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ORIGINAL ARTICLE

Between-Hospital Variation in All-Cause Mortality for Potentially Avoidable Hospitalizations in Older People

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Background: Potentially avoidable hospitalizations (PAH) contribute to an increased post-discharge mortality.
Methods: To investigate the between-hospital variation and the relationship between all predictors and mortality after discharge among older adults with PAH, we studied 15,186 older patients with PAH in 2,200 hospitals included in the National Health Insurance Service-Senior claims database from 2002 to 2013. Multivariable multilevel logistic regression analyses were performed to analyze the variance at between-hospital for mortality after accounting for differences in patient characteristics.
Results: The between-hospital variation in mortality that could be attributed to hospital practice variations were 37.6% at 1-week to 13.9% at 12-month post-discharge, after adjustment for individual patient characteristics and hospital-level factors. Hospital-level factors significantly explained mortality at 3 weeks after discharge. Clinics, compared with general hospitals, demonstrated a 2.75 times higher likelihood of deaths at 3-week post-discharge (p<0.001). Compared with private hospitals, public hospitals exhibited 1.61 times higher odds of 3-week mortality (p=0.01).
Conclusion: This study demonstrates considerable between-hospital variations in PAH-related mortality that could be attributed to hospital practices. Monitoring of hospitals to identify practice variations would be warranted to improve the survival of older patients with PAH.

Keywords: Aged; Hospitals; Practice; Variation

INTRODUCTION

Variations in the provision of healthcare services among hospitals have been an important issue of outcomes research on quality of care. This variability in outcomes represents inconsistencies in care, suggesting a considerable room for quality improvement. In the United States, to narrow the variability in the provision of healthcare services for ensuring the quality of care, the National Surgical Quality Improvement Project has allowed comparative assessment of outcomes and developed a set of quality indicators for continuous quality improvement within the Veterans Affairs health system [1].

In a study examining hospital variations, Garnick et al. [2] reported wide variations in 30-day postadmission hospital mortality rates. Hospital rankings by 30- and 180-day mortality rates after admission, however, did not yield markedly different results. Rosenthal et al. [3] also found nearly a three-fold variation across hospitals in both in-hospital and 30-day mortality rates, with substantial variations in discharge practices. In Korea, given the usefulness of mortality as a quality indicator, hospital mortality at discharge has been used for assessing outcomes of hospital practice [4], with 30-day mortality rates after discharge being evaluated in various studies [5,6]. Lee et al. [7], using administrative data, found large variations in hospital standardized mortality ratios among hospitals with more than 700 beds.

Substantial variability in hospital practices suggests that many hospitalizations are potentially avoidable, further contributing to the

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reduction of adverse outcomes. Identifying factors associated with these variations may further help in delivering patient-centered care. Whether the variation is attributable to patient- or hospital-level factors can contribute to the development of specific strategies for quality improvement. Although potentially avoidable hospitalizations (PAH) are reported to be associated with poor survival rates, the extent to which mortality is attributed to the hospital after discharge is largely unknown. Therefore, in this study, we analyzed national health insurance data collected for older patients with PAH to examine between-hospital variations and the relationship between all predictors and mortality after discharge.

METHODS

1. Data source

We used the National Health Insurance Service–Senior (NHIS–Senior) claim database from 2002 to 2013, released by the National Health Insurance Service in South Korea. To construct the NHIS-Senior cohort, the baseline sample was selected by stratified systematic random sampling to generate a representative sample in 2002. Non-citizens and special purpose employees with an unidentifiable income level were excluded. The sample consisted of 558,147 participants, comprising approximately 10% of people aged 60 years and older in 2002. The cohort was followed annually for 11 years until 2013 unless the participant became noneligible due to due to death or emigration. All databases are linked anonymously using unique encrypted patient codes in accordance with laws on personal information protection. Approval from an ethics committee is not required to analyze encrypted claims data.

2. Potentially avoidable hospitalizations

Based on the Agency for Healthcare Research and Quality indicators [8], PAH which included bacterial pneumonia admission rate, dehydration admission rate, pediatric gastroenteritis admission rate, urinary tract infection admission rate, perforated appendix admission rate, low birth weight rate, angina admission without procedure, congestive heart failure admission rate, hypertension admission rate, adult asthma admission rate, pediatric asthma rate, chronic obstructive pulmonary disease admission rate, uncontrolled diabetes admission rate, diabetes long-term complication admission rate, and rate of lower extremity amputation among patients with diabetes, was defined as incident cases if their first records had a hospital admission based on the International Classification of Disease 10th revision (ICD-10). Both acute and chronic PAH were considered. There were 15,186 patients identified as hospitalized with potentially avoidable conditions.

