

Factors influencing MRI of Cerebrovascular Disease Patients in Korea

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Cerebrovascular disease is the critical cause of death and is important cause of disability worldwide and the leading contributor to the chronic disease burden. Cerebrovascular disease, is also the leading contributor, to the chronic disease burden. In this study, we analyzed the factors affecting MRI, which are critical for the diagnosis of cerebrovascular disease, with high mortality rate, and high medical burden. In the present study, data from the Korean National Hospital Discharge In-depth Injury Survey for three years, from 2012 to 2014, we used. The subjects were 14,383 patients with cerebrovascular disease over 20 years of age who were first diagnosed with the international disease classification code I60-I67: cerebral hemorrhage, cerebral infarction, obstruction and stenosis of the precerebral artery, cerebral aneurysm etc. The analysis revealed the independent variables affecting MRI examination of cerebrovascular diseases were sex, age, type of insurance, admission route, length of stay, treatment result, location of hospital, and the number of hospital beds.

Keywords : Cerebrovascular disease, MRI, Stroke

1. Introduction

Cerebrovascular disease is the critical cause of death and is important cause of disability worldwide [1]. Cerebrovascular disease is the leading contributor, to the chronic disease burden [2]. Stroke represents one of the most severe complications of cerebrovascular events [3]. Survivors are often chronically impaired in their movements and are left with long-term disabilities [4]. The increase in the incidence of stroke, due to accelerated growth of Korea's elderly population, will rapidly increase the socioeconomic burden of stroke. Because immediate treatment affects prognosis, and survival after a stroke, awareness of stroke, warning signs, appropriate measures in the event of a stroke, and the need for rapid treatment, can be major consideration, in improving stroke results [5]. However, there is a lack of research, on the diagnosis of cerebrovascular disease. Therefore, it is necessary to study the diagnosis of cerebrovascular disease, which has a critical impact on the direction, and outcome of treatment.

X-ray, computerized tomography (CT), magnetic re-

sonance imaging (MRI), and nuclear medicine tests have been used, as medically advanced diagnostic methods, for early detection and diagnosis of diseases [6]. However, MRI may be as accurate as CT, for the detection of acute hemorrhage in patients with acute focal stroke symptoms, and is more accurate than CT for the detection of chronic intracerebral hemorrhage [7].

In this study, we analyzed the factors affecting MRI, which are critical for the diagnosis of cerebrovascular disease with high mortality rate, and high medical burden, and suggest essential data for the establishment of health-care policy for improvement of quality of medical care, evaluation of appropriateness, and efficient use of resources for diagnosis.

2. Subjects and Methods

For this study, we used data from the Korean National Hospital Discharge In-depth Injury Survey for three years, from 2012 to 2014. The Korean National Hospital Discharge In-depth Injury Survey was formulated based on the National Hospital Discharge Survey (NHDS) methodology of the United States of summary data of discharged patients. It is collected data from about 150 hospitals with more than 100 beds nationwide. The survey items include personal information of the patient

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such as gender, age, type of insurance, primary diagnosis, secondary diagnosis, hospitalization route, length of stay, discharge form, etc.

The subjects were 14,383 cerebrovascular disease patients, age 20 or older, with primary diagnosis code by international disease classification code I60-I67: cerebral hemorrhaging, cerebral infarction, obstruction and stenosis of the precerebral artery, cerebral aneurysm etc. Dependent variables were defined as patients with cerebrovascular disease MRI utilization, and MRI utilization with an 88.91 examination code, according to the International Classification of Disease 9th revision Clinical Modification (ICD - 9 - CM) code. As an independent variable revealing social demographic characteristics, we used variables of sex, age, and type of insurance. Types of insurance include national health insurance, medical care, etc. Variables such as admission route, length of stay, result of treatment, location of the hospital, and size of the hospital bed, were used as independent variables, indicating medical institution and medical use characteristics. The length of stay was divided into 1-4 days, 5-8 days, 9-16 days, 17 days or more, depending on the quartile. The treatment result was divided into improved, not improved,

only diagnosis, death, others. The location of the hospital was divided into Seoul, metropolitan, Gyeonggi, and other areas. The division between Seoul and metropolitan, and the divided other areas with Gyeonggi, classified it because Gyeonggi seemed to have similar characteristics as Seoul. The number of hospital beds was divided into 100-299 beds, 300-499 beds, 500-999 beds, 1,000 beds or more (Fig. 1).

Statistical analysis was assessed using the program of SPSS version 21.0, and frequency analysis was conducted, to examine general characteristics of the subjects to be analyzed. To ascertain the difference of MRI utilization rate, according to social demographic characteristics of cerebrovascular disease, medical institution and medical use characteristics, Chi-squared analysis was conducted. Multiple logistic regression analysis was conducted to determine factors that affect MRI use for cerebrovascular disease.

