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Incidence of Adult In-Hospital Cardiac Arrest Using National Representative Patient Sample in Korea

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Objectives: This study analyzed the incidence and characteristics of in-hospital cardiac arrest (IHCA) in Korea based on a sample group of patients that is representative of the population. **Methods:** The incidence of IHCA in adults was extracted from HIRA-NIS-2009, a sample of all patients using medical services in Korea. IHCA patients were analyzed according to gender, age, type of medical institute, and classification under the 6th revision of the Korean Standard Classification of Diseases (KCD-6). In addition, to assess the differences arising from the size of medical institutes, the IHCA incidence was analyzed in relation to the number of inpatient beds. **Results:** Based on the sample data, the total incidence of IHCA in Korea was found to be 2.46 per 1,000 admissions (95% confidence interval [CI], 2.37–2.55). A higher incidence was found among men at 3.18 (95% CI, 3.03–3.33), compared to women at 1.84 (95% CI, 1.74–1.94). The incidence of IHCA was also higher in hospitals that had more than 600 inpatients beds at 5.40 (95% CI, 5.16–5.66) in comparison to those that had less than 600 inpatients beds at 4.09 (95% CI, 3.76–4.36) ($p < 0.001$). By primary disease, the incidence was the highest for infectious diseases. **Conclusions:** We demonstrated that the IHCA incidence based on gender, age, diagnostic group, and number of beds could be analyzed using the insurance claim data from a national representative sample.

Keywords: In-hospital cardiac arrest, Cardiopulmonary resuscitation, Epidemiology, National health insurance, Claim analysis

I. Introduction

In-hospital cardiac arrest (IHCA) is a major cause of death among patients [1,2]. Extensive research has been performed regarding out-of-hospital cardiac arrest (OHCA) [3,4], and efforts to improve prognosis have led to a dramatic increase in survival [5]. However, IHCA has not been widely studied, and even basic data, such as incidence, has only been covered in a few reports. Previously, the IHCA incidence of elderly patients was analyzed using Medicare data [6,7], and that of adults was based on the United Kingdom National Cardiac Arrest Audit database [8]. Another study compared the incidence rates of IHCA and OHCA in specific hospitals in the United Kingdom [9]. The IHCA incidence rates in Australia

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and New Zealand were found [10]. In Korea, research has been limited to a small number of hospitals [11,12]. To date, the incidence of IHCA has not been studied using a national representative sample.

From 1977, Korea has started to partially adopt medical insurance and gradually widened the limit of applications. In 2000, medical insurance was integrated into the National Health Insurance Service (NHIS). All people who resided in Korea were provided with a fee-for-service system by a single healthcare agent, the NHIS. Every detail about the medical treatment, medication, and diagnosis of all patients was coded, and then input to the Health Insurance Review and Assessment Services (HIRA) [13-15]. In May 2012, the National In-patients Sample (NIS) data of about 13% of the in-patients and 1% of outpatients with national representativeness from the year 2009, named HIRA-NIS-2009, was provided [16,17]. HIRA-NIS-2009 was extracted by stratified and systematic sampling methods according to gender and age group among all patients who used medical services in 2009. It included every detail of the medical treatments and medications of the sample patients. The representativeness of the HIRA-NIS-2009 was verified by HIRA and five other medical associations in Korea [17].

Before national insurance claims were accessed, a pilot study was performed to check whether the IHCA incidence could be obtained by analyzing HIRA-NIS-2009, which was verified to have national representativeness. This study is the first to examine IHCA incidence among hospitalized patients in Korea, and it is the only one of its kind involving a national representative sample.

II. Methods

1. National Patient Sample 2009–001

HIRA-NIS-2009 consists of five tables, each with a unique key, called a KEYCODE. TABLE20 provides basic information on patients (unique identification number of HIRA-NIS-2009, age, gender, institution number, department, total costs, KEYCODE, etc.), while TABLE30 contains detailed medical claim data (procedure, surgery, medical supply, or drug identification code, price, counts, KEYCODE, etc.). TABLE40 gives the disease code, while TABLE53 contains details of drug prescriptions. Finally, TABLE YKIHO is the table for institutional information (institution number, classification code of the institute, inpatient bed numbers of the institute, computerized tomography availability, magnetic resonance imaging availability, etc.).

2. Case Definition

1) Research period

HIRA-NIS-2009 contains about 13% of the in-patient data and 1% of outpatient data of all patients who used medical services from January1, 2009 to December 31, 2009.

