ORIGINAL RESEARCH

The Association with COPD Readmission Rate and Access to Medical Institutions in Elderly Patients

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Purpose: Up to 20% of patients with chronic obstructive pulmonary disease (COPD) require re-admission within 30 days of discharge after hospitalization for acute exacerbations of the disease. These re-admissions can increase morbidity and the economic burden of COPD. Reducing re-admissions has become a policy target in many developed countries. We investigated the risk factors for COPD re-admissions among older adults with COPD.

Patients and Methods: Data obtained from the National Health Insurance Service-Senior Cohort (NHIS-SC) in Korea were analyzed. The subjects included 558,147 patients aged ≥70 who had been admitted for COPD between 2013 and 2015. Re-admission was defined as being re-hospitalized within 30 days after discharge. The key variables selected from the database included income-based insurance contributions, demographical variables, information on inpatient medical services, types of healthcare facilities, and emergency time relevance index (TRI). The TRI is a regional medical-use analysis index that evaluates whether the capacity of the medical services available is appropriate for the medical needs of the target residents.

Results: In 814 COPD re-admission cases among 4867 total admissions due to COPD in elderly subjects, higher re-admission rates were associated with male sex, admission to district hospitals, medical aid recipients, and a longer hospital stay. When additionally adjusting the TRI to identify the difference in re-admission rates due to medical service accessibility, the same results were found, except for the areas of residence. The TRI was lower in re-admission cases (odds ratio 0.991 [95% CI, 0.984–0.998], P = 0.013).

Conclusion: In this study, COPD re-admission rates among older adults were significantly associated with sex, length of hospital stay, and the type of hospital. The capacity of the medical services provided was also related to the COPD re-admission rate. Better access to appropriate emergency services is associated with reduction of COPD re-admission rates.

Keywords: rehospitalization, elderly, local characteristics, time relevance index

Introduction

Chronic obstructive pulmonary disease (COPD) is characterized by persistent respiratory symptoms and airflow limitation.[1] It is the third leading cause of death in US and seventh in Korea.[2,3] The estimated total costs were approximately 1245 million USD in 2015.[4] A recent concern about COPD is that up to 20% of patients require re-admission within 30 days of discharge after hospitalization for acute exacerbations of the disease.[5–7] These re-admissions can increase the morbidity and economic burden of COPD.[8,9] Because reducing re-admissions has

become a policy target in many developed countries, COPD was included the Medicare Hospital Re-admissions Reduction Program (HRRP) in 2014.[10] COPD is a progressive chronic diseases that require long-term management. Care for chronically-ill patients is characterized by undertreatment and failure to use preventive measures.[11] The prevalence of chronic disease was found to be higher in rural areas than in urban areas.[12–14] Additionally, there was an imbalance in health status depending on the area of residence.[15–17] Medically underserved areas (MUAs) are "geographic locations, which has insufficient health resources to meet the medical needs of the resident population".[18] MUAs are defined using the time relevance Index (TRI), a proven index of accessibility, to identify places with low accessibility and poor quality of care.[19] Previously, several studies have investigated risk factors for COPD re-admission,[5,6,20–23] but no studies on MUAs and COPD re-admission. Therefore, we investigated the factors associated with the risk of COPD re-admission in Korea and used TRIs to compare COPD re-admission in general populations with areas defined as MUAs.

Patients and Methods
Data Source and Subjects
Data obtained from the National Health Insurance Service-Senior Cohort (NHIS-SC) in Korea were analyzed. The NHIS-SC consists of 558,147 people selected by 10% random selection of a representative sample of 5.5 million eligible Koreans recorded in the National Health Information Database (NHID). The cohort was followed-up retrospectively through 2015 for all subjects, unless a participant's eligibility was lost due to death or emigration, in accordance with the National Health Insurance Act. Of these 558,147 people, we analyzed 4867 patients over 70 years of age and who were hospitalized due to COPD from 2013 to 2015. The objectives and design of the NHIS-SC study have been detailed elsewhere.[11]

Study Population
The subjects of the present study were aged 70 years or older and had been admitted for COPD between 2013 and 2015. Re-admission was defined as being re-hospitalized within 30 days of discharge. Re-admission to other institutions before or on the day of discharge was excluded from analysis. Patients were excluded from the study if they were transferred from another hospital or had a length of hospital stay of 0 days or less than 24 hours (Figure 1).

