Patient and hospital factors associated with 30-day unplanned readmission in patients with stroke

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► Additional material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/jim-2018-000748).

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Received 27 February 2018
Revised 23 May 2018
Accepted 23 June 2018
Published Online First 23 July 2018

To cite: Lee SA, Park E-C, Shin J, *et al*. *J Investig Med* 2019;**67**:52–58.

ABSTRACT

Stroke is frequently associated with readmission; moreover, readmission is regarded as an important indicator of the quality of stroke care. Thus, we investigated factors associated with 30-day readmission in patients with stroke in South Korea. We used claims data from 2013 for stroke (I60–I62) patients (n=44 729) in 94 hospitals and classified unplanned readmission according to the Centers for Medicare and Medicaid guidelines. We used multilevel models to investigate patient (age, gender, type of insurance, admission via emergency room, length of stay, type of stroke, Elixhauser Index Score) and hospital (stroke care quality grade, location of hospital, type of hospital, number of doctors and nurses per 100 beds) factors associated with readmission within 30 days of discharge. Among the 44 729 patients admitted due to stroke, 9.2% (n=4124) were readmitted to hospital and 7.6% (n=3379) had unplanned readmissions. Regarding patient characteristics, medical aid and longer hospital stay were associated with 30-day readmission rate. Among hospital factors, patients admitted to a low-grade hospital or a non-capital area hospital were more likely to be readmitted within 30 days of discharge. We identified patient and hospital factors associated with 30-day readmission among stroke patients. In particular, patients admitted to hospitals with higher quality stroke care showed lower readmission rates.

Significance of this study

What is already known about this subject?

- Hospital readmissions, especially unplanned readmissions, are considered to be an unpredicted outcome of care.
- Readmission is regarded as an important indicator of the quality of stroke care.
- As stroke prevalence increases, the quality of stroke care becomes a higher priority in the national healthcare quality agenda.

What are the new findings?

- With respect to patient factors, type of insurance, length of index admission stay, and Elixhauser Index Score showed significant associations with 30-day readmission.
- Among hospital factors, stroke care quality grade and hospital location showed significant associations with 30-day readmission.
- Stroke care quality grade was among the hospital factors associated with readmission rate.

How might these results change the focus of research or clinical practice?

- Our study showed that hospitals that were ineligible for quality assessment programs for stroke had higher readmission rates. Therefore, an alternative assessment program for ineligible hospitals is needed to address this blind spot.

INTRODUCTION

Readmission is one of the most frequently used indices of quality of care. Hospital readmissions, especially unplanned readmissions, are considered to be an unpredicted outcome of care,[1] because unplanned readmission within 30 days from discharge is usually the result of problems unresolved at the time of discharge.[2] As a quality indicator, readmission has various advantages. First, it reflects the efficiency of the hospital's practice, as well as indexing the quality of care until the point of discharge.[3] A study showed that comprehensive discharge planning, such as clearly communicated medication counseling, could reduce the risk of readmission.[4] Additionally, readmission is relatively easy to quantify via hospital information systems and easier to interpret than many other quality indicators.[5] Thus, studies conducted in many countries, including Spain, Switzerland, and Australia, have assessed the validity of readmission as a quality indicator.[6–8] Moreover, institutions in the USA, Canada, and UK have already used readmission rate as a quality indicator.[9–11]

Relative to many other diseases, stroke is known to have a high readmission rate.[12 13] Thus, readmission is regarded as an important indicator of the quality of stroke care.[14] Considering the high disease burden of stroke,

investigation of the association between stroke and readmission is important. Stroke is a leading cause of death and represents a significant public health burden worldwide.[15] In the USA, stroke is ranked as the fifth leading cause of death.[16] East Asian countries, including China and Japan, are also affected significantly by stroke due to its high mortality rate and cost burden.[17 18] In Korea, among single organ diseases, stroke was the leading cause of death in 2010.[19] In 2013, 557 285 individuals in Korea suffered a stroke, an increase of 11.6% compared with 2007. As Korea has the fastest-aging society among all Organization for Economic Cooperation and Development (OECD) countries,[20] the incidence of stroke is projected to further increase.[19]

As stroke prevalence increases, the quality of stroke care becomes a higher priority in the national healthcare quality agenda.[21] South Korea implemented a quality assessment program for acute stroke in 2007.[22] Although readmission is regarded as an important indicator of the quality of stroke care, the quality assessment program of 2013 did not include readmission as an outcome.[14] Instead, it contained only structure and process indicators as indices of the quality of stroke care. Currently, there is a movement toward including readmission rate in healthcare quality assessment programs in Korea. Given that patients with stroke are more likely to be readmitted to hospital compared with sufferers of many other chronic diseases and that they have a lower chance of survival,[23 24] investigating the association between acute stroke and 30-day readmission is important.