3. Dependent variable

Our main outcome was all-cause mortality. Data on mortality were collected at the time of 1-week to 12-month discharge. The event of death was counted after the date of first PAH based on ICD-10 code at hospital discharge.

4. Covariates

Both individual- and hospital-level covariates were included. Individual-level covariates included age, sex, residential region, income, Charlson Comorbidity Index (CCI), and route of admission. Age in years was categorized into four groups: ≤69, 70–79, 80–89, and ≥90. Residential region was categorized into metropolitan (Seoul), urban (Daejeon, Daegu, Busan, Incheon, Kwangju, or Ulsan), and rural (otherwise). Income in deciles was categorized into three groups: low (≤3), middle (4–7), and high (8–10). CCI was grouped as scores of 0, 1–2, and ≥3. Route of admission was categorized as emergency, outpatients, and others (decision by a physician included). As a hospital-level variable, hospital type was categorized as general hospital, hospital, and clinics. Ownership of the hospital was categorized as public, corporate, and private. Number of doctors within the hospital was categorized into five groups: ≤49, 50–149, 150–249, 250–349, and ≥350. Presence of medical devices, such as computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography (PET), was also included.

5. Statistical analysis

Chi-square tests were used to compare differences in the 3-week mortality by patient demographics and hospital characteristics. Hospital characteristics were presented as percentages. Because the 15,186 patients were nested within 2,200 hospitals, multilevel models were used to analyze the hierarchically structured data [9]. Multivariable multilevel logistic regression was used to analyze the between-hospital variance for mortality after accounting for differences in patient characteristics. We calculated the intraclass correlation coefficient (ICC) statistic, representing between-group variation as a proportion of all variation for the dependent variable when data are analyzed by groups (e.g., individuals or hospitals) by time of post-discharge death. The proportion of the between-hospital variation for mortality attributable to hospitals was calculated as 1－{(ICC of model accounting for hospital-level factors)÷(ICC of model not accounting for hospital-level factors)}. To account for differences in patient characteristics among hospitals, models were adjusted for the covariates listed previously. All analyses were performed using the SAS software ver. 9.4 (SAS Institute Inc., Cary, NC, USA). Two-sided *p*-values of less than 0.05 were considered to indicate statistical significance.

RESULTS

1. Sample characteristics

Of the 15,186 hospitalized with potentially avoidable conditions, 390 (2.6%) were deceased at 3-week post-discharge (Table 1). The 3-week mortality rates tended to be higher among hospitals smaller in size, staffed with fewer physicians, funded by the public sector, and not equipped with MRI, CT, or PET scans. Among the individual-level characteristics, older age, male gender, higher comorbidity, and potentially avoidable acute conditions exhibited higher mortality.

Of the hospital types, general hospitals accounted for 16.7%, and hospitals 34.1%. Private hospitals (59.8%) accounted for the largest percentage by type of hospital ownership (Table 2).

2. Between-hospital variation in mortality

Results from the multivariable multilevel models on mortality indicated clustering at the hospital level. The proportion of all variation (ICC) attributable to mortality in models accounting for hospital-level factors steadily increased from 0.060 (95% confidence interval [CI], -0.376 to 0.795) at 1-week post-discharge to 0.146 (95% CI, 0.207 to 0.921) at 3-week, 0.192 (95% CI, 0.581 to 0.985) at 3-month, 0.204 (95% CI, 0.683 to 1.007) at 6 months, and 0.220 (95% CI, 0.783 to 1.067) at 12-month post-discharge, adjusting for patient and hospital characteristics. Between-hospital variations for mortality attributed to the hospital-level factors accounted for 21.6% at 3-week, 17.6% at 3-month, 17.2% at 6-month, and 13.9% at 12-month post-discharge (Table 3).

Table 1. Characteristics of participants at first discharge

Characteristic	Total	3-Week mortality		*p*-value
		No	Yes	
Hospital level				
Hospital type				<0.001
General hospital	11,186 (73.7)	10,963 (98.0)	223 (2.0)	
Hospital	2,298 (15.1)	2,220 (96.6)	78 (3.4)	
Clinics	1,702 (11.2)	1,613 (94.8)	89 (5.2)	
Ownership type				0.001
Public	551 (3.6)	527 (95.6)	24 (4.4)	
Corporate	11,569 (76.2)	11,299 (97.7)	270 (2.3)	
Private	3,066 (20.2)	2,970 (96.9)	96 (3.1)	
No. of doctors				<0.001
≤49	6,162 (40.6)	5,947 (96.5)	215 (3.5)	
50–149	2,168 (14.3)	2,122 (97.9)	46 (2.1)	
150–249	1,652 (10.9)	1,624 (98.3)	28 (1.7)	
250–349	1,703 (11.2)	1,667 (97.9)	36 (2.1)	
≥350	3,501 (23.1)	3,436 (98.1)	65 (1.9)	

