

2010년 한국인 뇌졸중의 경제적 질병부담

김 현 진¹ · 김 영 애¹ · 서 혜 영² · 김 은 정³ · 윤 석 준⁴ · 오 인 환^{5*} | 고려대학교 ¹일반대학원 보건학협동과정, ²보건대학원 보건 정책 및 병원관리학과, ³제주한라대학교 간호학과, ⁴고려대학교 의과대학 예방의학교실, ⁵경희대학교 의학전문대학원 예방의학교실

The economic burden of stroke in 2010 in Korea

Hyun-Jin Kim, MPH¹ · Young-Ae Kim, MPH¹ · Hye-Young Seo² · Eun-Jung Kim, PhD³ · Seok-Jun Yoon, MD⁴ · In-Hwan Oh, MD^{5*}

¹Department of Public Health, Graduate School, ²Department of Health Policy and Hospital Management, Graduate School of Public Health, Korea University, Seoul, ³Department of Nursing, Cheju Halla College, Jeju, ⁴Department of Preventive Medicine, College of Medicine, Korea University, Seoul, ⁵Department of Preventive Medicine, School of Medicine, Kyung Hee University, Seoul, Korea

*Corresponding author: In-Hwan Oh, E-mail: ioh@khu.ac.kr

Received October 4, 2012 · Accepted October 25, 2012

Stroke is a disease that causes a substantial economic burden. With the rapidly aging population in Korea, the prevalence of chronic diseases, including stroke, is expected to rise, along with associated health care expenditures. Therefore, we estimated the economic burden of stroke in Korea in 2010 using nationally representative data. We used a prevalence-based approach to estimate the cost of stroke by claims data from the Korean National Health Insurance. Data from the Korea Health Panel, the Korea National Statistical Office's records of causes of death, and Labor Statistics were used to calculate direct non-medical costs and indirect costs. Direct costs included direct medical costs and direct non-medical costs, and indirect costs were opportunity costs lost due to premature death and productivity loss. Total costs were estimated by adding age- and gender-specific costs. The total economic burden of stroke was \$3.53 billion: \$1.87 billion for hemorrhagic stroke and \$1.66 billion for ischemic stroke. The direct costs were \$1.74 billion and the indirect costs were \$1.79 billion. By gender, males were burdened at \$2.19 billion, while females bore \$1.34 billion of the total burden. Stroke imposes a huge economic burden, as indicated by the fact that the costs of stroke increased by 4.4% from 2005 to 2010, and the estimated cost was 0.35% of gross domestic product. Therefore, effective prevention programs and treatments are needed to reduce the economic burden of stroke in Korea.

Keywords: Stroke; Cost of illness; Economic burden; Prevention & control

Introduction

Stroke is a major cause of death in developed countries, including the US and Europe [1,2]. In Korea, stroke rates are expected to increase due to the aging of population. According to the mortality data of the

Korean Statistical Information Service in 2010, the second leading cause of death by disease group in Korea is cardiovascular diseases, followed cancer. Stroke, which is one of the most common cardiovascular diseases, is currently the number one cause of death attributed to a single organ disease [3]. In addi-

© Korean Medical Association

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

tion, according to the Korean National Health and Nutritional Examination Survey (KNHANES), although the stroke mortality rate decreased by 12.1% from 2005 to 2008, the prevalence of stroke in people over the age of 30 increased by 0.4% [4].

In addition, elderly people (those over 65 years old) comprised 10.6% of the Korean population in 2010, and by 2019 that proportion is expected to increase to 14.4%. This demographic transition is likely to become even more significant as life expectancy increases [5]. This supports the theory that stroke will remain one of most important diseases in terms of Korea's overall disease burden.

Stroke is known to contribute to high mortality rates and socioeconomic costs. For example, a British study using a prevalence-based approach estimated the costs associated with stroke at \$13 billion, while a one-year study using an incidence-based approach reported that stroke-related costs equaled \$65.5 billion in 2008 in the US [1,6]. Previous studies have estimated the cost of stroke in Korea. One study using an incidence-based approach calculated the lifetime cost per person, and found that the cost for a Korean man was expected to be \$167,250 with an age of onset of 45 [7]. Another study by Lim et al, estimated the economic burden of stroke in 2005 using a prevalence-based approach [8]. However, this study did not assess the overall costs of stroke. For example, it excluded the cost of assistive devices integral to rehabilitation. Studies conducted in developed countries have typically included the cost of assistive devices in the estimation of overall costs [1,2,8,9]. Because stroke is often accompanied by disabilities that impede the activities of daily living, the costs for rehabilitation, such as assistive devices, should be considered when measuring the economic burden of stroke [1]. For example, in a Canadian study, the cost

of assistive devices was 0.3% of the direct medical costs of stroke, which was equal to the cost of prescription drugs and professional fees [10]. A Swedish study that assessed the cost of assistive devices during the first year after acute stroke showed that \$646 was spent per patient [11]. In order to manage stroke patients more efficiently, a more accurate estimate of Korean stroke-related costs is needed.