Thus, our study had two major aims. First, we investigated factors associated with 30-day readmission among patients with stroke at the patient and hospital levels. Second, we investigated the possibility of including readmission rate in quality assessment programs in Korea by examining the association between stroke care quality grade and 30 day unplanned readmission rate.

METHODS

Data and study population

We used claims data from the Health Insurance Review and Assessment Service (HIRA). HIRA is a quasi-governmental agency that mainly reviews medical claims and performs quality assessments. The HIRA claims data cover almost 90% of the total population in Korea.[25] We obtained claims data from HIRA for general hospitals with 500 beds or more from 1 January 2013 to 30 November 2013. The data include the characteristics of the hospital, patients' diagnostic codes, and general characteristics of patients, such as age, gender, and type of insurance. Our study population was patients aged 18 years or older who were admitted to a hospital with a major diagnosis of stroke based on the International Classification of Diseases (ICD) codes (I60: subarachnoid hemorrhage, I61: intracerebral hemorrhage, I62: other traumatic internal hemorrhage, I63: cerebral infarction). After excluding subjects with missing values, we analyzed data from 44 729 individuals who met criteria for inclusion in this study.

Dependent variable

Our dependent variable was 30-day readmission, defined as readmission to the hospital within 30 days of the index admission. Each readmission for one person was considered a case, and the admission before was set as the index admission. We distinguished planned readmission from all readmission, according to the Centers for Medicare and Medicaid (CMS) guidelines.[9] According to the CMS guidelines, readmissions for typically planned procedures, such as transplant surgery, maintenance chemotherapy, radiotherapy, immunotherapy, or rehabilitation, as well as for a prespecified list of other procedures, were classified as planned readmissions. Non-acute admissions for scheduled procedures and admissions when the primary discharge diagnosis at readmission was non-acute or was not for treatment of complications were classified as planned readmissions. With this definition of planned readmissions, we extracted unplanned readmissions from all readmission data.[9]

Independent variables

Patient level

We included age, gender, type of insurance, admission route of the index admission, length of index admission hospital stay, type of stroke, and Elixhauser Index Score as patient-level variables. Type of insurance was classified as national health insurance (NHI) or medical aid. The admission route of the index admission was classified as admission via emergency room (ER) or not. Length of stay was classified into three groups: <7 days, 7–14 days, and >15 days. We used the Elixhauser Index Score, which was developed to measure patient comorbidity via ICD codes, as a comorbidity variable; 30 comorbidities were included.[26] The patients were classified into four comorbidity groups (zero, one, two, or three or more comorbidities).

Hospital level

Hospital-level variables included the stroke care quality grade, location of the hospital, type of hospital, and the number of doctors and nurses involved in the index admission.

Regarding the stroke care quality grade, the indicators for the evaluation of stroke care quality by stroke type (hemorrhagic or ischemic), which was determined by HIRA, are shown in the online Supplementary table 1. The target hospitals for the evaluation were general and tertiary hospitals treating more than 10 cases of acute stroke. The target patients were those with Korean Classification of Diseases (KCD) codes for hemorrhagic or ischemic stroke (I60: subarachnoid hemorrhage, I61: intracerebral hemorrhage, I62: other traumatic internal hemorrhage, I63: cerebral infarction) as their major disease and who were admitted to the emergency room within 7 days of symptom appearance. Hospitals were categorized by five performance grades based on a composite stroke care quality score. A higher rank (first grade) indicates higher quality stroke care. Hospitals with small-volume stroke practices (ie, those for which we could not assess at least three of the quality indicators) were excluded from the assessment program and are classified as 'non-graded' in the present study. We included only hospitals with first- to third-grade hospitals in the analysis because the data set did not contain any fourth-grade or fifth-grade hospitals.

Regarding hospital location, we classified this into three types: capital area, metropolitan, and non-metropolitan

regions. Type of hospital was classified as general or tertiary. Tertiary hospitals receive special recognition from the government according to their structure, the severity of diseases treated, and the human resources available versus general hospitals.