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Table 1. Continued

Characteristic	Total	3-Week mortality		*p*-value
		No	Yes	
Presence of computed tomography				<0.001
No	1,669 (11.0	1,591 (95.3)	78 (4.7)	
Yes	13,517 (89.0	13,205 (97.7)	312 (2.3)	
Presence of magnetic resonance imaging				<0.001
No	2,863 (18.9	2,732 (95.4)	131 (4.6)	
Yes	12,323 (81.2	12,064 (97.9)	259 (2.1)	
Presence of positron emission tomography				<0.001
No	6,681 (44.0)	6,456 (96.6)	225 (3.4)	
Yes	8,505 (56.0)	8,340 (98.1)	165 (1.9)	
Individual level				
Age (yr)				<0.001
≤69	5,060 (33.3)	5,013 (99.1)	47 (0.9)	
70–79	6,830 (45.0)	6,674 (97.7)	156 (2.3)	
80–89	2,969 (19.6)	2,817 (94.9)	152 (5.1)	
≥90	327 (2.2)	292 (89.3)	35 (10.7)	
Sex				0.004
Male	5,952 (39.2)	5,772 (97.0)	180 (3.0)	
Female	9,234 (60.8)	9,024 (97.7)	210 (2.3)	
Residential region				0.09
Metropolitan	2,854 (18.8)	2,795 (97.9)	59 (2.1)	
Urban	3,397 (22.4)	3,315 (97.6)	82 (2.4)	
Rural	-	-	-	
Income				<0.001
Low	3,404 (22.4)	3,280 (96.4)	124 (3.6)	
Middle	4,098 (27.0)	4,006 (97.8)	92 (2.2)	
High	7,684 (50.6)	7,510 (97.7)	174 (2.3)	
Charlson Comorbidity Index				0.58
0	5,770 (38.0)	5,618 (97.4)	152 (2.6)	
1–2	5,627 (37.1)	5,492 (97.6)	135 (2.4)	
≥3	3,789 (25.0)	3,686 (97.3)	103 (2.7)	
Route of admission				0.001
Outpatient	4,674 (30.8)	4,520 (96.7)	154 (3.3)	
Emergency	9,713 (64.0)	9,496 (97.8)	217 (2.2)	
Others	799 (5.3)	780 (97.6)	19 (2.4)	
Type of potentially avoidable conditions				<0.001
Acute	1,046 (6.9)	981 (93.8)	65 (6.2)	
Chronic	14,140 (93.1)	13,815 (97.7)	325 (2.3)	
Total	15,186 (100.0)	14,796 (97.4)	390 (2.6)	

Values are presented as number (%).

3. Relationship between covariates and mortality

Table 4 shows the association between the covariates and 3-week mortality. The mortality risk in the smallest-sized hospital (clinics) was 2.75 times higher compared with that of the general hospital ($p<0.001$). Public hospitals, compared with private hospitals, demonstrated 1.61 times higher odds of mortality ($p=0.01$).

Table 2. Characteristics of hospitals at first discharge of participants

Characteristic	No. (%)
Hospital type	
General hospital	367 (16.7)
Hospital	749 (34.1)
Clinics	1,084 (49.3)
Ownership type	
Public	74 (3.4)
Corporate	811 (36.9)
Private	1,315 (59.8)
No. of doctors	
≤49	2,066 (93.9)
50–149	64 (2.9)
150–249	34 (1.6)
250–349	16 (0.7)
≥350	20 (0.9)
Presence of computed tomography	
No	1,080 (49.1)
Yes	1,120 (50.9)
Presence of magnetic resonance imaging	
No	1,527 (69.4)
Yes	673 (30.6)
Presence of positron emission tomography	
No	2,064 (93.8)
Yes	136 (6.2)
Total	2,200 (100.0)

DISCUSSION

In this cohort of older patients with PAH, large between-hospital variations in mortality were observed. Taking into account hospital-level factors reduced the ICC attributable to mortality throughout various time points after discharge, suggesting that characteristics of hospitals explain a significant portion of the difference in mortality rates among those with PAH.

After discharge from hospital, patients are at high risk of readmission and mortality, especially during the first weeks to months after discharge. Few patients, however, have access to multiprofessional disease management programs, which can reduce the risk of adverse outcomes [10]. In addition, factors related to physician's decision-making, such as perceived low risk, avoidance of patient anxiety, and litigation risk may contribute to the practice variation [11]. Moreover, economic incentives of hospitals or physicians may affect day-to-day clinical decisions [12].

Hospital-level factors significantly explained mortality at 3 weeks after discharge. In contrast, ICC for models including hospital-level factors was not statistically significant at 1- or 2-week mortality post-discharge. It is likely that between-hospital variations at 1-week and 2-week are attributable to individual-level factors, such as disease severity or management. A 3-week post-discharge mortality rate might be a more appropriate quality indicator for assessing the between-hospital variation in survival of PAH patients.