The objective of this study was to estimate the economic burden of stroke during 2010 using data from the National Health Insurance Corporation (NHIC). We also examined the components of stroke-related costs in Korea, using the most up-to-date nationally representative data available.

Methods

In this study, we calculated the cost of stroke using a prevalence-based approach. Stroke was defined as I60-I63 according to the International Classification of Disease 10th version, and stroke cases were classified into two subtypes: hemorrhagic stroke (codes I60-I62) and ischemic stroke (code I63) [12]. To increase the accuracy of the case definitions, stroke patients were defined as those with a primary diagnosis of stroke who had at least one inpatient or three outpatient claims for visiting or hospitalization in a medical institution during 2010 [2]. All costs measured were converted into US dollars using an exchange rate of 1,176 Korean won to US \$1 (2010 exchange rate) [13].

The economic costs of stroke were divided into direct and indirect costs. Direct costs were direct medical care costs, including non-NHIC-covered care costs, medical services, costs of meals, and elective services, as well as prescription and assistive device costs. Direct non-medical costs consisted of transportation costs and

caregiver costs [1,2,9].

In order to assess direct medical costs, we used claims data from the NHIC in 2010. In Korea, the NHIC is the exclusive health insurer. Thus, the NHIC claims data are representative of medical expenses from the Korean insurance program [14]. Prescription costs were defined as the calculated costs of drugs prescribed to stroke outpatients during 2010 based on NHIC claims data.

In order to assess non-NHIC-covered care costs, data on the proportion of non-NHIC covered cost were gathered. The non-NHIC covered cost rates of stroke patients were applied in our analysis (inpatient: 16.8% for hemorrhagic stroke and 13.9% for ischemic stroke; outpatient stroke: 16.6%) [15].

Additionally, to collect information on assistive devices costs, a survey of 83 patients was conducted at three rehabilitation hospitals by authors (Department of Rehabilitation Medicine, Konkuk University Medical Center, of Yeogang Rehabilitation Center, and of Bucheon Daesung Rehabilitation Hospital). This group was composed of patients in both acute and chronic stages of stroke. The survey determined the annual average cost of assistive devices to be \$205.40 per person. This amount was then multiplied by the number of stroke patients.

In order to calculate direct non-medical costs, the average two-way transportation cost per hospital visit was calculated based on data obtained from the Korean Health Panel in 2008 [14]. The average one-way transportation cost per inpatient visit for stroke was \$6.83, which covered the transportation costs of the patient and a caregiver. The cost of one-way transportation per outpatient visit was calculated to be \$0.70 [16].

For inpatient visits, caregiver costs were calculated by multiplying the number of days of hospitalization by the average caregiver cost per day (\$51.00 in 2005). We used the cost established by a representative nursing

service provider instead of the value of Korea Health Panel because of small proportion of using the paid caregiver in Korea Health Panel [17]. Also to estimate the cost of family or other voluntary caregiver, the average wage of paid caregiver is used as a proxy for the cost of caregiving, because the difference of task in caregiving between paid and unpaid caregiver is unknown [18]. In order to convert the caregiver rate to 2010 prices, the price index of 116 was adjusted, comparing with the price index of 2005. In order to calculate caregiver costs for outpatient visits, it was assumed that patients younger than nine years of age and older than 60 would require a caregiver. The average daily wage for a caregiver in 2005 was multiplied by the total number of outpatient visits and then adjusted to reflect the 2010 price index. It was assumed that each outpatient visit would require approximately 1/3 of the patient's daily working hours [14]. Visit duration was then multiplied by the number of outpatient visits.