3. Results and Discussion

In examining general characteristics of cerebrovascular diseases, results revealed 51.5 percent of males and 48.5

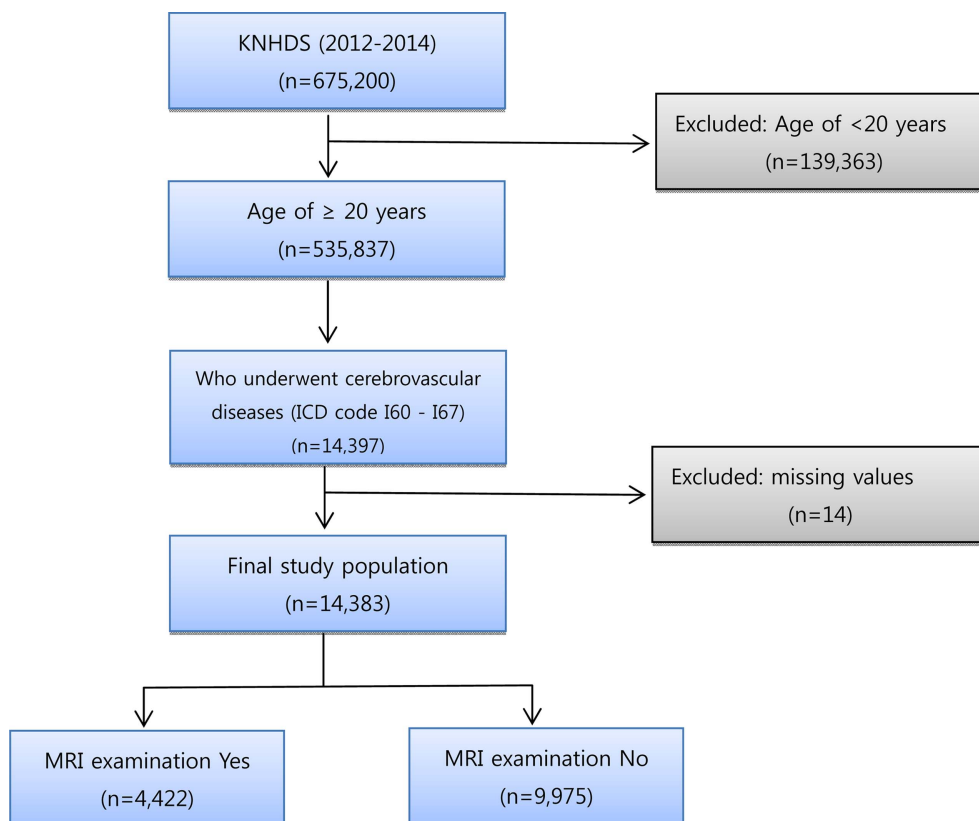


Fig. 1. (Color online) The selection process for the study population. KNHDS = The Korean National Hospital Discharge Survey ICD = International Classification of Diseases

percent of female, were among the 14,383 cerebrovascular disease patients. In distribution by age, cerebrovascular disease in 70-79 year-old patients was highest at 28.6 percent, 22.9 percent in 60-69-year-old patients, 20.6 percent in 50-59 year-old patients, 14.3 percent in younger than 50 year-old patients, and 13.7 percent at over 80 years. The type of insurance was 91.6 percent for national health insurance, 7.6 percent for medical care, and 0.8 percent for others. The admission route was 63.8 percent of cerebrovascular diseases using the emergency room, the distribution by length of stay was 26.8 percent for 1-4 days, 25.4 percent for 5-8 days, 23.8 percent at 9-16 days, on 17 days or longer was 24.8 percent. According to the results of treatment, improved was highest at 86.4 percent, 3.7 percent not improved, 3.8 percent by diagnosis only,

5.7 percent at death, and 0.4 percent at others. When conducting MRI examination of cerebrovascular disease, it was 69.3 percent, distribution by location of the hospital was in the order of others at 30.6 percent, metropolitan 29.5 percent, Seoul 24.6 percent, Gyeonggi 15.3 percent. In distribution by the number of hospital beds, cerebrovascular disease patients using the 500-999 beds was analyzed as 56.0 percent, followed by 1,000 or more beds 16.4 percent, 100-299 beds 16.3 percent, and 300-499 beds 11.2 percent, in order (Table 1).