Key Variables Affecting Re-Admission
In this study, the following general characteristics were included: age, sex, residential area, insurance type and quintile, length of hospital stay, and Charlson comorbidity index (CCI). Insurance types will be classified according to Korea's unique system, so more than 96.3% of the total
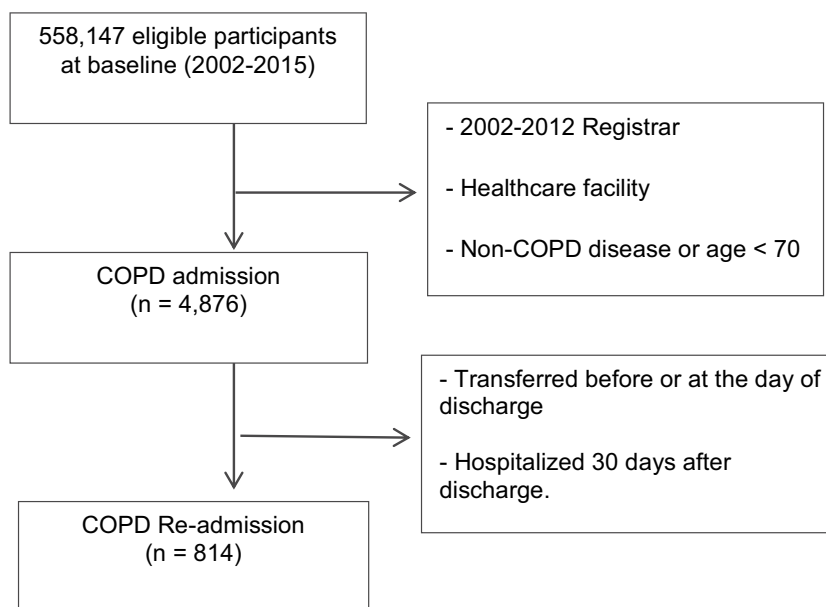

Figure 1 Flowchart of the study population.

population can receive insurance coverage under the National Health Insurance Program.[24] The insured are divided into two groups: employee insured and self-employed insured. Employee insured pay 5.08% of their average salary. The self-employed insured category includes people excluded from the category of insured employee and their contributions are set in consideration of their income, property, etc. The remaining 3.7% are supported by the Medical Aid Program. The following key variables were obtained from the database: income-based insurance contributions, demographical variables, information on inpatient medical services, and types of healthcare facility. The Institution is divided into district hospital (secondary level hospital), and general hospitals by size. The "insurance quintile" is categorized by income-based insurance contribution level, meaning that the higher the division, the higher the income. Region is divided into three categories: the Seoul-Gyeonggi area, which means Seoul and the surrounding cities, metropolitan cities, and provinces. Large cities include the Seoul-Gyeonggi area and metropolitan cities, while the provinces classified as small cities.[25] We also evaluated differences in COPD re-admission using TRI to identify areas where access to medical institutions was poor. The existing RI index is the ratio of medical use in the administrative area, which is flawed. For example, if there are several hospitals nearby in a specific area, but all administrative districts are different, the RI in hospital-level medical use would be "0%." To improve this, an indicator called "a medical use analysis index within the reference time" was used. TRI was calculated as follows: the travel time was determined using the patient's and hospital's addresses in the actual medical data, and the ratio at which the travel time required exceeded the standard travel time (180 minutes) was calculated.

Statistical Analysis

Statistical analysis was performed using SAS Entertainment Guide 7.13 (SAS Institute, Cary, NC, USA). Technical statistical analysis of the major variables was performed and a cross-analysis was performed to determine the difference between re-admission and re-admission depending on the general characteristics. To check the difference between re-admission status according to the medical service accessibility (emergency TRI), a logistic regression analysis was conducted to identify the risk factors for re-admission for COPD. Individual characteristics were applied in Model 1 and individual

characteristics and emergency TRI were applied in Model 2 to confirm medical service accessibility. The significance level for statistical significance was set at 0.05.

Ethics Statement

This research was conducted after receiving approval from the Kangwon National University Hospital Institutional Review Board (KNUH-2019-08-003-002) and undergoing a review process of the National Health Insurance Corporation. In the NHID, de-identified join keys are used for ethical clearance to replace personal identifiers, so patient consent was not required.[26]

Results

For the period 2013 to 2015, 4867 COPD cases were hospitalized. The general characteristics of the 4867 cases are shown in Table 1. Of these, 814 were re-admission cases. Re-admission rates were significantly higher in district hospitals than in hospitals (19.1% vs 15.8%) and in men than in women (18.4% vs 13.0%). In terms of insurance quintile, the re-admission rate decreased from the 0 to 3rd quintile and then increased from the 3rd to 5th quintile (P < 0.001). In addition, the re-admission rate was higher among Medical Aid recipients than among National Health Insurance patients (P < 0.001) (Table 1). When the length of hospital stay was divided into ≤ 1 week, >1 and up to 2 weeks, > 2 and up to 3 weeks, > 3 and up to 4 weeks, and > 4 weeks, the re-admission rate was higher for longer lengths of stay (P < 0.001). In terms of residential area, the re-admission rate increased for rural residential areas (P =. 002), and the readmission rate was higher in small cities than in large cities (18.1% vs 14.8%, P = 0.003).

