

Comparative Study of Characteristics among Severe Trauma Patients based on Health Insurance Systems

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Abstract

This study aimed to analyze the utilization patterns of emergency departments (EDs) by patients with severe trauma, using the health insurance system to understand their characteristics. The study utilized data from the 'Community-based Severe Trauma Surveillance' survey conducted from January 1, 2018, to December 31, 2019. The research findings showed significant differences in the degree of disability after injury and implementation of treatments (surgery, trauma intervention, and blood transfusion) based on the type of medical insurance ($p < .001$). Additionally, statistically significant differences were observed between pre- and post-injury disability levels based on the type of medical insurance ($p < .001$). In particular, cases of severe disabilities that could require rehabilitation were frequently observed with auto insurance and workers' compensation insurance, indicating the need for further research. From various perspectives, the health insurance system, which plays a vital role in ensuring the well-being of the population, should be continuously evaluated, and specific improvement measures should be proposed.

Index Terms: Car insurance, Emergency medical system, Health insurance system, Severe trauma, Workers' compensation insurance

1. INTRODUCTION

The national health insurance system in South Korea is provided by the government to protect citizens' health rights and includes health insurance, medical aid, and workers' compensation insurance [1]. The scope of the system is defined by the Constitution, Basic Social Security Act, and National Health Insurance Act, and it is managed under the responsibility of the state. Over time, laws have been revised and applied to establish a new system and framework that meets society's needs.

The insurance premiums for the operation of the health insurance system are levied differentially based on income

levels. Low-income households facing financial difficulties receive medical services through the medical aid system. However, when examining health insurance coverage rates by income group, it is evident that the coverage rate for low-income groups is lower than that for other income groups [2].

According to statistics from the Ministry of Health and Welfare, the coverage rate for the top 50 diseases in 2018 was 78.9%, indicating that not all individuals received 100% coverage. This has led to increased enrollment in private health insurance among the population. In fact, the 2018 Korean Medical Panel Basic Analysis Report indicated a private health insurance enrollment rate of 77.7%. However,

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low-income households face financial difficulties in enrolling in private health insurance. Previous studies have also reported that the private health insurance enrollment rate is higher among individuals with stable economic activities and large total assets [3,4].

This phenomenon can create challenges in accessing non-insured medical services, such as treatments and procedures, and can lead to disparities and gaps in healthcare utilization among different income groups. According to the Korean Medical Channel Basic Analysis Report of 2019, 21.2% of respondents reported not receiving hospital treatments or tests for economic reasons, and it was estimated that 4.06% of households fell into the category of catastrophic health expenditures [5]. These issues can occur frequently, not only for individuals with chronic illnesses or disabilities but also for those who experience severe trauma due to unexpected accidents. Severe trauma involves not only one-time accidents, but also various tests, treatments, prolonged hospitalization, and rehabilitation processes, which can impose significant economic burdens. While there have been many studies on the financial burden of medical expenses in low-income households, there is a lack of systematic investigations on emergency room visits by patients with severe trauma.

Therefore, this study aimed to analyze the utilization patterns of emergency departments by patients with severe trauma using the National Health Insurance system to understand their characteristics and identify areas for improvement in the future.

II. METHODS

A. Research Design

This study utilized data from the “Community-based Severe Trauma Surveillance” survey conducted between January 1, 2018 and December 31, 2019. The data were collected by the Korea Centers for Disease Control and Prevention (KCDC). The data included mandatory medical records of patients with severe injuries and multiple traumas.

B. A Subject of study

The study included patients with severe injuries and multiple traumas who were transported by 119 ambulance teams to emergency medical institutions from January 1, 2018 to December 31, 2019. The inclusion criterion was cases in which the patients' medical records were verified through mandatory record surveys. Individuals with multiple injuries but not classified as having severe trauma, patients with abnormal revised trauma scores (RTSs) due to simple intoxication or non-traumatic causes as assessed by the ambulance team, and cases with missing relevant information were

excluded.

The RTS evaluates patients based on three criteria: blood pressure, respiration, and the Glasgow coma scale (GCS), and assigns a corresponding score (1). It is used to assess the severity of a patient's injury and predict the likelihood of survival. A lower RTS indicates greater injury severity and a higher mortality risk. Therefore, RTS is commonly utilized in various emergency situations, including initial assessments and patient prioritization.

