



## Governmental designation of emergency medical institutes: 30 days mortality by types of designation



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### ABSTRACT

**Background:** In 2000, the South Korean government introduced a program in emergency medical institutions throughout the country to establish effective management system for emergency patients. The aim of this study was to investigate the effectiveness of this program for emergency patients and establish evidence for more effective strategy by comparing the relationship between types of emergency medical center and 30 day mortality after hospitalization in inpatients with cerebrovascular and cardiovascular diseases.

**Methods:** We used National Health Insurance claim data ( $n = 111,741$ ) from 115 hospitals during 2010–2013 to analyze readmissions within 30 days after hospitalization due to cerebrovascular and cardiovascular diseases. We performed  $\chi^2$  tests, analysis of variance and logistic regression analysis using generalized estimating equation (GEE) modeling to investigate associations with 30 day mortality after hospitalization.

**Results:** Deaths within 30 days of hospitalization due to cerebrovascular and cardiovascular diseases were 6.5%. Regional emergency medical center and localized emergency medical center had lower risk in 30 days mortality after hospitalization than localized emergency medical agency (regional emergency medical center = OR: 0.71, 95% CI: 0.60–0.84; localized emergency medical center = OR: 0.81, 95% CI: 0.72–0.90; ref. = localized emergency medical agency). In addition, reduction in 30 days mortality by types of emergency medical institutes was more highly associated in cerebrovascular diseases than cardiovascular diseases.

**Conclusions:** Government designated higher level emergency medical institutes had better outcomes in emergency medical care than localized emergency medical agencies. Thus, health policy makers have to consider optimal reimbursement in the field of emergency medicine.

### 1. Background

Cerebrovascular and cardiovascular diseases are serious medical problems associated with poor prognoses and mortality in severe cases and represent a significant cost-burden to patients and their families [1–3]. In non-fatal cases, cerebrovascular or cardiovascular disease can negatively affect a patient's entire life. Thus, optimal management of patients with emergent presentation of cerebrovascular or cardiovascular disease is critical. A number of studies have focused on addressing and managing cerebrovascular and cardiovascular diseases through the

development of new techniques [4–6]; however, there has been little improvement in overall outcomes due to the time-sensitive nature of these diseases [7].

According to the World Health Organization (WHO), cerebrovascular and cardiovascular represent the largest causes of mortality over the past 2 decades (1st = ischemic heart diseases: 6 million deaths in Y2000, 7.4 million deaths in Y2012; 2nd = stroke: 5.7 million deaths in Y2000, 6.7 million deaths in Y2012). These diseases represent a large proportion of the global disease burden (14.8% of all causes burden in 2016) [8–10]. In addition, the Statistics Korea report indicates that both

**Abbreviations:** WHO, World Health Organization; ICD, International Classification of Diseases; RNs, Registered Nurses; ICU, Intensive Care Unit; ER, Emergency Room; CCI, Charlson Comorbidity Index; NHI, National Health Insurance; ANOVA, Analysis Of Variance; GEE, Generalized Estimating Equation

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**Table 1**  
Criteria for emergency medical institutes.

	Regional emergency medical center	Localized emergency medical center	Localized emergency medical agency
Target hospital	General hospital	General hospital	General hospital, hospital, and clinic
Structural characteristics	≥30 emergency room (ER) beds 2 ≥ resuscitation room 2 ≥ operating room 20 ≥ intensive care unit (ICU) for emergency patient 30 ≥ bed for emergency patient	≥20 emergency room (ER) beds ≥ 1 causality ward	≥20 emergency room (ER) beds
Levels of medical equipment	Computed tomography Endoscopy Blood tester	Computed tomography	X-ray equipment
Hospital staffing	2 ≥ emergency medicine specialists 4 ≥ dedicated specialists 15 ≥ registered nurses	2 ≥ emergency medicine specialists 4 ≥ dedicated specialists 10 ≥ registered nurses	2 ≥ dedicated specialists

diseases are highly ranked among all causes of mortality (cerebrovascular diseases: 2nd in Y1993, 2nd in Y2013; cardiovascular diseases: 3rd in Y1993, 3rd in Y2013). These figures are expected to gradually increase with the increase in the aging population [11].