We also investigated the difference in COPD re-admission rates according to local characteristics. The local variable was the emergency TRI, a regional medical-use analysis index that evaluates whether the capacity of the medical services available is appropriate to meet the medical needs of the target residents. TRI was lower for re-admission cases than for non-re-admission cases (71.53 vs 68.56, P < 0.001) (Table 2).

Two logistic regression analyses were performed to study the factors affecting re-admission. Model 1 was analyzed by adjusting for individual characteristics, such as sex, age, insurance quintile, insurance type, hospital days, Charlson comorbidity index (CCI), type of hospital, and residential area (Table 3). The re-admission rate was higher in men than in women (Odds ratio [OR], 1.754; 95% confidence interval [CI], 1.46–2.106, P < 0.001). For

Table I Characteristics of the Patient According to Re-Admission Status at 30 Days After Discharge

Variables		Not Re-Admitted n (%) (n=4053)	Re-Admitted (≤30 Days) n (%) (n=814)	Re-Admission Rate (%)	P-value
Age, years	70–74	701 (17.3)	155 (19.0)	18.1	0.086
	75–79	1348 (33.3)	234 (28.7)	14.8	
	80–84	1192 (29.4)	257 (31.6)	17.7	
	≥85	812 (20.0)	168 (20.6)	17.1	
Sex	Male	2745 (67.7)	618 (75.9)	18.4	<0.001
	Female	1308 (32.3)	196 (24.1)	13.0	
Institution type	District hospital	2971 (73.3)	558 (68.6)	15.8	0.006
	Hospital	1082 (26.7)	256 (31.4)	19.1	
Insurance type	Self-employed insured	1008 (24.9)	174 (21.4)	14.7	<0.001
	Employee insured	2404 (59.3)	447 (54.9)	15.7	
	Medical aid	641 (15.8)	193 (23.7)	23.1	
Insurance quintile	0	641 (15.8)	193 (23.7)	23.1	<0.001
	1	552 (13.6)	107 (13.1)	16.2	
	2	367 (9.1)	70 (8.6)	16.0	
	3	472 (11.6)	72 (8.8)	13.2	
	4	656 (16.2)	107 (13.1)	14.0	
	5	1365 (33.7)	265 (32.6%)	16.3	
Length of stay (weeks)	≤1	1956 (48.3)	306 (37.6)	13.5	<0.001
	≤2	1410 (34.8)	235 (28.9)	14.3	
	≤3	413 (10.2)	151 (18.6)	26.8	
	≤4	152 (3.8)	58 (7.1)	27.6	
	>4	122 (3.0)	64 (7.9)	34.4	
Charlson comorbidity index	0	4042 (99.7)	812 (99.8)	16.7	0.897
	1	11 (0.3)	2 (0.2)	15.4	
Residence	Seoul Capital Area	933	143	13.3	0.002
	Metropolitan City	756	150	16.6	
	Province	2364	521	18.1	

longer lengths of stay and for more rural areas of residence, the re-admission rate was higher. However, the re-admission rate was lower among self-employed insured than among medical aid (OR, 0.617; 95% CI, 0.460–0.827, P < 0.001) and in hospitals than in district hospitals (OR, 0.798; 95% CI, 0.672–0.947, P = 0.01).

In Model 2, adjustments were made for local characteristics in addition to individual characteristics. This yielded the same results as in Model 1, except for the area of residence.

Re-admission rate was higher in men than in women (OR, 1.749; 95% CI, 1.456–2.101, P < 0.001) (Table 3). As the length of stay increased, the re-admission rate increased. However, re-admission rate was lower among self-employed insured than among Medical Aid patients (OR, 0.618; 95% CI, 0.460–0.829, P < 0.001) and in hospital than in district hospital (OR, 0.794; 95% CI, 0.669–0.943, P = 0.008). For each 1-unit increase in the TRI, OR for re-admission was 0.991 (95% CI, 0.984–0.998, P = 0.013).

