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Positive correlation between care given by specialists and registered nurses and improved outcomes for stroke patients

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ABSTRACT

Background: Cerebrovascular diseases are the second-highest cause of death in South Korea (9.6% of all causes of mortality in 2013). South Korea has a shortage of trained medical personnel compared with other countries and the demands for health care are continuously increasing. Our study sought to determine the relationship between hospital human resources and the outcomes of stroke patients.
Methods: We used data from NHI claims ($n = 99{,}464$) at 120 hospitals to analyze readmission or death within 30 days after discharge or hospitalization for stroke patients during 2010–2013. We used multilevel models that included both patient-level and hospital-level variables to examine factors associated with readmission or death within 30 days.
Results: A total of 1782 (1.8%) patients were readmitted within 30 days, and death occurred within 30 days for 6926 (7.0%) patients. Patients cared for by a higher percentages of specialists or registered nurses had a lower risk of readmission or death within 30 days (readmission per 10% increase in registered nurses, OR = 0.89 and SD = 0.85–0.94; death per 10% increase in specialists, OR = 0.93 and SD = 0.89–0.98).
Conclusions: The percentages of specialist and registered nurses caring for stroke patients were positively correlated with better patient outcomes, particularly for patients with cerebral infarction.

1. Introduction

The health status and longevity of people in South Korea improved rapidly during the latter 20th century due to the introduction of National Health Insurance (NHI) and the development of health technologies [1]. This led to increases in the elderly population, the emergence of new health problems associated with geriatrics (individuals aged greater than 65 years, who represented 12.2% of the total population in 2013), and increases in morbidity and mortality among the aged [2]. These health problems include chronic diseases and deterioration in mental health such as suicide among the elderly. Many health-care specialists are gaining expertise in working with and treating geriatric diseases. Chronic diseases remain as the primary cause of mortality among elderly populations in South Korea [3].

Cerebrovascular diseases are one of the primary causes of mortality in South Korea. National statistics in Korea indicate that cerebrovascular diseases are the second-highest cause of death (9.6% of all causes of mortality in 2013) [4]. The burden of cerebrovascular disease is expected to continuously increase in the immediate future because the major risk factor for stroke is advanced age [5,6]. Therefore, it is important to identify factors that can reduce or prevent mortality due to stroke. Here, we focus on the role of human resources and medical personnel during stroke patient hospitalization.

South Korea is recently experiencing a shortage in trained medical personnel, including specialist doctors and registered nurses. However, the demand for health care has increased during this time. The numbers of trained medical personnel in South Korea is lower than those in other countries within the Organization for Economic Cooperation and Development (OECD). In South Korea, there are 2.0 practicing doctors and 4.8 practicing nurses per 1000 people, whereas in the OECD there are an average of 3.2 practicing doctors and 8.8 practicing nurses per 1000 people [7]. Many studies have investigated the role of professional human resources in hospitals [8–10]. These studies indicate that the

Abbreviations: OECD, Organization for Economic Cooperation and Development; NHI, National Health Insurance; RNs, registered nurses; LPNs, licensed practical nurses; ICD, International Classification of Diseases; CCI, Charlson Comorbidity Index; ANOVA, analysis of variance; OR, odds ratio.

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quality of care and patient outcomes were significantly improved when the ratio of medical personnel to patients was larger, and when the medical personnel had specialized training [11–15]. The shortage of health-care human resources in South Korea is caused by practical constraints and limited resources, and it will be challenging to solve these problems in the immediate future. Therefore, our study investigated the relationship between the numbers of specialist doctors and registered nurses (RNs) in hospitals and stroke patient outcomes. We performed sub-group analysis to identify differences based on patient diagnoses.

2. Methods

2.1. Study population

There are about 1730 hospitals including 39 public hospitals during 2010–2013 year in South Korea, but, the data we used in this study was only included 156 hospitals (117 private and 39 public) after extracting through propensity score matching-methods (1:3) adjusting some variables as follows: region of hospitals, nursing staffing level, number of total beds, number of intensive care unit beds, number of emergency room beds, and number of doctors. And then, this study only included hospitalization due to stroke. Stroke was classified according to the International Classification of Diseases (ICD-10; including I61, I62, and I63). We excluded the hospitals without stroke inpatient cases (N = 36). Finally, 120 hospitals (public = 32 vs private = 88, 99,464 hospitalization cases) were included for analysis. The unit of analysis was one hospitalization case.

2.2. Variables

To reflect the quality of care and outcomes in stroke inpatient, we used readmission within 30 days after discharge for stroke and death within 30 days after hospitalization for stroke as outcome variables in this study. We identified the patient's first discharge or hospitalization in the calendar year as the first index discharge or hospitalization. Readmission or death within 30 days was defined as readmission or death within 30 calendar days based on the first index discharge or hospitalization.