In the year 2000, based on the reasons described above, the South Korean government introduced a program that designated emergency medical institutes throughout the country in order to establish an effective management system for emergency patients, including those with severe injury, cardiovascular disease, or cerebrovascular disease. The program evaluated hospitals based on criteria that included structure, human resources, and medical equipment. The program designated emergency medical institutes into three types according to specific criteria and provided additional compensation based on the results of its evaluation. Since introducing the program, the South Korean government continued to designate an increasing number of emergency medical centers (411 centers in Y2002 to 562 centers in Y2012) [12], with further increases expected in the future.

Previous studies have shown that emergency medical centers can effectively manage emergency patients and have a protective role based on the prompt response of emergency medicine personnel [13,14]. However, despite the increasing designation of emergency medical institutes, there have been relatively few studies of emergency medical centers in South Korea. Therefore, in order to establish evidence that the emergency medicine institute designation program is an effective strategy, we considered it worthwhile to investigate the effectiveness of this program from the viewpoint of emergency patients and survival. To this end, we assumed that emergency medical centers would be positively associated with better outcomes for emergency patients. In particular, we suspected that higher-level emergency medical centers would perform better than lower-level centers. To evaluate this possibility, we analyzed the relationship between emergency medical center type and 30-day mortality after hospitalization in patients with cerebrovascular or cardiovascular disease. In addition, we performed subgroup analysis to investigate whether any of the identified associations depended significantly on the type of disease.

## 2. Methods

### 2.1. Study population

There were approximately 1730 hospitals, including 40 public hospitals, in South Korea between 2010 and 2013. A total of 160 hospitals (120 private and 40 public) were initially included in our study after extracting data through propensity score matching-methods (1:3), which we adjusted according to the variables hospital region, level of nurse staffing, number of total beds, number of intensive care unit beds, number of emergency room beds, and number of doctors. This study only included hospitalizations due to cerebrovascular or cardiovascular disease as defined by the International Classification of Diseases (ICD-

10; cerebrovascular diseases: I60, I61, I62, I63; cardiovascular diseases: I21, I22, I50). We excluded hospitalizations without required variable codes. Finally, 115 hospitals were included in our analysis (public = 31 vs. private = 84, 111,741 hospitalization cases). The unit of analysis was one hospitalization case.

### 2.2. Variables

To measure emergency medicine outcomes, we used death within 30 days of hospitalization due to cerebrovascular disease or cardiovascular disease as the outcome variable in this study. We identified the patient's first hospitalization of the calendar year as the index hospitalization. All deaths within 30 calendar days of the index hospitalization were subsequently recorded.

The primary variable of interest in this study was type of emergency medical institution. The emergency medical centers were designated as either regional emergency medical center, localized emergency medical center, or localized emergency medical agency based on structural characteristics, hospital staffing, and level of medical equipment as determined by a central emergency medicine committee. The specific emergency medical center designation criteria are shown in Table 1.

In the system currently employed in South Korea, the process of emergency care is divided into two phases comprising a pre-hospital phase and in-hospital phase. In the first phase, during an emergency event, an initial eyewitness contacts the emergency system, and an ambulance goes directly to the location of the emergency. The rescue team then provides simple emergency treatment and, using an emergency information system, chooses a hospital. Additional emergency care is rendered while transferring the patient to the selected hospital. In the second phase, after arrival at the hospital, decisions for emergency care are made, and optimal care is provided to the patient, including surgical and medical treatment. Based on laws for emergency care, regional emergency centers have a defined role to provide emergency treatment or surgery for patients with severe injuries in each region and to assist with emergency care during times of disaster. Regional emergency centers also educate and manage the quality of emergency care human resources in each region.