Indirect costs were defined as the opportunity costs lost due to the use of medical services or premature death, and were estimated by calculating the total productivity loss based on the human capital approach [19]. Productivity loss for inpatients was determined by calculating the average monthly working hours and the average monthly wage as detailed by a survey report on labor conditions in 2007 [20]. Because patients under 19 and over 70 years of age were not considered to be of working age, only the productivity losses for patients between the ages of 20 and 69 were considered. In order to estimate average monthly work losses due to outpatient visits, the average visit duration was multiplied by the number of outpatient visits.

Productivity loss resulting from premature death was calculated based on the number of deaths from stroke reported in the cause of death statistics [3]. Potential

Table 1. Direct and indirect economic burden of stroke in Korea

Age of patients (yr)	Direct costs								Indirect costs			Total costs ^{b)}
	Direct medical care costs						Direct non-medical care costs		Total direct costs	Lost productivity	Cost of premature death	
	Paid by insurer	Copayment by patients	Non-covered services costs	Prescribed pharmaceutical costs	Assistive devices costs	Total direct medical care costs ^{a)}	Transportation costs	Caregiver costs				
Male												
Total	364.23	87.18	65.37	0.01	40.45	557.35	4.53	265.47	827.34	311.22	1,047.23	2,185.79
0-19	1.62	0.27	0.32	0.00	0.12	2.32	0.01	0.56	2.90	0.00	5.08	7.97
20-69	237.26	51.24	43.41	0.01	24.40	356.38	2.79	162.34	521.50	311.22	1,042.15	1,874.88
≥70	125.35	35.68	21.64	0.01	15.94	198.65	1.73	102.57	302.94	0.00	0.00	302.94
Female												
Total	386.85	93.77	69.06	0.01	44.53	594.29	4.68	309.65	908.61	95.10	338.39	1,342.10
0-19	1.07	0.21	0.21	0.00	0.08	1.57	0.01	0.45	2.03	0.00	2.31	4.34
20-69	151.81	33.44	28.38	0.01	13.87	227.53	1.72	95.57	324.82	95.10	336.08	756.00
≥70	233.98	60.12	40.47	0.00	30.58	365.19	2.95	213.63	581.77	0.00	0.00	581.77
Total	751.08	180.95	134.43	0.03	84.98	1,151.63	9.21	575.11	1,735.95	406.33	1,385.62	3,527.89

Expressed as \$US million.

^{a)} Sum of costs paid by insurer + copayment by patients + non-covered services + prescribed pharmaceuticals + assistive devices.^{b)} Sum of direct costs + indirect costs.

incomes of the age groups were converted into present values by an annual discount rate of 5% [21].

To complete the sensitivity analysis, two methods were employed: varying the discount rates for the cost of mortality and varying outpatient case definitions for stroke. The cost of premature death was recalculated using the annual discount rates of 0% and 3%, instead of 5%. Second, a cost estimation using three different outpatient case definitions, including having one or two outpatient claims and the present criteria, was conducted.

Results

In 2010, the total number of treated cases of stroke was 396,843, the number of cases of ischemic stroke was 332,523, and the number of cases of hemorrhagic

stroke was 64,319. There were no significant differences in the number of treated cases according to gender: 203,847 were males and 192,996 were females.

The total economic cost of stroke was \$3.53 billion: \$1.87 billion for hemorrhagic stroke and \$1.66 billion for ischemic stroke (Table 1). Direct costs were estimated to be approximately 49% of this total, with indirect costs counting for the remaining 51%. In the analysis of direct costs, direct medical care costs were \$1.15 billion and direct non-medical costs were \$584 million, which was 50% of the total direct medical care costs. In the breakdown of indirect costs, costs due to premature death were \$1.39 billion and costs due to lost productivity were \$406 million. The total indirect costs were estimated to be \$1.79 billion.