2) Classification of medical institutes

In the classification of medical institutes, dental hospitals and oriental hospitals were excluded. The analysis focused on tertiary-care hospitals, secondary-care hospitals, hospitals, geriatric hospitals, and clinics [18,19].

3) Data extraction procedures

(1) IHCA case detection

To pick out IHCA patients from HIRA-NPS-2009-001, key values corresponding to claim codes for cardiopulmonary resuscitation (CPR) were extracted from TABLE30. The claim codes include M5873, M5874, M5875, M5876, and M5877.

(2) In-patient case detection

In-patient cases of tertiary-care hospitals, secondary-care hospitals, hospitals, geriatric hospitals, and clinics was extracted from TABLE20. From this procedure, basic patient information was obtained from TABLE20 for the identified IHCA patients.

(3) Joining of in-patient cases and IHCA cases

Cases extracted from TABLE20 and TABLE30 through the above two steps were joined and IHCA cases were finally extracted.

(4) Exclusion of non-IHCA cases

Since Korea's health insurance considers hospitalization as more than 6 hours since admission to the emergency departments, OHCA patients who did not recover or died shortly after recovery were mostly excluded. This would minimize confusion over OHCA. However, some may have been included as the proportion of patients admitted after surviving OHCA is approximately 5.7% [20].

From TABLE30, cases with very few claim codes other than those for CPR were excluded from the count as they were unlikely among hospitalized patients.

(5) Processing of multiple IHCA case

For patients who have experienced IHCA multiple times, multiple inputs of claim codes for CPR during the same hospitalization were counted as one case. Multiple IHCAs dur-

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ing a subsequent hospitalization were also counted as one case.

4) Data analysis

Among the cases classified as IHCA, the patients were analyzed according to gender, age, type of medical institute, and primary diagnosis classified under the 6th revision of the Korean Standard Classification of Diseases (KCD-6). In addition, to assess the differences arising from the size of medical institutes, the IHCA incidence was analyzed in relation to the number of inpatient beds.

Using the disease codes of KCD-6, the frequency of diagnosis was analyzed for patients with prescriptions for CPR. To determine differences in IHCA incidence arising from the number of inpatient beds, tertiary and secondary-care hospitals were categorized into hospitals with more than 600 beds and those with less than 600. The number of hospitalizations and IHCA incidence were then compared. There were only two tertiary hospitals with less than 600 beds, and secondary-care hospitals with more than 600 beds were considered as being closer to tertiary hospitals.

Fischer exact test was employed, and a *p*-value less than 0.05 was regarded as statistically significant. All of the calculations were performed in SAS ver. 9.4 (SAS Institute, Cary, NC, USA).

III. Results

In the sample data of HIRA-NIS-2009-001, there were 3,393 cases with insurance claim codes corresponding to CPR (M5873–5877) among the 1,212,982 inpatients. Out of these cases, 2,978 were finally considered to be IHCA patients.

Based on the sample data, the total incidence of IHCA in Korea was found to be 2.46 per 1,000 admissions (95% confidence interval [CI], 2.37–2.55). A higher incidence was found among men at 3.18 (95% CI, 3.03–3.33) compared to women at 1.84 (95% CI, 1.74–1.94). By age group, the highest incidence was observed among patients aged 80–89 at

Table 1. In-hospital cardiac arrest (IHCA) cases classified according to gender and age of patients

Age (yr)	Male			Female			Total		
	Total	IHCA	Incidence[a]	Total	IHCA	Incidence[a]	Total	IHCA	Incidence[a]
20–29	38,641	26	0.67	60,783	16	0.26	99,424	42	0.42
30–39	63,140	73	1.16	91,785	39	0.42	154,925	112	0.72
40–49	108,357	186	1.72	95,345	87	0.91	203,702	273	1.34
50–59	119,997	351	2.93	97,909	141	1.44	217,906	492	2.26
60–69	107,069	401	3.75	96,217	213	2.21	203,286	614	3.02
70–79	84,456	469	5.55	124,279	337	2.71	208,735	806	3.86
80–89	31,469	237	7.53	78,297	333	4.25	109,766	570	5.19
>90	3,145	28	8.90	12,093	41	3.39	15,238	69	4.53
Total	556,274	1,771	3.18	656,708	1,207	1.84	1,212,982	2,978	2.46

[a]Incidence /1,000 admission.

