – 50 km - intermediate-distance, > 50 km - long-distance. Other variables were included in the estimation process. Patients age at the triage date was estimated using the difference between the triage date and the date of birth of the patients. Triage category associated with each ED presentation contained five categories. In Australia, triage category 1 is considered as immediately life-threatening, and triage category 5 is a less urgent case. Length of stay at the hospital after admission was measured by number of days. Insurance status was denoted by one of two categories: whether the patient used Medicare or private health insurance for the treatment. Patient employment status converted into three categories: pensioner, employed and all other status. For country of birth two categories were created: patients born in Australia, and overseas. Mode of arrival to the hospital had two categories: all types of ambulance, and otherwise. Source of referral was whether the patients were referred by a health practitioner (e.g. GP) or self or family/friend referred. Departure destination was converted into two categories: patients sent to home/usual residence or hospital admission. Number of hours the patient stayed at the emergency department. Number of times the patient was admitted during the period of data collection was converted into three categories: 1 ED presentation, 2-4 ED presentations and 5 ≤ ED presentations.

Statistical analysis

Initially, to examine potential variations in the patient characteristics based on distance of usual residence to hospital a one-way ANOVA (Analysis of Variance) test was conducted. This test can compare the means of more than two groups which are mutually independent[21]. Prior to conducting this analysis, the population normality was tested using the Kolmogorov-Smirnov and

Shapiro-Wilk test. This study uses continuous, ordinal and binary variables for estimation purposes. In particular, the key variable of interest in the first part of the analysis was the distance to the hospital (ordinal variable). Hence the Kruskal-Wallis (KW) test was used, which ranks the pooled data from 1 to N for the lowest and highest value, respectively[22]. The significant result in the Kruskal-Wallis test indicates that there are group differences.

The next part of the analysis focused on estimating the relationship between distance to hospital and length of stay. The goal was to estimate whether the means of the three categories of the independent variable (distance from the usual residence to the hospital) differ. Here the null hypothesis is that all means (each ordinal group of the independent variables) are equal. The ANOVA test uses F-statistics to calculate the outcome variable by using group means to test if they vary significantly or not. Next a specific model parameter was used to estimate which means are different from each other[21].

Lastly, to understand the impact of distance and frequency of ED presentation for each individual hospital, the Chi-square test was used. ED Patients were divided into two groups based on distance. Short and intermediate were combined whilst the long remained separate. For the first group, the patient's postcode was identical to the postcode of the hospital visited (short distance) and the second group of patients had a different postcode (long-distance). Then, the Chi-square test was used to compare the frequency of ED presentation between the two groups.

Ethics Approval

Multisite ethics approval was obtained from Queensland Health (HREC/17/QGC/249), with site specific approvals also occurring at participating health services.

Results

Among the 4914 COPD patients included in this study 90% came to hospital from a short or intermediate distance (0 to 50 kilometers), and the rest travelled long distance (more than 50 kilometers). Table 1 represents several patient characteristics, as well as the composition of care utilization by dividing the patients into three groups according to the distance to hospital. The mean age of the COPD patients admitted to ED varied significantly based on distance (p-value<0.05). Long-distance patients mean age were lower than those from short or intermediate distance. Around three-quarters of them were pensioners with no significant mean differences within the groups. Of the long-distance patients 89% of them were Australian born. Around one in four patients from a short and intermediate distance were born overseas. Notably, nine out of ten patients were Medicare patients for their treatment.

Table 1 here

One in two patients (all groups) who presented to ED were assessed as triage category 3. The majority (>85%) of the patients were triage category 2 or 3. Over 10% of patients from long-distance were triaged as category 1, compared to 4% from intermediate and 6% from short-distance. In addition, patients from short and intermediate distances were mostly referred to the ED by self or family or friends, while that was less among long distance patients (p-value<0.05). The mean length of hospital stay was considerably different between the groups. The mean length of stay for the short and intermediate distance patients was identical. However, the hospital stay of the long-distance patients were less than half comparatively. A large majority of them were discharged from hospital in less than two days compared to about half of the short and intermediate distance patients, respectively. Approximately, one in ten patients were discharged without hospital admission among short and intermediate distance patients, compared to one in twenty among long distance patients. Average hours spent at ED were identical across all groups.

The findings of the nonparametric Kruskal-Wallis test indicate that age, hospital length of stay, country of birth, referral person and departure destination were significantly different between the groups (based on distance). After establishing that the mean hospital length of stay varies significantly by distance, this study further investigated to what extent one group may differ from the other using the one-way ANOVA test (Table 2). The mean difference for length of stay among COPD patients of short and intermediate distance was statistically insignificant. However, patients from long-distance had shorter length of stay compared to both short and intermediate distance patients, both statistically significant. As expected, there was a negative correlation between distance and hospital length of stay, which was statistically significant.