In the present study, we adjusted our analysis for hospital- and inpatient-level variables when analyzing the relationship between type of emergency medical center and death within 30 days of a cerebrovascular or cardiovascular disease event. Hospital-level variables encompassed both human resource variables and structural characteristics, namely, proportion of specialists, doctor to bed ratio, nurse to bed ratio, proportion of registered nurses (RNs), number of beds, number of emergency room (ER) beds, number of intensive care unit (ICU) beds, teaching hospital status, and ownership status. In addition, we included the following inpatient-level variables in our analysis: major diagnosis, age, sex, Charlson Comorbidity Index (CCI), type of insurance coverage, length of stay, and year. For each patient, the

major diagnosis was categorized by ICD-10 code as acute myocardial infarction, subsequent myocardial infarction, heart failure, subarachnoid hemorrhage, intracerebral hemorrhage, or cerebral infarction. The CCI was calculated such that comorbid conditions at hospitalization were weighted and scored for comorbid conditions, with additional points added to consider comorbidities that could affect outcomes of cerebral infarction inpatients. We considered the possibility that different types of insurance coverage could reflect the socioeconomic status of each inpatient. Thus, the types of insurance coverage consisted of NHI, defined as the general population, and beneficiaries of Medical Aid, defined as patients categorized as either low income or disabled, elderly, or receiving free inpatient and outpatient care with government funds.

### 2.3. Statistical analysis

We examined the distribution of each categorical variable by examining frequencies and percentages and performed  $\chi^2$  tests to investigate any significant associations between the selected variables and death within 30 days of hospitalization for either cerebrovascular or cardiovascular disease. We performed analysis of variance (ANOVA) to compare average values and standard deviations for continuous variables. These analyses were performed repeatedly for both hospital- and inpatient-level variables. Finally, we performed multiple logistic regression analysis using a generalized estimating equation (GEE), including both hospital- and inpatient-level variables, to examine the relationship between type of emergency medical institution and death within 30 days of hospitalization. Additional analyses were performed to investigate potential differences in associations according to disease type. All analyses were performed using SAS statistical software version 9.4. All calculated *P*-values were 2-sided and were considered significant at *P* < .05.

### 3. Results

A total of 111,741 hospitalizations were included in this study. Among the included cases, 6.5% resulted in death within 30 days of hospitalization. Table 2 shows the univariate associations of hospital- and inpatient-level variables used in this study. In terms of hospital-level variables, hospitalization at a regional emergency medical center was associated with decreased 30-day mortality compared to other types of emergency medical institutions (regional emergency medical center: 6.1%, localized emergency medical center: 6.3%, localized emergency medical agency: 6.9%). With respect to hospital staffing, hospitals with more doctors or nurses per bed were associated with decreased 30-day mortality. For inpatient-level variables, death within 30 days of hospitalization was more frequent in patients diagnosed with stroke, more specifically subarachnoid hemorrhage or intracerebral hemorrhage. In addition, medical-aid beneficiaries were more likely to die within 30 days of hospitalization compared to NHI beneficiaries.

Table 3 shows the results of the GEE model used to investigate the relationship between type of emergency medical institution and 30-day mortality after hospitalization due to cerebrovascular or cardiovascular disease. Among hospital-level variables, regional emergency medical centers and localized emergency medical centers were associated with a lower risk of 30-day mortality after hospitalization due to cardiovascular or cerebrovascular disease compared to localized emergency medical agencies (regional emergency medical center = OR: 0.768, 95% CI: 0.650–0.907; localized emergency medical center = OR: 0.853, 95% CI: 0.762–0.955; ref. = localized emergency medical agency). In terms of hospital staffing, patients at hospitals with a higher proportion of specialists or higher number of doctors per 10 beds had a lower risk of death within 30 days of hospitalization (per 10% increases proportion of specialists = OR: 0.922, 95% CI: 0.882–0.963; per 1 increases number of doctors per 10 beds = OR: 0.848, 95% CI: 0.793–0.906). In addition, older patients had a higher risk of 30-day mortality. With

respect to insurance coverage, medical-aid beneficiaries who were hospitalized were at greater risk of 30-day mortality than NHI beneficiaries (medical-aid = OR: 1.300, 95% CI: 1.182–1.430; ref. = NHI).