Table 2. In-hospital cardiac arrest (IHCA) cases classified according to the class of hospital

Class of hospital	Male			Female			Total		
	Admission	IHCA	Incidence[a]	Admission	IHCA	Incidence[a]	Admission	IHCA	Incidence[a]
Tertiary hospital	104,070	669	6.43	103,052	402	3.90	207,122	1,071	5.17
Secondary hospital	142,159	820	5.77	143,086	538	3.76	285,245	1,358	4.76
Hospital	179,836	194	1.08	181,524	164	0.90	361,360	358	0.99
Geriatric hospital	54,601	82	1.50	101,747	103	1.01	156,348	185	1.18
Clinic	75,344	6	0.08	127,048	0	0.00	202,392	6	0.03
Total	556,010	1,771	3.19	656,457	1,207	1.84	1,212,467	2,978	2.46

[a]Incidence /1,000 admission.

Table 3. In-hospital cardiac arrest (IHCA) cases classified according to the KCD-6

Code	Diagnostic group	Male			Female			Total		
		Admission	IHCA	Incidence[a]	Admission	IHCA	Incidence[a]	Admission	IHCA	Incidence[a]
A00-B99	Certain infectious and parasitic diseases	10,791	141	13.07	14,043	129	9.19	24,834	270	10.87
C00-D48	Neoplasm	75,914	308	4.06	79,441	155	1.95	155,355	463	2.98
D50-D89	Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	1,124	10	8.90	1,888	5	2.65	3,012	15	4.98
E00-E90	Endocrine, nutritional and metabolic diseases	16,745	32	1.91	16,638	20	1.20	33,383	52	1.56
F00-F99	Mental and behavioral disorders	94,152	10	0.11	72,650	9	0.12	166,802	19	0.11
G00-G99	Diseases of the nervous system	21,347	37	1.73	23,453	31	1.32	44,800	68	1.52
H00-H59	Diseases of the eye and adnexa	20,123	0	0.00	31,281	0	0.00	51,404	0	0.00
H60-H95	Diseases of the ear and mastoid process	3,238	0	0.00	5,871	0	0.00	9,109	0	0.00
I00-I99	Diseases of the circulatory system	78,647	502	6.38	87,256	377	4.32	165,903	879	5.30
J00-J99	Diseases of the respiratory system	36,830	302	8.20	32,458	200	6.16	69,288	502	7.25
K00-K93	Diseases of the digestive system	52,814	141	2.67	35,279	61	1.73	88,093	202	2.29
L00-L99	Diseases of the skin	5,082	2	0.39	3,748	2	0.53	8,830	4	0.45
M00-M99	Diseases of the musculoskeletal system and connective tissue	42,975	15	0.35	68,171	14	0.21	111,146	29	0.26
N00-N99	Diseases of the genitourinary system	17,283	88	5.09	35,654	92	2.58	52,937	180	3.40
O00-O99	Pregnancy, childbirth and the puerperium	1	0	0.00	67,422	5	0.07	67,423	5	0.07
P00-P96	Certain conditions originating in the perinatal period	7	0	0.00	35	0	0.00	42	0	0.00
Q00-Q99	Developmental anomalies	646	0	0.00	949	1	1.05	1,595	1	0.63
R00-R99	Symptoms, signs and abnormal clinical and laboratory findings	7,130	43	6.03	8,417	26	3.09	15,547	69	4.44
S00-T98	Injury, poisoning and certain other consequences of external causes	69,425	137	1.97	68,875	77	1.12	138,300	214	1.55
U00-U99	Codes for special purposes	2	0	0.00	1	0	0.00	3	0	0.00
V01-Y98	External causes of morbidity and mortality	3	0	0.00	2	0	0.00	5	0	0.00
Z00-Z99	Factors influencing health status and contact with health services	1,990	3	1.51	3,172	3	0.95	5,162	6	1.16
Unclassified		5	0	0.00	4	0	0.00	9	0	0.00
		556,274	1,771	3.18	656,708	1,207	1.84	1,212,982	2,978	2.46

KCD-6: the 6th revision of the Korean standard classification of diseases.

[a]incidence /1,000 admission.