The primary variables of interest with respect to readmission or death within 30 days after discharge or hospitalization were the percentages of specialist doctors and RNs. These were defined as the percentage of specialist doctors to the total number of doctors, and the percentage of RNs to the total number of nurses [including RNs and licensed practical nurses (LPNs)] in each hospital. These indicators were used to reflect the richer skill mix in human resource pool, and were calculated as shown in the following two equations:

$$\text{Percentage of specialist doctors} = (\text{Number of specialist doctors}/\text{Total number of doctors}) \times 100$$

$$\text{Percentage of RNs} = (\text{Number of RNs}/\text{Total number of nurses}) \times 100.$$

We adjusted these correlation analyses for patient-level and hospital-level variables. Patient-level variables included major diagnosis, age, gender, Charlson Comorbidity Index (CCI) score, health insurance type, hospitalization year, and length of hospitalization. Major diagnoses were classified according to the following ICD groupings: I61–I62, intracerebral hemorrhage; and I63, cerebral infarction. These classifications reflected specific pathological mechanisms. The CCI was used to account for the effect of comorbid disorders or diseases. Hospital-level variables included structural characteristics, human resources, and the number of stroke patients in each hospital. The structural characteristic variables included ownership status, teaching status, and number of beds. The human resource variables included the number of doctors and nurses per bed, and the number of neurosurgeons and neurologists.

2.3. Statistical analysis

We analyzed the distribution of each categorical variable by examining the frequencies and percentages of the variables and performing χ^2 tests to identify correlations with patient readmission or death within 30 days. These analyses were performed for both patient-level and hospital-level variables. We also performed analysis of variance (ANOVA) to compare the average values and standard deviations for continuous variables. Then, we used multilevel models including both patient-level and hospital-level variables to identify correlations with patient readmission or death within 30 days after discharge or hospitalization, respectively. We also performed sub-group analyses with respect to major diagnoses for stroke patients. All statistical analyses were performed using SAS statistical software version 9.2. All calculated *P*-values were two-sided and considered significant at $P < 0.05$.

3. Results

The data used in this study included 99,464 hospitalization cases. The number of patients readmitted within 30 days after discharge was 1782 (1.8%), and the number of mortalities within 30 days after hospitalization was 6926 (7.0%). Table 1 presents the results of univariate associations between each variable and readmission or death within 30 days after discharge or hospitalization, respectively, for stroke. The numbers of readmissions and deaths within 30 days after discharge or hospitalization were greater for patients with major diagnoses of intracerebral hemorrhage (2.3% and 17.1%, respectively) than cerebral infarction (1.7% and 4.5%, respectively). Analysis of CCI scores showed that the higher the score, the higher the percentages of readmission within 30 days. Mortality due to stroke was inversely correlated to the time since hospitalization (decreasing over the years of analysis), whereas readmission due to stroke was directly correlated with time (increasing during the years of analysis). These correlations also were observed when analyzing the length of hospitalization.

The analyses of hospital characteristics revealed significant differences in readmissions or deaths within 30 days for teaching hospitals (1.7% and 6.6%, respectively) and non-teaching hospitals (2.0% and 7.6%, respectively). The average percentage of RNs was lower for cases that were readmitted or perished within 30 days after discharge or hospitalization. The average numbers of neurosurgeons, neurologists, beds, and stroke patient admittance were lower in patients that were readmitted or perished within 30 days after discharge or hospitalization for stroke.

Table 2 presents the results of multilevel analyses considering both patient-level and hospital-level variables for readmission or death within 30 days after discharge or hospitalization for stroke. Patients hospitalized for intracerebral hemorrhage had a higher risk of readmission or death within 30 days [for readmission, odds ratio (OR) = 1.20 and SD = 1.04–1.39; for death, OR = 8.68 and SD = 8.07–9.34] than patients hospitalized for cerebral infarction (this group was used as the reference). Multilevel analyses of age groups indicated that older patients had a higher risk of death within 30 days after hospitalization, and a lower risk of readmission within 30 days. Analyses of CCI scores showed that higher scores were associated with greater risk for readmission or death within 30 days after discharge or hospitalization. Multilevel analyses of hospital-level variables show that patients at non-teaching hospitals have lower trend for readmission or death within 30 days after discharge or hospitalization, but this was not statistically significant. Patients at private hospitals had lower risk for death within 30 days (OR = 0.82 and SD = 0.75–0.91; teaching hospitals were used as the reference).

Patients at hospitals with a higher percentage of specialist doctors (for each 10% more specialists, OR = 0.93 and SD = 0.89–0.98) or