Table 2 here

The hospital-specific variations in the association between ED presentation and distance to the hospital they presented to (from usual residence) were presented in Table 3. The estimates have been presented for each hospital separately as these hospitals had unique resource profiles, including distinct policies and capabilities to provide ED care. Patients were divided into two groups based on whether they had the same postcode as the hospital (short distance) or otherwise (long-distance). Then the mean frequency of ED presentation was compared using the Chi-squared test. No significant differences were observed. In the Darling Downs, three quarters of presenting patients were from a short distance. For those with five or more ED presentations, a vast majority came from a short distance. In the West Moreton, of the patients with only one ED presentation, about half were short-distance. In the Gold Coast, the values were similar to West Moreton. Noticeably, for all hospitals, around half of patients had two to four ED presentations. Lastly, Darling Downs had more patients from a short distance than the other two hospitals.

Table 3 here

Discussion

This study identified important variation in COPD-related hospital length of stay and distance to hospital among COPD patients within three hospitals in south east Queensland, Australia. These results confirm that distance plays an important role in determining duration of hospital stay (in number of days) among COPD patients, with clear evidence of the distance decay phenomenon. The distance decay effect states that the interaction between two locales declines as the distance between them increases. Therefore, people living more distant from the hospital typically had a significantly shorter length of stay compared to those living closer. On the other hand, this study did not find any significant differences in ED presentation and distance to hospitals.

Past studies have indicated that due to unavailability of primary and specialist care in rural areas, care for COPD (particularly among the most socioeconomically disadvantaged patients) occurs in EDs[11] as well as distance to hospitals has no relationship with early discharge from hospital (Agboado)[20]. However, several distance-specific studies have concluded that lower utilisation of hospital care is associated with distance to hospital (Terry et al.[5], Zielinsk et al[15], LaVela[16] and Escarce et al[17]). One possible explanation of the findings in this study could be the mean age difference between the short and intermediate distance patients with long-distance patients. The COPD patients from long-distance were comparatively younger than those from short distance, and there is compelling evidence in the literature that age has an important relationship with hospital length of stay among COPD patients (Agboado)[20]. Another possible reason for this finding is that COPD patients of rural residency may have better health status than their urban counterparts, as indicated by the findings of Iversen et al[23]. Moreover, this is the potential that people with severe chronic illnesses may already live closer to hospital facilities to hasten quicker access if needed among higher risk cohorts; however, further research is required in these areas. Another possibility is that if patients come from further afield and are not really needing to be admitted for medical reasons it could be that they are kept in hospital for logistical/practical/social reasons (i.e. if they lived close by they would not have been admitted but discharged).

It appears from the findings of the current study that distance to the hospital is not associated with the greater likelihood of ED presentation. The penultimate goal of an effective contemporary healthcare system is to reduce inequity in access to care. From this perspective, these results are promising for Australians. Noticeably, the findings contradict the conclusions of Purdy et al.[4], Paul et al.[18] and Henneman et al.[19] who found distance to ED was significantly associated with the greater likelihood of admission in the UK, Singapore and the USA, respectively. However, none of these studies used ED presentation data specifically among COPD patients. One possible explanation for the findings of this current study could be that patients with greater health care needs are more willing to travel longer distances to access ED services[19]. Hence if COPD patients are critically ill due to inappropriate disease management and/or other comorbidities, it would be highly appropriate for them to travel considerable distances to access treatment. Another key factor may be the availability of free ambulance services for residents in Queensland. The results indicate over eight out of ten COPD patients (86% of patients from > 50km) arrived at ED by ambulance and may have increased the ED accessibility of COPD patients living farthest from ED facilities. Lastly, it also important to note that a patient's choice of hospital is significantly influenced by perceived quality of care[24]. If the perceived quality of a particular hospital is deemed very high, patients will travel long distances (often bypassing smaller secondary care facilities) to access treatment[17]. This might explain why around 85% of the patients in the Gold Coast came from long distances. These factors might have positively impacted the rate of ED presentation of COPD patients living longer-distances from the servicing hospital. Hence, their frequency of ED use was similar to those living a shorter distance away (who have comparative easier ED access).

Conclusions and Policy Implications

The findings of this study have several key policy implications. Understanding the impact of distance on ED presentation and length of stay is important to ensure optimal care. Improving access to care whilst reducing avoidable hospital/ED admissions are important goals of healthcare systems around the world, including Australia. The role of telehealth is increasing in many health services. In geographically diverse states like Queensland its use is rapidly increasing across illnesses and treatment modalities to overcome the 'tyranny of distance'. The results of this study indicate differential behaviours and outcomes for COPD patients based on their distance to treating hospital. The role of telehealth could be important in reducing avoidable ED presentations of COPD patients, especially those coming from long distances. This issue needs to be investigated further. Distance-specific comparison of duration of hospitalisation could also assist in improving healthcare practice for COPD prevention and management. Knowledge of factors (e.g. distance to the hospital) influencing COPD patients hospital length of stay could assist in reducing avoidable hospital bed days and COPD treatment costs. Future studies should investigate the key factors that may influence lower hospital length of stay among COPD patients from longer distances. It is also important to understand the health impacts of such findings or whether shorter length of stay sufficiently accounts for the COPD related mortality and remoteness nexus in Australia.