Finally, we performed sub-group analysis according to disease type in order to investigate the differences in relationships between type of emergency medical institutes and 30-day mortality after hospitalization. Hospitalization for cardiovascular disease treated at an emergency department of a higher level medical center was associated with a lower risk of 30-day mortality compared to localized emergency medical agencies. However, in terms of cerebrovascular disease, regional emergency medical centers and localized emergency medical centers exhibited an inverse trend in mortality, although the results were not statistically significant (Fig. 1). However, based on major diagnosis, 30-day mortality was more significant for cases of myocardial infarction and heart failure (Appendix Fig. 1).

### 4. Discussion

With the South Korean government's introduction of a program in the year 2000 to designate emergency medical institutes throughout the country as part of an effort to develop an effective management system for emergency patients, there has been an expectation for a substantial impact on emergency patient outcomes [12,15]. With the anticipated gradual expansion of the program across South Korea, there is now a need for objective evaluation of the effects of this program on emergency patient outcomes in order to establish evidence-based policy in the field of emergency medicine [16]. The results of the present study suggest that higher level emergency medical institutes are associated with better outcomes in emergency medical care compared to localized emergency medical agencies. We attributed this finding to the superior characteristics of higher level institutions in terms of hospital structure, equipment, and hospital staffing [17,18].

Previous studies have suggested that introduction of specific designations among existing emergency systems in South Korea could improve the overall management of emergency care from a national perspective. Indeed, increased access to medical resources has had a positive role in reducing mortality due to myocardial infarction, stroke, and accidental events [19]. Thus, the evaluation criteria for designating emergency medical institutes adequately reflect the quality of emergency medicine care. However, the benefits offered by regional accessibility might be short-term. From a long term prospective, there is an ongoing need to develop monitoring systems and tools to evaluate emergency systems beyond increasing regional accessibility. For example, the future is likely to bring a more efficient system for distributing emergency resources, which in turn is expected to reduce preventable deaths related to inequalities in the distribution of medical resources [20].

Due to the better quality of care at higher-level emergency medical institutes, the South Korean government currently provides additional reimbursement to these institutes, although there is no difference in reimbursement according to level of emergency center from the patient's perspective. Recently, however, there has been some debate between policy makers and healthcare providers regarding the additional reimbursement provided to various emergency medical institutes based on evaluation. Currently, the South Korean government provides additional reimbursement specifically for personnel expenses, although some emergency medicine specialists and hospital managers have claimed that these additional funds would be better used to provide better overall treatment processes rather than as a limited fee to support hospital staffing. Previous studies have shown that the optimal incentive payment for emergency medicine is care of acute diseases and can lead to significant increases in quality of care. In other words, additional payments are an effective method for improving acute care in emergency departments through motivation of hospital staffing [21,22]. Indeed, based on the better quality of care in superior level emergency medical institutes, health policy makers have continued to