By gender, males accounted for \$2.19 billion of the

Table 2. Direct and indirect economic burden of hemorrhagic stroke in Korea

Age of patients (yr)	Direct costs								Indirect costs			Total costs ^{b)}
	Direct medical care costs						Direct non-medical care costs		Total direct costs	Lost productivity	Cost of pre-mature death	
	Paid by insurer	Copayment by patients	Non-covered services costs	Prescribed pharmaceutical costs	Assistive devices costs	Total direct medical care costs ^{a)}	Transportation costs	Caregiver costs				
Male												
Total	147.47	25.71	29.77	0.01	12.24	215.21	1.07	82.00	298.28	128.96	816.07	1,243.31
0-19	1.36	0.20	0.27	0.00	0.08	1.90	0.01	0.42	2.33	0.00	4.88	7.22
20-69	117.26	19.10	23.67	0.00	9.36	169.40	0.84	63.82	234.05	128.96	811.18	1,174.20
≥70	28.85	6.42	5.82	0.00	2.81	43.90	0.23	17.76	61.89	0.00	0.00	61.89
Female												
Total	149.86	27.16	30.25	0.01	11.92	219.22	1.04	82.07	302.32	44.82	281.63	628.78
0-19	0.85	0.14	0.17	0.00	0.06	1.22	0.01	0.33	1.56	0.00	2.31	3.86
20-69	90.33	15.29	18.23	0.00	6.23	130.08	0.59	43.36	174.03	44.82	279.32	498.18
≥70	58.69	11.73	11.85	0.00	5.64	87.91	0.44	38.38	126.73	0.00	0.00	126.73
Total	297.33	52.87	60.02	0.01	24.16	434.42	2.11	164.07	600.61	173.78	1,097.70	1,872.09

Expressed as \$US million.

^{a)} Sum of costs paid by insurer + copayment by patients + non-covered services + prescribed pharmaceuticals + assistive devices.

^{b)} Sum of direct costs + indirect costs.

total cost, compared to a total cost of \$1.34 billion for females. By age group, the economic burden of male patients (\$1.88 billion) aged between 20 and 69 was higher than that of females (\$760.34 million), whereas female patients (\$581.77 million) over the age of 70 accounted for approximately 1.9 times the costs of males in the same age group (\$302.94 million).

Comparing the costs of hemorrhagic stroke with ischemic stroke, the cost of hemorrhagic stroke was approximately 1.13 times higher than ischemic stroke. For hemorrhagic and ischemic stroke, the direct costs were \$600.61 million and \$1.14 billion, respectively, while the indirect costs were \$1.27 billion and \$520.46 million, respectively. For the hemorrhagic stroke costs, the indirect costs were more than twice as high as the direct costs, while the direct costs of ischemic stroke

were 2.16 times more than the indirect costs.

By age group, cost of premature death for hemorrhagic stroke was the highest burden aged 20 to 69 (\$1.09 billion), ischemic stroke was similar result both the cost of premature death and direct medical costs (\$287.72 million, \$284.43 million). The direct costs over the age of 70 were \$188.62 million for hemorrhagic stroke, \$696.08 million for ischemic stroke and the cost of ischemic stroke was 3.7 times more than that of hemorrhagic stroke (Tables 2,3).

In the sensitivity analysis of the discount rate, the cost of premature death ranged from \$1.39 billion to \$2.20 billion. Indirect costs ranged from \$1.79 billion to \$2.61 billion. Consequently, the total economic burden of stroke ranged from \$3.53 billion to \$4.34 billion. This is between 5.2% and 6.4% of the total cost of health

Table 3. Direct and indirect economic burden of ischemic stroke in Korea

Age of patients (yr)	Direct costs								Indirect costs			Total costs ^{b)}
	Direct medical care costs						Direct non-medical care costs		Total direct costs	Lost productivity	Cost of premature death	
	Paid by insurer	Copayment by patients	Non-covered services costs	Prescribed pharmaceutical costs	Assistive devices costs	Total direct medical care costs ^{a)}	Transportation costs	Caregiver costs				
Male												
Total	216.77	61.47	35.60	0.01	28.21	342.14	3.45	183.47	529.06	182.26	231.16	942.48
0-19	0.26	0.07	0.04	0.00	0.04	0.42	0.01	0.14	0.56	0.00	0.20	0.76
20-69	120.00	32.14	19.74	0.00	15.04	186.98	1.95	98.52	287.45	182.26	230.96	700.68
≥70	96.50	29.26	15.81	0.00	13.14	154.74	1.50	84.81	241.05	0.00	0.00	241.05
Female												
Total	236.99	66.61	38.81	0.01	32.61	375.07	3.64	227.58	606.29	50.28	56.76	713.32
0-19	0.22	0.07	0.04	0.00	0.02	0.35	0.00	0.12	0.47	0.00	0.00	0.47
20-69	61.48	18.15	10.15	0.00	7.65	97.45	1.12	52.21	150.78	50.28	56.76	257.82
≥70	175.29	48.39	28.62	0.00	24.94	277.28	2.51	175.25	455.03	0.00	0.00	455.03
Total	453.75	128.08	74.41	0.01	60.82	717.21	7.09	411.05	1,135.35	232.54	287.92	1,655.81

Expressed as \$US million.