Probably the major limitation of this study is the measure of distance. Due to the unavailability of the address of patients, this study used the postcode to calculate the distance. Hence, a precise estimate of the distance to the hospital was not possible. Furthermore, several key patient characteristics such as gender, income level or existence of comorbidities were unavailable. Lastly, this study did not take into account the quality of hospital care which can significantly influence patient's choice of hospitals.

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Table 1: Descriptive statistics of the key variables

Variables	0-15 KM (short-distance)	>15-50 KM (intermediate-distance)	>50 KM (long-distance)	One-way ANOVA F-ratio (Sig.)
Number, n (%)	2962 (60.3%)	1499 (30.5%)	453 (9.2%)	
Age, years (Mean)	71.1	72.2	67.3	32.63 (0.00)
Employment status				0.74 (0.48)
Pensioner	78.5%	77.3%	74.6%	
Employed	6.9%	8.5%	10.2%	
All other	14.7%	14.1%	15.2%	
Country of birth				29.62 (0.00)
Australia	75.1%	71.2%	89.0%	
Insurance status				0.08 (0.92)
Medicare only	88.3%	88.4%	89.0%	
Triage category				5.26 (0.00)
1	6.9%	4.1%	10.6%	
2	35.1%	38.5%	37.1%	
3	54.4%	55.6%	49.9%	
4	3.5%	1.8%	2.2%	
5	0.1%	0.0%	0.2%	
Mode of arrival				4.60 (0.01)
Ambulance (All types)	81.5%	79.8%	86.1%	
Referral person				87.73 (0.00)
Self or Family/friend	83.6%	88.4%	65.3%	
Hospital length of stay (days)				
0 to < 2	58.4%	52.9%	80.2%	
≥ 2 to <4	16.2%	22.7%	10.4%	
≥ 4 to <6	6.4%	7.1%	2.4%	
≥ 6	18.9%	17.3%	7.1%	
Mean length of stay (days)	2.62	2.63	1.10	30.01 (0.00)
Departure destination				11.48 (0.00)

Home or Usual Residence and Discharged after ED services completed	12.2%	9.2%	5.5%	
Hospital stay after ED service completed	87.8%	90.8%	94.5%	
ED length of Stay, hrs (Mean)	4.71	4.55	4.78	2.25 (0.11)

Note: Test of normality used the Kolmogorov-Smirnov and Shapiro-Wilk test. Results are available upon request. ED: Emergency Department

Table 2: One-way ANOVA test (distance and length of stay)

(I) Distance into three categories	**(J) Distance into three categories**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**	**95% Confidence Interval** Lower Bound	Upper Bound
0-15 KM	>15-50 KM	-0.011610	0.126911	0.995	-0.30914	0.28592
	>50 KM	1.525608*	0.201990	0.000	1.05206	1.99915
>15-50 KM	0-15 KM	0.011610	0.126911	0.995	-0.28592	0.30914
	>50 KM	1.537217*	0.214667	0.000	1.03395	2.04049
>50 KM	0-15 KM	-1.525608*	0.201990	0.000	-1.99915	-1.05206
	>15-50 KM	-1.537217*	0.214667	0.000	-2.04049	-1.03395
ANOVA		Sum of Squares	df	Mean Square	F	Sig.
Between Groups		962.188	2	481.094	30.011	0.000
Within Groups		78726.481	4911	16.031		
Total		79688.668	4913			
Correlation test between distance and length of stay		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance	
Interval by Interval	Pearson's R	-0.033	0.015	-2.284	0.022[c]	
Ordinal by Ordinal	Spearman Correlation	-0.034	0.014	-2.408	0.016[c]	
N of Valid Cases		4914				

Note: Dependent Variable: Length of stay. The mean difference is significant at the 0.05 level.

Table 3: Hospital-specific relationship between multiple ED presentations and distance

Darling Downs	**All other post codes**	**Local**	**Total ED presentations**	**Chi-Square Tests (df = 2) p-value**
1 ED presentation	26.0%	74.0%	227	0.138
2-4 ED presentations	22.2%	77.8%	370	Pearson's R (Appx. Sig.) = 0.049[a]
5 ≤ ED presentations	16.7%	83.3%	120	Spearman Correlation (Appx. Sig.) = 0.051[a]
West Moreton	**All other post codes**	**Local**	**Total ED presentations**	**Chi-Square Tests (df = 2) p-value**
1 ED presentation	61.7%	38.3%	243	0.756
2-4 ED presentations	62.4%	37.6%	434	Pearson's R (Appx. Sig.) = 0.496[a]
5 ≤ ED presentations	58.2%	41.8%	189	Spearman Correlation (Appx. Sig.) = 0.532[a]
Gold Coast	**All other post codes**	**Local**	**Total ED presentations**	**Chi-Square Tests (df = 2) p-value**
1 ED presentation	85.1%	14.9%	422	0.582
2-4 ED presentations	84.2%	15.8%	765	Pearson's R (Appx. Sig.) = 0.610[a]
5 ≤ ED presentations	86.6%	13.4%	322	Spearman Correlation (Appx. Sig.) = 0.630[a]

Note: [a] means based on normal approximation.