Statistical analyses

To investigate the general characteristics of the study population, we used the X^2 test and Student's t-test. We applied multilevel models to assess clustered data structures at the hospital and patient levels. We used a generalized linear mixed model (GLIMMIX) for hierarchical logistic regression analysis to investigate factors associated with 30-day readmission. We also performed subgroup analyses, stratified by stroke type (hemorrhagic or ischemic) and admission route of the index admission. ORs and 95% CIs were calculated. All analyses were performed using SAS software (V.9.4).

RESULTS

Tables 1 and 2 show the general characteristics of the patients with stroke. Among 44 729 patients admitted due to stroke, 9.2% (n=4124) were readmitted and 7.6% (n=3379) had an unplanned readmission. In total, 75.6% (n=33 814) of the patients had ischemic stroke ad 24.4% (n=10 915) had hemorrhagic stroke. Regarding the stroke evaluation grade, 93.8% (n=41 972) of the patients were admitted to a first-grade hospital and 4.53% (n=2025) were admitted to a second-grade hospital. Only 0.6% of patients were admitted to a third-grade hospital. The mean Elixhauser Index Score among those who experience unplanned readmission was 2.1 (±1.7), whereas the score was 1.9 (±1.5)

Table 1 General characteristics of the study population (categorical variables)

		30-Day all readmission			30-Day unplanned readmission		
	Total	No	Yes		No	Yes	
Variables	N (%)	N (%)	N (%)	P values	N (%)	N (%)	P values
Patient factors							
Age							
18–44	2987 (6.7)	272 (391.2)	264 (8.8)	0.0005	2754 (92.2)	233 (7.8)	0.0002
45–65	15 462 (34.6)	14 150 (91.5)	1312 (8.5)		14 408 (93.2)	1054 (6.8)	
65–75	12 364 (27.6)	11 173 (90.4)	1191 (9.6)		11 406 (92.3)	958 (7.8)	
75+	13 916 (31.1)	12 559 (90.3)	1357 (9.8)		12 782 (91.9)	1134 (8.2)	
Gender							
Male	25 074 (56.1)	22 786 (90.9)	2288 (9.1)	0.4331	23 245 (92.7)	1829 (7.3)	0.0189
Female	19 655 (43.9)	17 819 (90.7)	1836 (9.3)		18 105 (92.1)	1550 (7.9)	
Type of insurance							
National health insurance	41 509 (92.8)	37 741 (90.9)	3768 (9.1)	0.0003	38 438 (92.6)	3071 (7.4)	<0.0001
Medical aid	3220 (7.2)	2864 (88.9)	356 (11.1)		2912 (90.4)	308 (9.6)	
Admission via emergency room							
Yes	32 084 (71.7)	29 126 (90.8)	2958 (9.2)	0.9961	29 635 (92.4)	2449 (7.6)	0.3145
No	12 645 (28.3)	11 479 (90.8)	1166 (9.2)		11 715 (92.7)	930 (7.4)	
Length of stay of the index admission							
Less than 7 days	15 832 (35.4)	14 554 (91.9)	1278 (8.1)	<0.0001	14 816 (93.6)	1016 (6.4)	<0.0001
7–14 days	16 299 (36.4)	14 825 (91.0)	1474 (9.0)		15 117 (92.8)	1182 (7.3)	
More than 15 days	12 598 (28.2)	11 226 (89.1)	1372 (10.9)		11 417 (90.6)	1181 (9.4)	
Stroke							
Ischemic	33 814 (75.6)	30 683 (90.7)	3131 (9.3)	0.6107	31 294 (92.6)	2520 (7.5)	0.1531
Hemorrhagic	10 915 (24.4)	9922 (90.9)	993 (9.1)		10 056 (92.1)	859 (7.9)	
Hospital factors							
Stroke evaluation grade							
First grade	41 972 (93.8)	38 151 (90.9)	3821 (9.1)	0.0007	38 843 (92.6)	3129 (7.5)	0.0006
Second grade	2 025 (4.5)	1817 (89.7)	208 (10.3)		1857 (91.7)	168 (8.3)	
Third grade	261 (0.6)	2239 (85.4)	38 (14.6)		228 (87.4)	331 (2.6)	
Non-grading	471 (1.1)	414 (87.9)	57 (12.1)		422 (89.6)	49 (10.4)	
Hospital region							
Capital area	20 349 (45.5)	18 604 (91.4)	1745 (8.6)	<0.0001	18 940 (93.1)	1409 (6.9)	<0.0001
Metropolitan area	14 431 (32.3)	13 022 (90.2)	1409 (9.8)		13 271 (92.00)	1160 (8.0)	
Non-metropolitan area	9949 (22.2)	8979 (90.3)	970 (9.8)		9139 (91.9)	810 (8.1)	
Hospital type							
General hospital	19 188 (42.9)	23 203 (90.9)	2338 (9.2)	0.5774	23 614 (92.5)	1927 (7.5)	0.929
Superior general hospital	25 541 (57.1)	17 402 (90.7)	1786 (9.3)		17 736 (92.4)	1452 (7.6)	
Total	44 729 (100.0)	40 605 (90.8)	4 124 (9.2)		41 350 (92.4)	3 379 (7.6)	