^{a)} Sum of costs paid by insurer + copayment by patients + non-covered services + prescribed pharmaceuticals + assistive devices.^{b)} Sum of direct costs + indirect costs.**Table 4.** Sensitivity analysis for various discount rates

Cost category	Discounted at 0%	Discounted at 3%	Discounted at 5%
Lost productivity	406	406	406
Cost of premature death	2,201	1,630	1,386
Indirect cost	2,607	2,036	1,792
Total cost ^{a)}	4,343	3,773	3,527

Expressed as \$US million.

^{a)} Sum of direct costs + indirect costs.

care in 2010 (\$68 billion) [5]. A sensitivity analysis of outpatient case definitions was also performed. The estimated total cost for one outpatient claim was \$3.86 billion, which was increased than three outpatient claims by 9.3%. The cost of outpatient case ranged from \$71.80 million (present criteria) to \$357.47 million (one outpatient claim) (Tables 4,5).

Discussion

This study estimated the economic burden of stroke using data sources such as the NHIC and survey data. In 2010, 396,843 patients in Korea were diagnosed and treated in stroke. The total cost of stroke was estimated to be \$3.53 billion: \$1.87 billion for hemorrhagic stroke and \$1.66 billion for ischemic stroke. The estimated cost of stroke was 0.35% of the Korean gross domestic product (GDP) and 5% of national health care expenditures [5].

By cost item, total direct medical costs were \$1.15 billion, total non-medical costs were \$584 million, and indirect costs were \$1.79 billion. Direct costs were 2.6% of the total cost of health care in 2010, and were 1.2 times larger than the costs of lung cancer (\$1.41

Table 5. Sensitivity analysis using various outpatient case definitions

Cost component	Three or more visits (present criteria)	Two or more visits	One or more visits
Direct medical cost			
Inpatient care	1,079.83 (30.61)	1,079.83 (28.18)	1,079.83 (27.98)
Outpatient care	71.80 (2.04)	335.07 (8.75)	357.47 (9.26)
Direct non-medical cost			
Caregiver cost	575.11 (16.30)	577.64 (15.08)	580.57 (15.04)
Transportation	9.21 (0.26)	9.39 (0.24)	9.45 (0.24)
Indirect cost			
Lost productivity	406.33 (11.52)	443.70 (11.58)	446.37 (11.57)
Cost of premature death	1,385.62 (39.28)	1,385.62 (36.17)	1,385.62 (35.90)
Total cost ^{a)}	3,527.90 (100.00)	3,831.24 (100.00)	3,859.30 (100.00)

Expressed as \$US million.

Values are presented as cost (%).

^{a)} Sum of direct costs + indirect costs.

billion) in 2005 [22]. Also the proportion of 0.35% is lower than all musculoskeletal diseases (0.7% of GDP in 2008) or all cancer (1.75% of GDP in 2005), but is a substantial burden in Korea [14,22]. In the sensitivity analysis, the rate of increase of the total economic burden of stroke ranged from 6.9% to 23.13%, as seen when applying the different discount rates and outpatient case definitions.

In 2005, the economic burden of stroke in Korea was estimated as \$3.38 billion, of which medical costs were \$1.02 billion, which was approximately 7.8% of national health care expenditures and 0.46% of the GDP in Korea that year [8]. In this study, there was a difference in stroke-related costs between 2005 and 2010, and a cost increase of almost \$0.15 billion from 2005 to 2010.

This distinction may be the burden of rising direct medical costs due in part to the development of new diagnostic equipment, the increased use of more expensive equipment and inflation of prices [8]. However, methodological differences could also be partly responsible. First, Lim et al. [8] included transient ischemic attacks (TIA, G45) patients with the stroke patients

classified as I60-I69, and defined them as adult patients over age 20 who have claimed stroke as the primary or secondary diagnosis. However, in this study, we defined stroke patients who had at least one inpatient or three outpatient claims as I60-I63, and patients with TIA were excluded. In addition, we estimated the costs of entire age groups with stroke as the primary disease. Second, in the study by Lim et al. [8], the cost of assistive devices was excluded due to the difficulty

involved in quantification. In contrast, our study included the cost of assistive devices. Considering that non-covered care represented 3% to 4% of the total costs, the cost of assistive devices is an also important part of the overall economic burden of stroke. Last, the results of the KNHANES for transportation were applied in the estimation of direct non-medical costs, and transportation costs were estimated to be 0.7% of the total direct costs. However, because we hypothesized that patients who suffer from chronic diseases such as stroke would rarely travel to another region to receive treatment, we estimated the cost of stroke-specific transportation from Korea Health Panel data. Therefore, the transportation costs were assessed as 0.5% of the total direct costs, which is lower than that used by Lim et al. [8].