Table 2 Chronic Obstructive Pulmonary Disease Re-Admission Difference According to Emergency TRI

		Total Cases	Mean	SD	t	p
Emergency TRI	Not Readmitted	4053	71.53	19.73	3.9	<0.001
	Readmitted	814	68.56	20.22		

Note: P-value by *t*-test.

Table 3 Factors Affecting COPD Re-Admission. Models 1 and 2 Were Analyzed by Adjusting Individual and Local Characteristic Variables, Respectively

		Model 1			Model 2		
		OR	95% CI	P	OR	95% CI	P
Sex	Male	1.754	1.46–2.106	<0.001	1.749	1.456–2.101	<0.001
	Female	1			1		
Age (years)	70–74	1.077	0.843–1.381	0.077	1.072	0.836–1.047	0.087
	75–79	0.836	0.669–1.046		0.837	0.669–1.047	
	80–84	1.05	0.843–1.308		1.045	0.839–1.302	
	≥85	1			1		
Insurance quintile	1	1.066	0.806–1.409	0.309	1.056	0.799–1.397	0.319
	2	0.953	0.703–1.29		0.746	0.698–1.282	
	3	0.799	0.597–1.071		0.802	0.599–1.075	
	4	0.841	0.656–1.078		0.834	0.651–1.07	
	5	1			1		
Insurance type	Self-employed insured	0.617	0.460–0.827	<0.001	0.618	0.460–0.829	<0.001
	Employee insured	0.673	0.541–0.837		0.672	0.540–0.837	
	Medical aid	1			1		
Length of stay (weeks)	≤1	0.29	0.208–0.404	<0.001	0.289	0.208–0.403	<0.001
	≤2	0.308	0.22–0.432		0.307	0.219–0.431	
	≤3	0.66	0.46–0.947		0.66	0.46–0.948	
	≤4	0.691	0.448–1.067		0.692	0.448–1.069	
	>4	1			1		
Charlson comorbidity index	0	1.033	0.226–4.729	0.914	1.088	0.237–4.991	0.914
	1	1			1		
Institution type	District hospital	0.798	0.672–0.947	0.01	0.794	0.669–0.943	0.008
	Hospital	1			1		
Residence	Seoul Capital Area	0.74	0.062–0.911	0.016	1.02	0.734–1.417	0.308
	Metropolitan City	0.886	0.721–1.089		1.2	0.878–1.684	
	Province	1			1		

Abbreviations: OR, odds ratio; CI, confidence interval.

Discussion

In this study, we investigated factors associated with re-admission of elderly COPD patients within 30 days after discharge from hospitalization for acute exacerbation. Based on analysis of a national sample cohort for older people in Korea, we found that COPD re-admission rates among older adults were significantly associated with male sex, longer length of stay, insurance type, and the type of hospital.

Our findings were consistent with those of several previous studies. Male sex and length of stay were associated with increased risk of COPD re-admission in retrospective studies.[6,20,21,27,28] It can be inferred that the COPD re-admission rate will be higher in men, as men

have a higher prevalence of COPD, because a larger proportion of men are smokers and their compliance with medical recommendations is less than that of women.[29] Additionally, although the mechanism remains incompletely understood, factors associated with this include the susceptibility to toxin inhalation, airway structures, and female sex hormones.[30,31] A longer hospitalization period also implies that the disease was more severe and difficult to treat; consequently, the COPD re-admission rate is likely to be higher. The minimum number of days of hospitalization was eight at the time of re-admission, which was higher than the minimum five days for the group without re-admission. In our study, we set the continuous category criterion for the length of stay at 7 days,

making it almost consistent with the aforementioned results. Other studies have shown that older patients are more fragile and more likely to be hospitalized,[20,21,23] but our study showed no significant association of re-admission with age. One potential explanation may be the age distribution in our study. Other studies focused on patients over 40 years of age, with a mean age of 70, whereas, our study only focused on patients over the age of 70.