Table 2 General characteristics of the study population (continuous variables)

		30-Day all readmission			30-Day unplanned readmission		
	Total	No	Yes		No	Yes	
Variables	Mean (SD)	Mean (SD)	Mean (SD)	P values	Mean (SD)	Mean (SD)	P values
Elixhauser Index Score	2.0 (1.6)	1.9 (1.5)	2.1 (1.7)	<0.0001	1.9 (1.5)	2.1 (1.7)	<0.0001
Number of doctors per 1000 beds	395.7 (140.3)	396.0 (139.9)	392.8 (145.0)	0.1601	396.0 (139.9)	392.3 (145.4)	0.1398
Number of nurses per 1000 beds	563.5 (197.4)	563.6 (197.1)	562.1 (201.0)	0.6382	563.5 (197.1)	563.8 (201.4)	0.9382

for those who did not experience unplanned readmission. The 30-day all readmission showed same mean and SD with unplanned readmission.

Table 3 shows the factors associated with 30-day readmission (unplanned and all readmissions). Patients admitted to a third-grade or non-evaluated index hospital were more likely to be readmitted within 30 days of discharge versus those admitted to a first-grade index hospital (third grade: OR 1.66, 95% CI 1.08 to 2.55; non-evaluated: OR 1.40, 95% CI 1.00 to 1.95). The association was slightly stronger

Table 3 Factors associated with 30 day readmission

	30-Day all readmission		30-Day unplanned readmission	
Variables	Adjusted OR	95% CI	Adjusted OR	95% CI
Patient factors				
Age				
18–44	1		1	
45–65	0.93	0.81 to 1.07	0.85	0.73 to 0.99
65–75	1.03	0.89 to 1.19	0.94	0.81 to 1.10
75+	1.03	0.89 to 1.20	0.98	0.84 to 1.14
Gender				
Male	1		1	
Female	1	0.93 to 1.07	1.05	0.97 to 1.13
Type of insurance				
National health insurance	1		1	
Medical aid	1.16	1.03 to 1.30	1.22	1.07 to 1.38
Admission via emergency room				
Yes	1		1	
No	1.03	0.95 to 1.12	1.03	0.94 to 1.13
Length of stay of the index admission				
Less than 7 days	1		1	
7–14 days	1.1	1.01 to 1.19	1.11	1.01 to 1.21
More than 15 days	1.34	1.22 to 1.47	1.41	1.28 to 1.56
Stroke				
Hemorrhagic	0.92	0.85 to 1.00	0.99	0.90 to 1.08
Ischemic	1		1	
Elixhauser Index Score (per one score)	1.06	1.04 to 1.09	1.06	1.03 to 1.09
Hospital factors				
Stroke evaluation grade				
First grade	1		1	
Second grade	1.13	0.90 to 1.43	1.08	0.83 to 1.41
Third grade	1.66	1.08 to 2.55	1.73	1.09 to 2.77
Non-grading	1.4	1.00 to 1.95	1.44	1.00 to 2.08
Hospital region				
Capital area	1		1	
Metropolitan area	1.21	1.07 to 1.37	1.2	1.05 to 1.39
Non-metropolitan area	1.26	1.08 to 1.47	1.29	1.08 to 1.53
Hospital type				
General hospital	1		1	
Superior general hospital	1.07	0.93 to 1.23	1.03	0.88 to 1.21
Number of doctors per 1000 beds	1	1.00 to 1.00	1	1.00 to 1.00
Number of nurses per 1000 beds	1	1.00 to 1.00	1	1.00 to 1.00

Table 4 Associations between the quality assessment grade of acute stroke and 30-day readmission by stroke type and admission route of the index admission*