In 2010, direct costs were 49% and indirect costs were 51% of the total costs, compared to 2005 where the direct costs were 31% and indirect costs were 69% of the total costs [8]. Our results showed a trend similar to that seen in many other studies. In studies done in other countries, direct costs have been shown to be

higher than indirect costs in spite of methodological differences [1,2]. A study conducted in the UK (2004) estimated direct costs to be \$9.40 billion, of which \$6.15 billion (65%) were medical costs, \$2.05 billion (22%) were non-medical costs, and \$1.07 billion (12%) were costs due to productivity loss. In addition, in a study conducted in the EU, direct costs (61.1%) were found to be greater than indirect costs (38.9%) [1,2]. The results of the present study showed that the direct costs associated with stroke increased from 2005 to 2010. Since stroke occurs primarily in people over the age of 60, indirect costs caused by productivity loss and premature death were relatively small in this age group, as compared to those of young adults and middle-aged people. Therefore, indirect costs are not a large part of the overall economic burden of this disease compared to direct costs.

The cost of hemorrhagic stroke was higher than the cost of ischemic stroke according to disease group. In addition, some differences in cost distribution were observed. In the analysis of hemorrhagic stroke costs, indirect costs (67.92%) were the highest, followed by direct medical costs (23.20%) and direct non-medical costs (8.87%). For ischemic stroke, direct medical costs (43.41%) were the greatest burden, followed by indirect costs (31.43%) and direct non-medical costs (25.25%). According to age group, the estimated cost for patients between the ages of 20 and 69 with hemorrhagic stroke was higher than for those with ischemic stroke: 89.33% vs. 57.88%, respectively. Hemorrhagic stroke, which carried a heavier burden in indirect costs, occurred in the younger age groups and had a higher fatality rate, accounting for relatively greater predicted life-time earnings foregone. For ischemic stroke, the cost of health care use was high due to the large prevalence of the disease.

Between the male and female patients, men had a heavier economic burden of disease than women, and a subsequently higher socio-economic cost. However, females had higher total direct medical costs and direct non-medical costs than did males. Males incurred higher indirect costs compared to females. This is because males typically experience stroke at an earlier age. On the other hand, women had higher direct costs than indirect costs and had higher overall medical costs due to the gender differences in stroke. In a study of the functional outcomes after stroke and the use of medical resources, it was found that females experience stroke later in life compared to males, and their number of inpatient days was slightly longer [23]. Hence, their functional outcome after the onset of stroke is worse than that seen in males. Females also have a higher risk of developing severe disability, resulting in subsequently higher direct medical costs. Studies in Europe, Canada, and Korea have shown similar findings [23-26]. Therefore, intervention strategies which take into account gender differences in stroke outcome should be considered.

When we compare the results according to age group, the economic burden of stroke in patients over the age of 60 accounted for 49.45% of the total cost (data not shown). This phenomenon is associated with the high prevalence of stroke after the age of 65. In a study of the relationship between stroke and TIA prevalence in the elderly Korea population, the prevalence of stroke increased until the ages of 75 and 79, but decreased thereafter [27]. In addition, institutionalization costs incurred by elderly patients who suffer an incapacitating stroke will most likely increase, and ultimately the social costs will increase as well [28]. Therefore, Korea requires a health care policy to manage stroke that matches the needs of our rapidly aging

society.

This study has several limitations. First, we were not considered the cost of disability after stroke. There was no disability data in Korea National Health Insurance Claims Database, such as the modified Rankin Scale (mRS). Especially, the mRS was important to expect the extent of disability in stroke survivors and the estimation of rehabilitation cost due to disability was necessary after stroke [29]. Thus, the economic burden of stroke may have been underestimated. Second, we were unable to estimate the costs of house repairs, health supplement food, herbal medicine, and long-term use of a nursing facility due to limitations in the data. The economic burden could be even heavier when these costs were included. Third, it has been reported that 15.7% of stroke patients use over-the-counter (OTC) products for the prevention of secondary complications, which should be included in drug-related costs. However, because a large number of aspirin-type OTC products are also used to prevent hypertension and cardio-cerebrovascular diseases, the costs of these types of drugs were excluded from this study to avoid overestimation [30]. Fourth, there may have been validity problem of survey sampling in the cost of assistive devices, and there is a possibility of overestimation of stroke burden. Finally, because it was difficult to quantify the deterioration in quality of life resulting from social and environmental changes, such as psychological pain and anxiety, these factors were excluded from the cost analysis. If these costs were considered, the economic burden due to stroke could be even higher.