Recently, Jo et al found that risk factors for re-admission for COPD within 30 days of discharge in Korea were male sex, insurance type, and longer hospital stay.[22] Our study found that, not only these patient-related factors, but also accessibility to medical institutions is associated with COPD re-admission, as the COPD re-admission rate decreased as TRI increased. The ability of medical services to meet the medical needs of local residents was mainly verified through the relevance index (RI), a regional medical use analysis index.[32–36] The RI has been improved on by "the TRI", to improve the ratio of medical use in administrative districts. The actual patient's and hospital's addresses are used to analyze the travel time, and the ratio at which this time exceeds the reference time is calculated. Kim et al used TRI to identify medically underserved areas and found that hypertension in residents of such areas was undiagnosed and under-controlled.[19] Specifically, the actual prevalence did not differ significantly between the two groups, whereas awareness (OR, 0.40; 95% CI, 0.25–0.64, P < 0.001) and disease control (OR, 0.27; 95% CI, 0.18–0.41, P < 0.001) were lower in the underserved areas than that in the general population.[19] Another study of patients, aged over 70 years, with chronic diseases also used TRI to evaluate access to medical services.[37] They studied the relationship between medical experience, including medical accessibility, and unmet medical health care perception in areas with a TRI of less than 30%. In the above study, they used TRI as an indicator of medical accessibility and found that TRIs were associated with primary care. In our study, TRI was also used as an indicator of access to medical institutions. The result is that the lower the TRI, the higher the COPD re-admission rate. Many factors are associated with increased COPD re-admission rates; not only individual factors (such as age, sex, and a longer length of stay) but also local factors, are also associated with re-admission rates. Although these results were not consistent with previous studies that the resources and place of healthcare provision are ostensible drivers of re-admission,[38] we believe that, re-admission rates will vary depending on

the existence of support frameworks in different regions as shown in other systematic reviews.[39] Additionally, there was a systematic review that no single comorbidity was associated with COPD re-admission,[40] but when expanded to all-cause hospital re-admission, three comorbidities (heart failure, renal failure and depression) were related.

Other variables associated with COPD re-admission were insurance type and institution type. Self-employed insured or Employee-insured patients had a lower re-admission rate than those receiving medical aid, which is thought to be due to the relatively low income level of patients who are medical aid recipients. Insurance and income are related to one another, as confirmed not only in studies using medical claims data from all hospitals in Korea,[22] but also in studies that analyzed nationwide re-admission databases in the United States under the HRRP.[5] Other studies have also reported that medical aid recipients, along with patients with low income levels, have relatively reduced access to higher level hospitals.[41] The type of institution eventually refers to the size of the hospital. A UK national observational study of factors associated with hospital emergency re-admission in patients with COPD reported that a smaller hospital size had significantly 2.27-fold increased re-admission risk factors and 67% increased odds of re-admission.[42] Additionally, a greater number of comorbidities is associated with a higher COPD re-admission rate,[6,21–23] but this finding was not significant in our study. We used health insurance claims data, where the diagnosis is classified using International Classification of Disclosure, 10th Revision (ICD-10) codes, which together extracts the main and sub-sickness. We set the main sickness to COPD and extracted the sub-sickness from the data. However, sub-sicknesses were rarely indicated; thus, we had to set CCI 1 or higher as CCI 1. This may be the reason for the lack of effect of CCI on COPD re-admission in our study.

This study is meaningful in that it reported the relationship between COPD re-admission rate and access to medical institutions using TRI in Korea. Due to the nature of Korea's health insurance system, it was possible to analyze the medical insurance claim data of the entire nation, which provided a large sample size and range of clinical data. There have been previous studies on COPD re-admission rates and their relationship to clinical factors (longer hospital stay, more comorbid conditions and discharge to a skilled nursing facility);[5] however, we also studied the effect of a local factor (accessibility to medical

institution) and found it to be a significant factor associated with re-admission.

Despite these strengths, our study had some limitations. First, there is no objective spirometry data for COPD diagnosis in our study. The possibility of misdiagnosis cannot be completely excluded because COPD is confirmed only by medical diagnosis.[43] Additionally, we did not include an objective index to assess the severity of the disease at the time of index admission. Because COPD severity is unknown, this can also affect the overall conclusion. The NHIS-SC did not provide clinically important biomarkers for re-admission risk, such as forced expiratory volume in 1 s (FEV1), arterial blood gas analysis, and severity of dyspnea.[44–46] Therefore, in this study, we focused on socioeconomic factors. Second, there is no economic variable other than the insurance quintile. The restricted variables are limitations of our data. However, the insurance quintile based on earned income (employee insured) and real estate, etc. (self-employed insured) is relatively accurate data, including economic aspects.

Conclusion

COPD re-admission rates among older adults was significantly associated with sex, the length of hospital stay, and the type of hospital. Importantly, the capacity of the medical services provided was also related to the COPD re-admission rate. Specifically, better access to appropriate emergency services is associated with reduction of COPD re-admission rates.

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Disclosure

The authors report no conflicts of interest in this work.

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