**Table 2**  
Univariate correlations between death within 30 days after hospitalization.

Variables	Total		Alive		Death		P-value
	N	%	N	%	N	%	
<b>Hospital-level</b>							
Types of emergency medical institution							
Regional emergency medical center (N = 2)	8807	7.9	8271	93.9	536	6.1	0.0002
Localized emergency medical center (N = 40)	69,938	62.6	65,531	93.7	4407	6.3	
Localized emergency medical agency (N = 73)	32,996	29.5	30,710	93.1	2286	6.9	
Teaching status							
Non-teaching hospital (N = 84)	35,408	31.7	33,042	93.3	2366	6.7	0.0490
Teaching hospital (N = 31)	76,333	68.3	71,470	93.6	4863	6.4	
Ownership							
Public (N = 31)	11,976	10.7	11,211	93.6	765	6.4	0.7007
Private (N = 84)	99,765	89.3	93,301	93.5	6464	6.5	
<b>Patient-level</b>							
Major diagnosis							
Acute myocardial infarction	16,217	14.5	15,033	92.7	1184	7.3	< 0.0001
Subsequent myocardial infarction	383	0.3	365	95.3	18	4.7	
Heart failure	13,142	11.8	12,227	93.0	915	7.0	
Subarachnoid hemorrhage	6957	6.2	5841	84.0	1116	16.0	
Intracerebral hemorrhage	13,278	11.9	11,124	83.8	2154	16.2	
Cerebral infarction	61,764	55.3	59,922	97.0	1842	3.0	
Sex							
Male	64,772	58	61,576	95.1	3196	4.9	< 0.0001
Female	46,969	42	42,936	91.4	4033	8.6	
Charlson Co-morbidity Index							
0	6852	6.1	6449	94.1	403	5.9	< 0.0001
1	13,630	12.2	12,924	94.8	706	5.2	
2	19,389	17.4	18,393	94.9	996	5.1	
3+	71,870	64.3	66,746	92.9	5124	7.1	
Types of insurance coverage							
NHI	98,230	87.9	91,976	93.6	6254	6.4	< 0.0001
Medical-aid	13,511	12.1	12,536	92.8	975	7.2	
Year							
2010	18,195	16.3	16,929	93.0	1266	7.0	0.0318
2011	37,715	33.8	35,299	93.6	2416	6.4	
2012	37,630	33.7	35,229	93.6	2401	6.4	
2013	18,201	16.3	17,055	93.7	1146	6.3	
Variables	Total		Alive		Death		P-Value
	Mean	SD	Mean	SD	Mean	SD	
<b>Hospital-level</b>							
Proportion of specialists	2.3	± 1.2	2.4	± 1.2	2.3	± 1.2	0.0029
Number of doctors per 10 beds	137.7	± 107.0	138.0	± 107.2	132.9	± 104.2	< 0.0001
Proportion of RNs	87.3	± 10.2	87.3	± 10.2	86.8	± 10.5	< 0.0001
Number of nurses per 10 beds	5.6	± 2.0	5.6	± 2.0	5.5	± 2.0	0.0098
Number of beds	502.3	± 226.0	503	± 226.2	492.8	± 222.2	0.0002
Number of ER beds	23.7	± 10.5	23.8	± 10.5	23.4	± 10.5	0.0114
Number of ICU beds	35.3	± 22.2	35.4	± 22.3	35	± 21.6	0.2038
<b>Patient-level</b>							
Age (years)	63.4	± 11.9	63	± 11.9	65	± 12.1	< 0.0001
Length of stay (days)	17.1	± 27.0	17.7	± 27.7	7.8	± 6.7	< 0.0001
Total	111,741	100.0	104,512	93.5	7229	6.5	

review incentive payment systems for the field of emergency medicine while considering expansion of the emergency medical system.

Many countries have various alternatives to emergency care based on patient symptoms. For example, suitable care is often provided to specific patients through organized care, although this is not the case for emergency care in South Korea. While South Korea has continued to manage the quality of emergency care interventions for stroke and myocardial infarction through healthcare quality assessments, which were introduced to evaluate whether optimal coverage benefits were being provided to patients, there are currently few routine alternatives for optimal emergency care, especially those based on specific symptoms. Thus, there is a need for alternative ways to manage the quality of emergency care and to develop routine processes according to specific symptoms. We believe that such efforts could increase the level of emergency care in South Korea not only in terms of quality, but also quantity.