To examine differences in utilization of MRI of cerebrovascular disease by general characteristics, the Chi-squared test was conducted. The utilization of MRI according to cerebrovascular disease patients' sex, age, type of insurance, admission route, length of stay, treatment result, location of the hospital, and the number of hospital beds were significantly different statistically. The ratio of MRI examination of male cerebrovascular disease patients was 32.6 percent, which was significantly higher than that of female cerebrovascular disease patients, at 28.7 percent. The ratio of MRI examination by age, was highest at 35.7 percent, in the case of patients 80 years old or older. In the type of insurance, case of National Health Insurance was highest, 31.1 percent. When patients were hospitalized via emergency, the ratio of MRI examinations was significantly higher, than that from ambulatory. Whether to MRI scan according to the length of stay were 37.2 percent at 5-8 days, 35.4 percent at 9-16 days, 28.6 percent at 17 days or longer, and 22.1 percent at 1-4 days. The ratio of MRI examination according to the result of treatment, was the highest at 37.2 percent in the case of improved. The ratio of MRI examination according to location of hospital was the highest at 40.3 percent in the case of Gyeonggi. Whether to conduct MRI examination according to the bed size were 33.6 percent at 300-499 beds, 32.9 percent at 100-299 beds, 32.3 percent at 500-999 beds, and 21.6 percent at 1,000 or more beds (Table 2).

Logistic regression analysis was performed to identify factors affecting MRI examination of cerebrovascular disease patients. The independent variables affecting MRI examination of cerebrovascular disease patients were sex, age, type of insurance, admission route, length of stay, treatment result, location of hospital, and the number of hospital beds. MRI examinations of male cerebrovascular disease patients were significantly higher by 1.176 times than female patients, and the examination ratio of cerebrovascular disease patients of 80 years or older, was significantly higher by 1.540 times, than that of patients younger than 50 years old. The ratio of MRI examination of medical care, and other insurance types of cere-

Table 1. General characteristics of study population.

Variables		N	%
Sex	Male	7,406	51.5
	Female	6,977	48.5
Age	< 50	2,057	14.3
	50-59	2,960	20.6
	60-69	3,290	22.9
	70-79	4,110	28.6
	≥ 80	1,966	13.7
Insurance type	National health	13,171	91.6
	Medicare	1,095	7.6
	Others	117	0.8
Admission route	Emergency	9,180	63.8
	Ambulatory	5,203	36.2
Length of stay	1-4	3,748	26.1
	5-8	3,655	25.4
	9-16	3,419	23.8
	≥ 17	3,561	24.8
Result of treatment	Improved	12,422	86.4
	Not improved	538	3.7
	Diagnosis only	551	3.8
	Death	821	5.7
	Others	51	0.4
MRI	Yes	9,961	69.3
	No	4,422	30.7
Hospital area	Seoul	3,532	24.6
	Metropolitan	4,244	29.5
	Gyeonggi	2,201	15.3
	Others	4,406	30.6
Number of hospital beds	100-299	2,343	16.3
	300-499	1,617	11.2
	500-999	8,058	56.0
	≥ 1,000	2,365	16.4
Total		14,383	100.0

Table 2. Distribution of MRI utilization according to general characteristics.

Variables		MRI utilization		Total (n=14,383)	χ^2	p
		Yes(n=4,422)	No(n=9,961)			
Sex	Male	2,418(32.6)	4,988(67.4)	7,406(51.5)	26.01	.000*
	Female	2,004(28.7)	4,973(71.3)	6,977(48.5)		
Age	< 50	525(25.5)	1,532(74.5)	2,057(14.3)	79.557	.000*
	50-59	829(28.0)	2,131(72.0)	2,960(20.6)		
	60-69	976(29.7)	2,314(70.3)	3,290(22.9)		
	70-79	1,390(33.8)	2,720(66.2)	4,110(28.6)		
	≥ 80	702(35.7)	1,264(64.3)	1,966(13.7)		
Insurance type	National health	4,092(31.1)	9,079(68.9)	13,171(91.6)	13.934	.001*
	Medicare	310(28.3)	785(71.7)	1,095(7.6)		
	Others	20(17.1)	97(82.9)	117(0.8)		
Admission route	Emergency	3,134(34.1)	6,046(65.9)	9,180(63.8)	137.355	.000*
	Ambulatory	1,288(24.8)	3,915(75.2)	5,203(36.2)		
Length of stay	1-4	829(22.1)	2,919(77.9)	3,748(26.1)	264.249	.000*
	5-8	1,361(37.2)	2,294(62.8)	3,655(25.4)		
	9-16	1,212(35.4)	2,207(64.6)	3,419(23.8)		
	≥ 17	1,020(28.6)	2,541(71.4)	3,561(24.8)		
Result of treatment	Improved	4,060(32.7)	8,362(67.3)	12,422(86.4)	168.749	.000*
	Not improved	107(19.9)	431(80.1)	538(3.7)		
	Diagnosis only	120(21.8)	431(78.2)	551(3.8)		
	Death	130(15.8)	691(84.2)	821(5.7)		
	Others	5(9.8)	46(90.2)	51(0.4)		
Hospital area	Seoul	929(26.3)	2,603(73.7)	3,532(24.6)	132.036	.000*
	Metropolitan	1,318(31.1)	2,926(68.9)	4,244(29.5)		
	Gyeonggi	887(40.3)	1,314(59.7)	2,201(15.3)		
	Others	1,288(29.2)	3,118(70.8)	4,406(30.6)		
Number of hospital beds	100-299	772(32.9)	1,571(67.1)	2,343(16.3)	111.54	.000*
	300-499	544(33.6)	1,073(66.4)	1,617(11.2)		
	500-999	2,594(32.2)	5,464(67.8)	8,058(56.0)		
	≥ 1,000	512(21.6)	1,853(78.4)	2,365(16.4)		