Conclusion

In this study, the economic burden of stroke was estimated using current nationally representative data

and was determined to be in \$3.53 billion in costs, the equivalent of 0.35% of the GDP. The economic burden of stroke has increased by 4.4% from 2005 to 2010. With the Korean society increasingly aging, the economic burden of stroke will continue to be substantial into the future. Therefore, we must endeavor to reduce the economic burden of stroke in Korea and the more accurate estimation of economic burden would help this goal.

Acknowledgement

This research was supported by the Basic Science Research Program through the National Research Foundation of Korea funded by the Ministry of Education, Science and Technology (20120001612).

핵심용어: 뇌졸중; 질병비용; 경제적 질병부담; 예방과 관리

REFERENCES

1. Luengo-Fernandez R, Leal J, Gray A, Petersen S, Rayner M. Cost of cardiovascular diseases in the United Kingdom. *Heart* 2006;92:1384-1389.
2. Leal J, Luengo-Fernandez R, Gray A, Petersen S, Rayner M. Economic burden of cardiovascular diseases in the enlarged European Union. *Eur Heart J* 2006;27:1610-1619.
3. Statistics Korea. Report on death causes 2008. Daejeon: Statistics Korea; 2008.
4. Korea Centers for Disease Control and Prevention. The Korea National Health and Nutrition Examination Survey (KNHANES). Cheongwon: Korea Centers for Disease Control and Prevention; 2005.
5. Statistics Korea. Report on the social statistics survey 2008. Daejeon: Statistics Korea; 2010.
6. American Heart Association. Heart disease and stroke statistics: 2008 update. Dallas: American Heart Association; 2008.
7. Kang HY, Lim SJ, Suh HS, Liew D. Estimating the lifetime economic burden of stroke according to the age of onset in South Korea: a cost of illness study. *BMC Public Health* 2011; 11:646.
8. Lim SJ, Kim HJ, Nam CM, Chang HS, Jang YH, Kim S, Kang