With respect to specific symptoms, we also evaluated associations

between 30-day mortality using sub-group analysis based on disease type. Interestingly, the association between reduced mortality and type of emergency medical institute was significant only for cardiovascular disease, not cerebrovascular disease. Although both cardiovascular disease and cerebrovascular disease are associated with significant mortality, diseases such as myocardial infarction encompass a higher risk of death during the early phase compared to cerebrovascular diseases. Thus, we attributed the increased survival of patients with cardiovascular disease observed in this study to improved accessibility based on designation of emergency care center. These findings also suggested that differences in the impact of superior level emergency institutes should be considered, especially when reviewing quality designations and payment systems. Such efforts will likely be helpful in establishing policies that provide optimal reimbursements for emergency medical care.

There were several strengths of the present study compared to previous efforts. First, we employed GEE models based on NHI claim

**Table 3**  
Factors associated with death within 30 days after hospitalization for cardiovascular and cerebrovascular diseases; derived from a GEE model.

Variables	Death within 30 days after hospitalization			P-Value
	OR	95% CI		
<b>Hospital-level</b>				
Types of emergency medical institution				
Regional emergency medical center	0.768	0.650	0.907	0.0019
Localized emergency medical center	0.853	0.762	0.955	0.0059
Localized emergency medical agency	1.000	–	–	–
Teaching status				
Non-teaching hospital	0.896	0.774	1.037	0.1403
Teaching hospital	1.000	–	–	–
Ownership				
Public	1.000	–	–	–
Private	0.922	0.838	1.016	0.0999
Proportion of specialists (per 10% increases)	0.922	0.882	0.963	0.0002
Number of doctors per 10 beds	0.848	0.793	0.906	< 0.0001
Proportion of RNs (per 10% increases)	1.002	0.998	1.006	0.2734
Number of nurses per 10 beds	0.978	0.956	1.002	0.0663
Number of beds (per 10 beds increases)	0.988	0.984	0.992	< 0.0001
Number of ER beds	1.002	0.997	1.008	0.3958
Number of ICU beds	1.011	1.006	1.016	< 0.0001
<b>Patient-level</b>				
Major diagnosis				
Acute myocardial infarction	2.342	2.123	2.582	< 0.0001
Subsequent myocardial infarction	1.426	0.818	2.487	0.2113
Heart failure	1.782	1.606	1.977	< 0.0001
Subarachnoid hemorrhage	15.594	13.920	17.470	< 0.0001
Intracerebral hemorrhage	14.216	12.992	15.557	< 0.0001
Cerebral infarction	1.000	–	–	–
Age (years)	1.031	1.027	1.036	< 0.0001
Sex				
Male	0.916	0.856	0.980	0.0107
Female	1.000	–	–	–
Charlson Co-morbidity Index				
0	1.000	–	–	–
1	0.942	0.797	1.113	0.4825
2	0.907	0.764	1.077	0.2665
3+	1.376	1.151	1.646	0.0005
Types of insurance coverage				
NHI	1.000	–	–	–
Medical-aid	1.300	1.182	1.430	< 0.0001
Length of stay (days)	0.912	0.907	0.916	< 0.0001
Year				
2010	1.000	–	–	–
2011	0.813	0.730	0.906	0.0002
2012	0.881	0.803	0.966	0.0068
2013	0.897	0.819	0.983	0.0205

data, which is useful for accurately evaluating emergency care in South Korea and for establishing evidence-based policy [23]. Thus, our results might prove useful in designing effective strategies for acute diseases treated through emergency medical institutes and paid for through an incentive payment system in South Korea. Next, to the best of our knowledge, this is the first study to specifically examine differences in patient outcomes, in particular death within 30 days of hospitalization, according to type of emergency medical institute for patients with cerebrovascular or cardiovascular disease following introduction of the South Korean program designating emergency medical institutes. Thus, our findings should provide useful evidence for establishing or reviewing policies related to emergency medicine in South Korea. A final

strength of this study was that we considered both patient and hospital variables such as hospital staffing, hospital structural characteristics, and patient information [24,25], which allowed us to more concisely analyze quality difference according to emergency medical institute type.