The study population consisted of a total of 42,027 severe trauma patients in 2018 and 50,054 severe trauma patients in 2019, whose data were used for analysis.

$$RTS = 0.9368. \{GCS\} + 0.7326. \{SBP\} + 0.2908. \{RR\} \quad (1)$$

SBP, systolic blood pressure

RR, respiratory rate

C. A Research Tool

The control variables in this study included sex, age, insurance type, accident location, medical institution visited by the patient, and mechanism of injury. The type of medical insurance was treated as an independent variable, whereas the dependent variables included post-injury disability (measured using the Glasgow outcome scale, GOS) and treatment implementation, such as surgery, interventional radiology, and blood transfusion. The types of medical insurance included National Health Insurance, automobile insurance, industrial accident insurance, medical aid type 1, medical aid type 2, general insurance, other insurance, and unknown insurance. Disability codes (scores) were assigned and compared to assess pre- and postinjury disabilities according to the type of medical insurance. Disability codes were set as follows: 1, no disability mentioned; 2, moderate disability; 3, severe disability; 4, vegetative state; 5, death. Unknown cases were excluded. In terms of treatment outcomes, patients were categorized based on whether they underwent surgery, interventional radiology, or blood transfusion.

D. Data Analysis

The data collected for this study were analyzed using Statistical Package for the Social Sciences WIN 25.0. A frequency analysis was conducted to examine the general characteristics of the study participants. Chi-square tests for independence were performed to investigate the relationship between post-injury disability and treatment (surgery, interventional radiology, or blood transfusion) according to the type of medical insurance. Paired-sample t-tests were conducted to compare the pre- and post-injury disability levels according to the type of medical insurance. For all statistical analyses, a level of $p < .05$ was considered statistically significant.

III. RESULTS

A. General Characteristics

The general characteristics of the study participants (n=92,076) were as follows: 63.1% were male and 36.9% were female, indicating a relatively higher proportion of males. The mean age was 51.1 years, with males having an average age of 50.2 years and females having an average age of 52.6 years. The most common type of medical insurance was the national health insurance (61.9%), followed by automobile insurance (24.0%). Regarding accident location, the highest proportion was at home (31.0%), followed by on roads (30.9%). In terms of the type of medical institution, regional emergency medical centers (42.0%) were the most common, followed by regional trauma centers (21.2%). The most common mechanisms of injury were transportation accidents (33.1%), falls or slips (30.35%), and contact with chemicals or other substances (18.1%).

B. Relationship between Injury Outcome and Type of Medical Insurance

According to the chi-square test for independence, there was a significant relation between the injury outcomes and type of medical insurance. General insurance (37.1%) and automobile insurance (16.6%) accounted for the highest proportions of fatalities. Regarding vegetative state outcomes, general insurance (1%) and national health insurance (1%) had the highest proportions. Severe disability outcomes were higher for occupational injury insurance (11.2%), other insurance (10.9%), and automobile insurance (8.9%). Moderate disability outcomes were most frequent in patients covered by occupational injury insurance (33.1%), other insurance (20.5%), automobile insurance (18.0%), and medical aid type 1 (15.4%) (Table 2).

Within the National Health Insurance category, relatively high proportions were observed for recovery (64.6%) and vegetative states (1.0%). Automobile insurance was associated with a higher proportion of patients with moderate disabilities (18.0%), fatalities (16.6%), and severe disabilities (8.9%). Occupational injury insurance had higher proportions of moderate disability (33.1%), severe disability (11.2%), and vegetative state (1.0%). Medical aid types 1 and 2 had higher proportions of recovery (64.9% and 75.8%, respectively). General insurance was associated with a higher proportion of fatalities (37.1%) (Table 2).