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Table 4. In-hospital cardiac arrest (IHCA) cases classified according to the class of hospital and the bed number of the institute

Bed number of institute	Tertiary hospital				Secondary hospital				Hospital				Geriatric hospital				Clinic			
	N[a]	Admission	IHCA	Incidence	N[a]	Admission	IHCA	Incidence	N[a]	Admission	IHCA	Incidence	N[a]	Admission	IHCA	Incidence	N[a]	Admission	IHCA	Incidence
0–100	-	-	-	-	-	-	-	-	479	65,628	24	0.37	362	31,989	50	1.56	26,794	202,392	6	0.03
101–200	-	-	-	-	32	11,256	38	3.38	546	131,807	193	1.46	373	76,492	84	1.10	-	-	-	-
201–300	-	-	-	-	80	45,158	154	3.41	186	74,538	94	1.26	95	34,797	39	1.12	-	-	-	-
301–400	-	-	-	-	53	39,702	169	4.26	75	41,650	28	0.67	16	9,549	8	0.84	-	-	-	-
401–500	1	1,314	2	1.52	28	30,224	129	4.27	20	15,738	13	0.83	3	2,525	3	1.19	-	-	-	-
501–600	1	1,861	17	9.13	31	41,435	183	4.42	20	13,346	6	0.45	1	996	1	1.00	-	-	-	-
601–700	4	10,370	54	5.21	26	46,990	242	5.15	9	9,637	-	0.00	-	-	-	-	-	-	-	-
701–800	1	2,930	16	5.46	13	31,864	210	6.59	0	-	-	-	-	-	-	-	-	-	-	-
801–900	7	22,938	124	5.41	4	10,946	72	6.58	2	3,745	-	0.00	-	-	-	-	-	-	-	-
901–1,000	6	22,241	117	5.26	6	20,812	127	6.10	1	1,448	-	0.00	-	-	-	-	-	-	-	-
>1,000	24	145,468	741	5.09	2	6,858	34	4.96	3	3,823	-	0.00	-	-	-	-	-	-	-	-
Total	44	207,122	1,071	5.17	275	285,245	1,358	4.76	1,341	361,360	358	0.99	850	156,348	185	1.18	26,794	202,392	6	0.03

[a]Total number of institutes of Korea.

Table 5. In-hospital cardiac arrest (IHCA) classified according to the group below 600 beds and more than 600 beds in tertiary and secondary hospitals

Beds	Admission	IHCA	Incidence
≤600	170,950	692	4.05
>600	321,417	1,737	5.40
Total	492,367	2,429	4.93

$p < 0.001$.

5.19. Men aged 90 and above had the highest incidence of 8.90, while women aged 80–89 recorded 4.25 (Table 1).

By medical institute, the incidence of IHCA in tertiary-care hospitals was the highest at 5.17, followed by secondary-care hospitals at 4.76, geriatric hospitals at 1.18, hospitals at 0.99, and clinics at 0.03 (Table 2).

Patients diagnosed as suffering from certain infectious and parasitic diseases (A00–B99) as defined in KCD-6 had the highest incidence of 10.87. This was followed by diseases of the respiratory system (J00–J99) at 7.25, and diseases of the circulatory system (I00–I99) at 5.30 (Table 3).

Excluding hospitals with a low incidence of IHCA, long-term-care hospitals and clinics, tertiary and secondary-care hospitals combined were categorized into hospitals with more than 600 beds and those with less than 600. The number of admissions and IHCA incidence were then compared. The incidence was 4.09 (95% CI, 3.76–4.36) for hospitals with less than 600 beds, and 5.40 (95% CI, 5.16–5.66) for those with more than 600 beds, indicating a significant difference in IHCA incidence between the two hospital groups ($p < 0.001$) (Tables 4, 5).

IV. Discussion

There are very few countries with a national insurance policy provided by a single insurer. Korea has a special system in which medical claims are made to the NHIS based on the resident registration number of each citizen [13,14]. The health insurance claim data contains extensive information on the use of medical services, but it may be distorted in order to receive more compensation [15]. The scale of data also makes it difficult to identify the desired clinical data for analysis. HIRA-NIS-2009, verified as having national representativeness, was obtained from the health insurance claims of 2009 [17-19], and it is being used in some studies [15]. Based on HIRA-NIS-2009, this study found that the incidence of IHCA was 2.46 per 1,000 admissions. Since most countries do not have data on the use of medical services by all citizens, research on the IHCA incidence has been

mostly limited to certain age groups or a few hospitals. Such studies have been carried out based on data provided by the Medicare Provider Analysis and Review (MedPAR) [7], the United States National Registry of Cardiopulmonary Resuscitation (NRCPR) [6], and the United Kingdom National Cardiac Arrest Audit (NCAA) [8].

Recently, an NCAA audit report found that there were 1.6 IHCA patients per 1,000 admissions in 144 hospitals [8]. This is significantly different from the incidence reported in the present study. In a review on hospitals in Australia and New Zealand, the IHCA incidence ranged from 1.31–6.11 per 1,000 admissions in four population studies, and 0.58–4.59 in 16 cohort studies from 1964 to 2014 [10]. This study showed a difference in IHCA between hospitals with a rapid response system and those without [10].