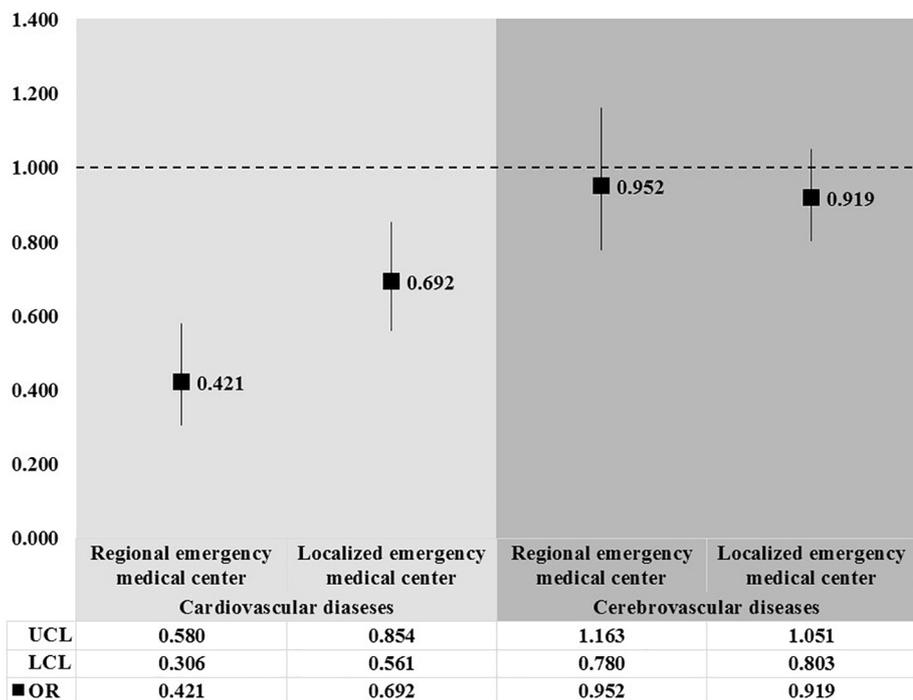
There were some limitations to our study. First, although there are approximately 1730 hospitals in South Korea, patient medical records were only available after 1989, corresponding to the introduction of the National Health Insurance Services (NHIS). Ideally, data from all hospitals in Korea should have been included in our study; however, there were some difficulties in accessing patient information due to issues such as personal privacy. As a result, the NHI claim data we analyzed included hospitalizations from only 115 hospitals. Thus, it might be difficult to generalize our results from this relatively small sample to the entire country of South Korea. Another limitation of the present study was that it consisted of hospitalization cases and not inpatient units. Thus, we could not differentiate between first admissions and recurrent hospitalizations, nor could we distinguish among individual patients using the available dataset. Cost comparisons and uninsured services were also not included in our results. Third, due to limitations of the dataset, we were unable to obtain medical history details including surgeries and specific procedures performed for cardiovascular or cerebrovascular diseases, even though these are important indicators of the severity and quality of disease. In addition, we could not consider who clinician provided treatment to patients due to same reasons although the clinician who provided treatment could be important factors in patient's outcomes related to CVD. Likewise, severity of individual inpatient cases through specific assessment tools for cardiovascular and cerebrovascular diseases was not performed, again due to limitations of the dataset. To address this limitation, we used CCI as an indicator of severity [26,27]. In addition, we had intended to include time to presentation to emergency care as part of the key information for dealing with survival of patients; however, due to the nature of claim data in South Korea, we were unable to use such information in this study. Finally, although the data is seemed to be old data, but many specialists still argue that the designations of emergency center have been attributed to improve accessibility of emergency patients in recent. During several years, South Korean emergency care policy has been experienced the several changes. Differently with governmental expectations, the number of emergency center was reduced than before (Y2017: 532 centers). Many emergency institution make an appeal in difficult about financial management under low health insurance cost of emergency care despite to designation of emergency centers with financial incentives. Thus, the criteria of designation is getting ease up on the aspect of size compared to past, and the variety of emergency care resources is added. Based on this system and its changes, the emergency outcomes would be expected to continuously be improved in the future.