Variables	Stroke evaluation grade	30-Day all readmission		30-Day unplanned readmission	
		Adjusted OR	95% CI	Adjusted OR	95% CI
Stroke					
Ischemic	First grade	1		1	
	Second grade	1.1	0.86 to 1.41	1.15	0.88 to 1.49
	Third grade	1.52	0.96 to 2.40	1.71	1.06 to 2.78
	Non-grading	1.41	1.00 to 1.99	1.48	1.02 to 2.16
Hemorrhagic	First grade	1		1	
	Second grade	1.14	0.69 to 1.88	0.86	0.49 to 1.52
	Third grade	2.61	1.02 to 6.67	2.2	0.79 to 6.14
	Non-grading	1.26	0.47 to 3.35	1.45	0.54 to 3.89
Admission route					
Via emergency room	First grade	1		1	
	Second grade	1.4	1.02 to 2.92	1.34	0.93 to 1.93
	Third grade	1.81	0.86 to 3.82	1.95	0.87 to 4.40
	Non-grading	1.87	1.12 to 3.10	2.22	1.30 to 3.80
Via non-emergency room	First grade	1		1	
	Second grade	0.92	0.67 to 1.25	0.87	0.63 to 1.20
	Third grade	1.64	0.98 to 2.75	1.66	0.98 to 2.83
	Non-grading	1.22	0.79 to 1.88	1.14	0.72 to 1.80

*Adjusted for age, gender, type of insurance, length of stay of the index admission, type of stroke, Elixhauser Index Score, hospital region, hospital type, number of doctors and number of nurses. The full version of this table is available in the online Supplementary tables 3–4.

for unplanned readmissions (third grade: OR 1.73, 95% CI1.09 to 2.77; non-evaluated: OR 1.44, 95% CI 1.00 to 2.08). Regarding type of insurance, medical aid patients were more likely to be readmitted to the hospital, for both all (OR 1.16, 95% CI 1.03 to 1.30) and unplanned (OR 1.22, 95% CI 1.07 to 1.38) readmissions. Additionally, those with a longer index admission stay were more likely to be readmitted (for both all and unplanned readmissions).

Subgroup analyses of the association between stroke care quality grade and 30-day readmission, stratified by stroke type and admission route of the index admission, are detailed in table 4. Patients with ischemic stroke whose index admission was to a third-grade or non-evaluated hospital were more likely have an unplanned readmission compared with those whose index admission was to a first-grade hospital (third grade: OR 1.71, 95% CI 1.06 to 2.78; non-evaluated: OR 1.48, 95% CI 1.02 to 2.16). However, only 30-day all readmissions were significantly associated with a third-grade hospital index admission for patients with hemorrhagic stroke (OR 2.61, 95% CI 1.02 to 6.67).

DISCUSSION

In this study, we investigated factors associated with 30-day readmission rate among patients with stroke in South Korea. Among 44 729 patients with stroke, 7.6% (n=3379) had an unplanned readmission within 30 days. With respect to patient factors, type of insurance, length of index admission stay, and Elixhauser Index Score showed statistically significant associations with 30-day readmission. Among hospital factors, the stroke care quality grade and hospital location showed statistically significant associations with 30-day readmission. Most of the results showed similar trends between all-cause and unplanned readmissions, with unplanned readmissions having slightly higher ORs.

Our results indicated that medical aid patients were more likely to be readmitted within 30 days than those with NHI. This result is consistent with a previous study that indicated that income inequality contributed to negative outcomes, including 30-day readmission.[27 28] Usually, readmission is influenced by social factors that are associated with the level of postdischarge care. Income inequality causes disparities in social capital, manifested in lack of accessibility to, or poor infrastructure of, care.[29] Poor access to care might be related to insufficient postdischarge care and can have negative consequences, such as a higher rate of readmission.[30] Additionally, our study showed that as length of stay increased, so did the likelihood of readmission. This finding may be explained by the association of shorter stays with less severe medical conditions. That is, patients who had longer stays might have experienced additional medical issues, such as complications, which extended their hospital stay.[31] Therefore, it seems that suffering from a severe condition during the index admission, which lengthened the stay, might be related to readmission.