- HY. Socioeconomic costs of stroke in Korea: estimated from the Korea national health insurance claims database. *J Prev Med Public Health* 2009;42:251-260.
9. Saka RO, McGuire A, Wolfe CD. Economic burden of stroke in England. London: University of London; 2009.
 10. Chan B, Hayes B. Cost of stroke in Ontario, 1994/95. *CMAJ* 1998;159:S2-S8.
 11. Gosman-Hedstrom G, Claesson L, Blomstrand C, Fagerberg B, Lundgren-Lindquist B. Use and cost of assistive technology the first year after stroke. A randomized controlled trial. *Int J Technol Assess Health Care* 2002;18:520-527.
 12. World Health Organization. International Classification of Diseases (ICD) [Internet]. Geneva: World Health Organization [cited 2010 Nov 1]. Available from: <http://www.who.int/classifications/icd/en>.
 13. Kim SG, Hahm MI, Choi KS, Seung NY, Shin HR, Park EC. The economic burden of cancer in Korea in 2002. *Eur J Cancer Care (Engl)* 2008;17:136-144.
 14. Oh IH, Yoon SJ, Seo HY, Kim EJ, Kim YA. The economic burden of musculoskeletal disease in Korea: a cross sectional study. *BMC Musculoskelet Disord* 2011;12:157.
 15. Kim JH, Chung JC, Kim SO. Results of survey on medical care cost by patient. In: Lee SY, editor. Survey in the benefit coverage rate of National Health Insurance in 2006. Seoul: National Health Insurance Corporation; 2007. p. 111-125.
 16. Korea Health Panel. Transportation cost for healthcare utilization in 2008 [Internet]. Seoul: Korea Health Panel [cited 2010 Nov 1]. Available from: <http://www.khp.re.kr>.
 17. Sarangnangum Medicare Service Association. The official average guardian cost [Internet]. [place unknown]: Sarangnangum Medicare Service Association [cited 2010 Nov 1]. Available from: <http://www.sarangnangum.or.kr/esnc/service.htm>.
 18. Kim SY, Yoon SJ, Jo MW, Kim EJ, Kim HJ, Oh IH. Economic burden of allergic rhinitis in Korea. *Am J Rhinol Allergy* 2010; 24:e110-e113.
 19. Drummond MF, Stoddart GL, Torrance GW. Methods for the economic evaluation of health care programmes. 2nd ed. Toronto: Oxford University Press; 1997.
 20. Ministry of Employment and Labor. Survey report on wage structure in 2007 [Internet]. Gwacheon: Ministry of Employment and Labor [cited 2010 Nov 1]. Available from: http://laborstat.molab.go.kr/SurveyWH/OLAP/Analysis/stat_OLAP.jsp?tbl_id=DT_PAY0004&org_id=118&path.
 21. Schmid A, Pugin J, Chevrolet JC, Marsch S, Ludwig S, Stocker R, Finner H. Burden of illness imposed by severe sepsis in Switzerland. *Swiss Med Wkly* 2004;134:97-102.
 22. Kim J, Hahm MI, Park EC, Park JH, Park JH, Kim SE, Kim SG. Economic burden of cancer in South Korea for the year 2005. *J Prev Med Public Health* 2009;42:190-198.
 23. Oh MS, Yu KH, Roh JK, Lee BC; Korean Stroke Registry Study Group. Gender differences in the mortality and outcome of stroke patients in Korea. *Cerebrovasc Dis* 2009;28:427-434.
 24. Glader EL, Stegmayr B, Norrving B, Terent A, Hultcrantz K, Wester PO, Asplund K; Riks-Stroke Collaboration. Sex differences in management and outcome after stroke: a Swedish national perspective. *Stroke* 2003;34:1970-1975.
 25. Di Carlo A, Lamassa M, Baldereschi M, Pracucci G, Basile AM, Wolfe CD, Giroud M, Rudd A, Ghetti A, Inzitari D; European BIOMED Study of Stroke Care Group. Sex differences in the clinical presentation, resource use, and 3-month outcome of acute stroke in Europe: data from a multicenter multinational hospital-based registry. *Stroke* 2003;34:1114-1119.
 26. Reid JM, Dai D, Gubitz GJ, Kapral MK, Christian C, Phillips SJ. Gender differences in stroke examined in a 10-year cohort of patients admitted to a Canadian teaching hospital. *Stroke* 2008;39:1090-1095.
 27. Han MK, Huh Y, Lee SB, Park JH, Lee JJ, Choi EA, Lim JY, Lim S, Kim KI, Park YJ, Paik NJ, Kim TK, Jang HC, Kim KW; Korean Consortium for Health and Aging Research. Prevalence of stroke and transient ischemic attack in Korean elders: findings from the Korean Longitudinal Study on Health and Aging (KLoSHA). *Stroke* 2009;40:966-969.
 28. Thorngren M, Westling B. Utilization of health care resources after stroke: a population-based study of 258 hospitalized cases followed during the first year. *Acta Neurol Scand* 1991; 84:303-310.
 29. Hong KS. Disability-adjusted life years analysis: implications for stroke research. *J Clin Neurol* 2011;7:109-114.
 30. Koh IS, Kim HC, Kwon SB, Hwang SH, Kwon KH, Kim SM, Song HK, Lee BC. The compliance of stroke patients for secondary prevention: in Seoul & Kyunggi province. *J Korean Neurol Assoc* 1999;17:472-477.



Peer Reviewers' Commentary

뇌졸중은 우리나라 사망원인 중 2위를 차지하는 심혈관계 질환의 가장 흔한 상병이며, 단일기관에 발생하는 사망원인 중 1위임에도 불구하고, 질병부담과 같은 경제적 손실에 대한 실증적 자료가 없었다. 이에 본 연구는 우리나라의 뇌졸중으로 인한 총 질병부담액이 4조 1,488억원이며, 출혈성 뇌졸중은 2조 2,016억원, 뇌경색 뇌졸중은 1조 9,472억원에 달한다고 보고하고 있어 의미 있는 연구라고 판단된다. 우리나라에서 뇌졸중으로 인한 총 질병부담액의 크기는 우리나라 GDP(2010년 기준) 0.35%에 해당하며, 향후 인구고령화에 급속한 진행과 함께 뇌졸중으로 인한 질병부담액의 지속적 증가가 의료비 증가의 주요원인으로 대두될 것으로 예상할 수 있다는 점에서 주목할 필요가 있다.

[정리: 편집위원회]