### 5. Conclusions

Hospitals designated as superior level emergency medical institutes perform better in caring for emergency patients with cardiovascular or cerebrovascular diseases compared to lower level emergency medical institutes. In addition, performance according to type of emergency medical institutes differed according to the specific type of disease. Health policy makers could benefit from the results of our study in designing an optimal incentive payment system for the field of emergency medicine.

### Authors' contributions

KTH and Seung Ju Kim designed the study, collected data, performed statistical analyses, and wrote the manuscript. KTH, Seung Ju Kim, MIH, ECP, and Sun Jung Kim contributed to the discussion and reviewed and edited the manuscript. Sun Jung Kim is the guarantor of



**Fig. 1.** Odds ratio for types of emergency medical institutes associated with risk of 30 day mortality, stratified by types of diseases.

\* Localized emergency medical agency was the reference group.

† the OR is marked as square point; and results were statistically significant if each bar as marked to SD did not reached the cutoff line at 1.00.

this work and as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analyses. The text in this document has been checked by professional editors who are native English speakers. All authors have read and approved the final manuscript.

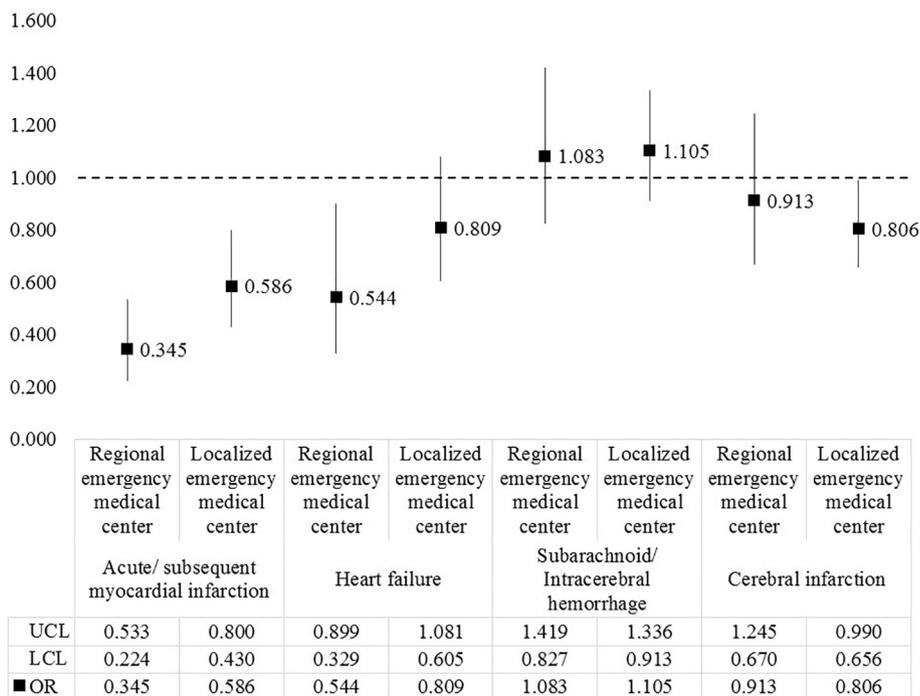
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**Conflict of interests**

The authors declare no competing interests.

**Appendix A. Appendix**



**Appendix Fig. 1.**

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