Regarding hospital factors, hospital location showed a statistically significant association with 30-day readmission rate. Compared with patients admitted to hospitals in the capital area, those admitted to other metropolitan and non-metropolitan area hospitals had higher readmission rates. This result could be explained as follows. First, in South Korea, large hospitals and healthcare facilities are concentrated in the capital area.[32] Therefore, other areas have relatively insufficient facilities and thus offer a relatively lower quality of care. Second, rural area residents usually use the hospital in their local area.[33] Thus, after discharge, there is a possibility of insufficient postdischarge care relative to that available to capital area patients.

A noteworthy result of this study is that the stroke care quality grade was among the hospital factors associated with readmission rate. Patients admitted to a third-grade hospital had a higher readmission rate than those admitted to a first-grade hospital. This indicates that the structure and process indicators, which consist of the quality assessment program, were relevant to the outcome indicator of readmission. In our study, 42 of 43 tertiary hospitals in South Korea were first-grade hospitals and no tertiary hospital was judged to be third grade (online Supplementary table 5). Tertiary hospitals are certified by the Ministry of Health and Welfare of Korea according to their human resources, facilities, and equipment, as well as the complexity of the diseases treated; it seems that better infrastructure is positively associated with a better standard of care.[34] Another possible explanation for the higher quality of care in tertiary hospitals is that large, tertiary hospitals have higher patient volumes than general hospitals.[35] Compared with lower-volume hospitals, patients in high-volume hospitals receive more care in early-stage stroke treatment and have a shorter length of stay and better prognosis.[36] This is supported by another previous study indicating that lower-volume hospitals are more likely to have higher readmission rates than higher-volume hospitals.[37 38] In our study, not only third-grade hospitals but also hospitals ineligible for assessment showed higher readmission rates. This suggests that ineligible hospitals represent a policy 'blind spot'. Another previous study showed that after implementing an acute stroke care quality assessment, both practice behaviors and stroke outcomes showed improvement.[22] Thus, a gap exists in care quality between eligible and ineligible hospitals.[39] An alternative assessment program for ineligible hospitals is needed to address this blind spot.

Our subgroup analyses indicated that patients with ischemic stroke were more likely to be readmitted (unplanned) to the hospital when the index hospital was a third-grade hospital; however, this was not the case for patients with hemorrhagic stroke. The difference in the characteristics and the outcomes of care between those types of stroke may have caused this result. The outcomes of patients with hemorrhagic stroke were worse than those of patients with ischemic stroke.[40] Therefore, patients with ischemic stroke have a relatively lower mortality rate than patients with hemorrhagic stroke; therefore, they may have a higher rate of readmission based on the quality of care. Given that first-grade hospitals have better structures and processes than third-grade hospitals, those who were admitted to first-grade hospitals might have a lower readmission rate. However, further study is needed to determine the reasons for this difference in readmission rate between patients with hemorrhagic and ischemic stroke.

Our study had several limitations. First, we only included hospitals with 500 or more beds. Thus, we did not examine the association between stroke care quality grade and 30-day readmission rate among smaller hospitals. Second, we could only include first-grade to third-grade hospitals because there were no fourth-grade or fifth-grade hospitals contained in the database. Third, information on severity of stroke was also absent from the database. Fourth, we did not include an income variable, which is known to be an important factor in readmission. However, we did assess the type of insurance by classifying patients as NHI or medical aid. Fifth, the criteria for unplanned readmission followed those of CMS. Sixth, although it is important to review information about transfer, we were unable to obtain these data due to a limitation in the database. For the same reason, we could not identify the patients who received tissue plasminogen activator, endovascular therapy, or surgery that could affect readmission. Additionally, patients who were readmitted to a hospital with fewer than 500 beds were not be counted as a readmission due to a limitation of the data set. Nevertheless, to our knowledge, this is the first report of an association between stroke care quality grade and 30-day readmission rate among Korean hospitals.

CONCLUSIONS

In the current study, we investigated patient and hospital factors associated with 30 day unplanned readmission rate. Among hospital factors, stroke care quality grade was associated with readmission rate, indicating that the structures and processes of stroke care are important to outcome and readmission rate. Further studies are needed that control for the severity of stroke and include hospitals ineligible for the quality assessment program for stroke.

Correction notice This article has been corrected since it was published Online First. The author name Jaeyong shin has been amended to read Jaeyong Shin.

Contributors SAL designed the study and directed its implementation, including quality assurance and control. JYS and YJJ participated in the design of the study and performed the statistical analysis. H-YL helped supervise the field activities and designed the study's analytic strategy. YC helped conduct the literature review and prepare the Methods and the Discussion sections of the text. All authors read and approved the final manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

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