*P < 0.05 by chi-square test

brovascular disease patients, is significantly lower, than that of national health insurance patients. The ratio of MRI examination of cerebrovascular disease patients hospitalized through emergency rooms was significantly higher by 1.572 times, than in cases through ambulatory. In the case of 5-8 days, compared with the case in which the length of stay was 1-4 days, the ratio of MRI examination was significantly higher by 1.589 times. The ratio of MRI examination was significantly lower in patients who did not improve, or were diagnosed only and died, compared with when treatment was improved. The ratio of MRI examination when the medical institute was in Gyeonggi, was significantly 1.808 times higher, compared to other areas except Gyeonggi.

The ratio of MRI examination of cerebrovascular disease patients using medical institutions with 100-299 beds, and

300-499 beds, was significantly higher than 1.987 times, as compared to cerebrovascular disease patients using hospitals with 1,000 or more beds. Result of the Likelihood ratio test was p < 0.05 (Table 3).

In Korea, the aging of the population will lead to an increase in cerebrovascular disease, including cerebral hemorrhage, and cerebral infarction. The first step in treating cerebrovascular disease is an accurate diagnosis based on clinical symptoms, a neurological examination, and brain imaging. Brain MRI and CT, are the most frequently used methods for diagnosis of cerebrovascular disease [8]. An MRI scan is a primary marker of small vessel disease, which is linked with increased risk of stroke, functional and cognitive impairment, dementia, and death [6]. Moreover, conducting an MRI for patients experiencing acute stroke, allows for a rapid diagnostic

Table 3. Factors influencing on MRI utilization of cerebrovascular disease patients.

Variables		OR	95 % CI
Sex	Female	1	
	Male	1.176	(1.097-1.267)*
Age	< 50	1	
	50-59	1.084	(0.951-1.235)
	60-69	1.183	(1.042-1.345)*
	70-79	1.378	(1.219-1.557)*
	≥ 80	1.540	(1.334-1.776)*
Insurance type	National health	1	
	Medicare	0.841	(0.730-0.969)*
	Others	0.482	(0.294-0.789)*
Admission route	Ambulatory	1	
	Emergency	1.572	(1.444-1.711)*
Length of stay	1-4	1	
	5-8	1.589	(1.424-1.774)*
	9-16	1.438	(1.285-1.610)*
	≥ 17	1.000	(0.890-1.124)
Result of treatment	Improved	1	
	Not improved	0.568	(0.454-0.710)*
	Diagnosis only	0.776	(0.625-0.964)*
	Death	0.330	(0.271-0.402)*
	Others	0.192	(0.076-0.488)*
Hospital area	Others	1	
	Seoul	1.104	(0.991-1.231)
	Metropolitan	1.200	(1.089-1.323)*
	Gyeonggi	1.808	(1.615-2.024)*
Number of hospital beds	≥ 1,000	1	
	100-299	1.987	(1.721-2.294)*
	300-499	1.987	(1.709-2.310)*
	500-999	1.585	(1.415-1.776)*

*P < 0.05 by multivariate logistic regression
Likelihood ratio test: p-value < 0.05

evaluation, and provides necessary and relevant information [9].

There have been many studies on the effectiveness, and cost-effectiveness, of MRI for diagnosis of various brain diseases. Wardlaw *et al.* [10] reported that MRI is not cost-effective for secondary stroke prevention, and was most helpful in patients presenting at > 1 week after symptoms, if blood-sensitive sequences were used. However, Sidorov *et al.* [11] suggested that if a brain CT at the emergency room is bypassed, a brain MRI and an MRA, would be the most effective tool at the lowest cost.

Cerebrovascular disease mortality rate has significantly declined, in the last 30 years in Korea, but remains a

health burden [12]. In the present study, factors affecting MRI for the diagnosis of cerebrovascular disease were sex, age, type of insurance, admission route, length of stay, treatment result, location of the hospital, and the number of hospital beds. We must continue researching the factors related to MRI, for diagnosis of cerebrovascular disease, which could reduce the burden of cerebrovascular disease, and establish public health policy.

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