In addition, the results of multivariate analyses revealed higher mortality rates for clinic than for general hospitals and for public hospitals than for private hospitals. As noted, public hospitals are totally controlled by district governments, and this may contribute to difficulties recruiting well-trained physicians, acquiring medical equipment, and the higher mortality rates [13]. Additionally, restrictions of medical equipment for specialized treatments in clinics than general hospital may contribute to higher mortality rates.

The findings of our study have implications for improving survival of elderly patients admitted for PAH. This study shows that the

Table 3. ICC for variation in mortality by time of post-discharge

Time	Model not including hospitals		Model including hospitals		Proportion (%)*	*p*-value
	ICC	95% CI	ICC	95% CI		
1 Week	0.096	-0.163 to 0.862	0.060	-0.376 to 0.795	0.376	<0.001
2 Week	0.160	0.261 to 0.996	0.114	-0.004 to 0.853	0.288	<0.001
3 Week	0.187	0.444 to 1.068	0.146	0.207 to 0.921	0.216	<0.001
1 Month	0.202	0.567 to 1.097	0.161	0.330 to 0.930	0.204	<0.001
3 Month	0.233	0.813 to 1.187	0.192	0.581 to 0.985	0.176	<0.001
6 Month	0.247	0.925 to 1.233	0.204	0.683 to 1.007	0.172	<0.001
12 Month	0.255	0.987 to 1.265	0.220	0.783 to 1.067	0.139	<0.001

ICC, intraclass correlation coefficient; CI, confidence interval.
*Proportion of variation in the outcome attributable to hospital-level factors.

Table 4. Adjusted OR of mortality at 3-week post-discharge

Variable	3-Week mortality		
	OR	Standard error	*p*-value
Hospital level			
Hospital type			
General hospital	1.00		
Hospital	1.42	0.18	0.045
Clinics	2.75	0.26	<0.001
Ownership type			
Public	1.61	0.20	0.01
Corporate	1.13	0.11	0.30
Private	1.00		
No. of doctors			
≤49	1.26	0.22	0.28
50–149	1.08	0.17	0.66
150–249	0.77	0.18	0.16
250–349	0.89	0.17	0.48
≥350	1.00		
Presence of computed tomography			
No	1.00		
Yes	1.36	0.19	0.11
Presence of magnetic resonance imaging			
No	1.00		
Yes	0.77	0.18	0.13
Presence of positron emission tomography			
No	1.00		
Yes	1.28	0.19	0.18
Individual level			
Age (yr)			
≤69	1.00		
70–79	2.11	0.13	<0.001
80–89	4.47	0.14	<0.001
≥90	7.53	0.19	<0.001
Sex			
Male	1.55	0.08	<0.001
Female	1.00		
Residential region			
Metropolitan	0.99	0.11	0.96
Urban	0.88	0.10	0.20
Rural	1.00		
Income			
Low	1.30	0.10	0.005
Middle	0.94	0.10	0.58
High	1.00		
Charlson Comorbidity Index			
0	1.00		
1–2	1.11	0.09	0.29
≥3	1.23	0.10	0.04
Route of admission			
Outpatient	2.52	0.21	<0.001
Emergency	1.30	0.19	0.18
Others	1.00		
Type of potentially avoidable conditions			
Acute	2.14	0.12	<0.001
Chronic	1.00		

OR, odds ratio.

mortality of patients with PAH varied significantly between hospitals, implying that there is room for improvement in survival of elderly patient at the hospital level. In addition to improving survival of older patients admitted to the hospital, interventions tailored for individual hospitals may be necessary to improve patient survival rates. A detailed examination of hospital-level factors is necessary, since such understanding would facilitate implementation of effective interventions to reduce between-hospital variations.

In interpreting our findings, several potential methodological limitations should be considered. First, due to lack of data, our models could not account for some clinical and demographic factors associated with the between-hospital variation in outcomes. Although we found that mortality after discharge was clustered within the hospital, we were unable to determine whether the between-hospital variation resulted from differences in hospital and physician practices or the implementation of quality improvement programs, such as clinical pathways and protocols, affecting patient safety. Second, although we adjusted for severity of illness based on clinical data that were abstracted from the claims database, it is possible that unmeasured severity varied across hospitals or across patients. Finally, it is important that future research examine the applicability of our findings to diverse patient groups, particularly to surgical conditions and conditions associated with either higher or lower post-discharge mortality.

There are considerable between-hospital variations in mortality among older patients with PAH. The between-hospital variation was significantly higher at 3-week mortality after discharge. A close examination and monitoring of hospital and physician practices would be needed to increase the survival of older patients with PAH.

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