The incidence reported by the study based on MedPAR insurance claims of patients aged 65 and older was 2.73 per 1,000 admissions, which is similar to the results of this study [7]. The study based on NRCPR found 14,720 cases of IHCA in a year among 287 hospitals in the United States, or 0.175 cases/bed [6].

Age was found to be an important variable in IHCA incidence. The higher the age, the greater the incidence of IHCA. The higher incidence in the 80–89 age group compared to the 90 or older age group can be traced to other factors, such as severity of disease and DNAR (do not attempt resuscitation) orders.

Previous research found gender did not have any significant influence on IHCA incidence [6,7]. However, in this study, a higher incidence was found among men at 3.18 per 1,000 admissions (59.47%), compared to women at 1.84. This is similar to the results of a Korea-based study on OHCA that excluded cases associated with non-cardiac reasons, where men accounted for 58.9% and women for 41.1% [20]. In the NCAA report, men accounted for 57.2% of all IHCA cases, which is consistent with the findings of the present study [8]. The variation in results can be traced to differences in average life span, gender differences in use of medical services, and causes of cardiac arrest.

The incidence of IHCA also differed according to the size of hospitals, or more specifically, the number of inpatient beds. A US study based on NRCPR data reported a lower incidence of cardiac arrest in hospitals with more than 500 beds [6], whereas this study found a higher IHCA incidence in hospitals with more than 600 beds. This reflects Koreans' preference for major hospitals, which have more inpatient beds, when seeking treatment for diseases with high severity.

The incidence of IHCA in tertiary-care hospitals and secondary-care hospitals was 4 to 5 times the incidence in hospitals and long-term-care hospitals. This can be explained by the higher proportion of critical patients among the hospitalized patients in tertiary-care hospitals and secondary-care hospitals. The slightly higher incidence in long-term-care hospitals over hospitals is due to patients being older and at the end stage of life.

Further research is needed because the differences may have resulted from the hospital's response to cardiac arrest, the medical staff's level of training on basic and advanced life support, and the availability of the medical emergency teams (MET) and rapid response teams (RRT) [21-23].

In previous research, the primary diseases suffered by patients before cardiac arrest were myocardial infarction (36%), respiratory failure (35%), heart failure (34%), arrhythmia (29%), renal failure (29%), diabetes (28%), and infection (24%) [6]. More patients were admitted for conditions associated with internal medicine than for external injuries or surgical problems [7]. In this study, the primary diseases of IHCA were in the order of infection, respiratory, and circulatory, indicating that patients had experienced similar primary diseases before IHCA. The United States has a smaller proportion of IHCA patients with infections because CPR is not required for progressive septic shock-induced cardiac arrest under the guidelines of the American Heart Association [24], whereas it is frequently performed in Korea.

With more than half of OHCA patients suffering from circulatory diseases [25], it is evident that different approaches are needed for IHCA and OHCA. In a study aimed at improving the survival rate of IHCA, which was limited to a single domestic hospital, some possible solutions mentioned were training in basic and advanced life support, CPR by experienced medical staff, and MET utilization [12].

This study, based on health insurance claim data, had the following limitations: first, the health insurance claims only contained coded titles of diagnosis, procedures, surgery, and drug administration, but not the detailed responses and test results. An in-depth examination of the causes behind cardiac arrest was not possible. Second, the condition of patients at the time of cardiac arrest could not be determined without access to medical records. Third, the state of patients at the time of transfer, return, and discharge was not available as health insurance claim data only classified treatment results as continued, transfer, return, death, discharge, or other. Analysis using the Cerebral Performance Categories Scale [26,27], which is needed in the prognosis evaluation of IHCA patients, could not be performed. Fourth, patients and hospitals were anonymous. Analysis according to seasonal/

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annual/regional characteristics and institutional characteristics could not be performed.

In conclusion, using health insurance claim data of HIRA-NIS-2009, this study found an IHCA incidence of 2.46 per 1,000 admissions among adults hospitalized in 2009. The results of this study, based on data having national representativeness, are expected to serve as a valuable reference in the multi-faceted analysis of IHCA. In addition, various indicators, such as MET, RRT system enhancement, IHCA prevention, and improvement of survival rate can be derived by comparing the total incidence of IHCA and the incidence at each hospital.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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We used the HIRA-NIS-2009 data that the Health Insurance Review and Assessment Service (HIRA) provided but declare that the results do not in any way reflect the positions of either HIRA or the Ministry of Health and Welfare of the Republic of Korea.

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