C. Relationship between Treatment (Surgery, Interventional Radiology, Blood Transfusion) and Type of Medical Insurance

According to the chi-squared test for independence, there were significant differences in the occurrence of surgery,

Table 1. General Characteristics (N=92,076)

General characteristics		N	%
Gender	Male	58110	63.1
	Female	33966	36.9
Age	0-9	4691	5.1
	10-19	4314	4.7
	20-29	8833	9.6
	30-39	8767	9.5
	40-49	11966	13.0
	50-59	17833	19.4
	60-69	15364	16.7
	70<	20308	22.1
Medical insurance type	National health insurance	57018	61.9
	Car insurance	22104	24.0
	Industrial accident insurance	1924	2.1
	Medical benefit (1)	5237	5.7
	Medical benefit (2)	1103	1.2
	General insurance	3904	4.2
	Etc.	258	.3
	Unknown	528	.6
Location of accident	Home	28547	31.0
	Residential facilities	1077	1.2
	Medical facility	477	.5
	Educational facilities	485	.5
	Sports facilities	148	.2
	Road	28442	30.9
	Of-road traffic area	3998	4.3
	Factories, industries, construction facilities	3404	3.7
	Farms, other primary industries	1391	1.5
	Entertainment, culture, public facilities	1220	1.3
	Commercial facility	4343	4.7
	Outdoor, sea, river	3153	3.4
	Etc.	7192	7.8
	Unknown	8199	8.9
Medical facilities	Regional trauma center	19531	21.2
	Regional emergency medical center	17403	18.9
	Local emergency medical center	38691	42.0
	Local emergency medical agency	16451	17.9
Mechanism of injury	Transport accident	30474	33.1
	Fall and slip	27906	30.3
	Blunt injury	4422	4.8
	Penetrating injury	2803	3.0
	Machine	1137	1.2
	Temperature damage	1320	1.4
	Choking, strangulation	3094	3.4
	Airway obstruction by foreign substances	1015	1.1
	Drowning	1201	1.3
	Contact with chemicals or other substances	16675	18.1
	Overuse of the body	287	.3
	Etc.	370	.4
	Unknown	1372	1.5

Table 2. Relationship between the degree of disability after injury according to the type of medical insurance

Variable	Post-damage score (N / %)						×2
	Expired	vegetative state	Severe disability	Moderate disability	Recovery status	Unknown	
Type of medical insurance	National health insurance	8345 (14.6)	554 (1.0)	396 (6.9)	7286 (12.8)	36828 (64.6)	44 (0.1)
	Car insurance	3666 (16.6)	141 (0.6)	1965 (8.9)	3971 (18.0)	12348 (55.9)	13 (0.1)
	Industrial accident insurance	273 (14.2)	20 (1.0)	215 (11.2)	636 (33.1)	778 (40.4)	2 (0.1)
	Medical benefit (1)	621 (11.9)	30 (0.6)	380 (7.3)	809 (15.4)	3397 (64.9)	0 (0.0)
	Medical benefit (2)	80 (7.3)	7 (0.6)	59 (5.3)	119 (10.8)	836 (75.8)	2 (0.2)
	General insurance	1449 (37.1)	40 (1.0)	206 (5.3)	390 (10.0)	1818 (46.6)	1 (0.0)
	Etc.	32 (12.4)	4 (1.6)	28 (10.9)	53 (20.5)	141 (54.7)	0 (0.0)
	Unknown	207 (39.2)	9 (1.7)	36 (6.8)	60 (11.4)	212 (40.2)	4 (0.8)
	Total	14673 (15.9)	805 (0.9)	6850 (7.4)	13324 (14.5)	56358 (61.2)	66 (0.1)

*** $p < .001$ **Table 3.** Relationship between medical treatment (surgery, trauma embolization, blood transfusion) according to the type of medical insurance

Variable		Surgery		Trauma embolization		Blood transfusion	
		No	Yes	No	Yes	No	Yes
Type of medical insurance	National health insurance	50548 (88.7)	6470 (11.3)	56613 (99.3)	405 (0.7)	53460 (93.8)	3558 (6.2)
	Car insurance	17339 (78.4)	476 5(21.6)	21650 (97.9)	454 (2.1)	18874 (85.4)	3230 (14.6)
	Industrial accident insurance	873 (45.4)	1051 (54.6)	1831 (95.2)	93 (4.8)	1436 (74.6)	488 (25.4)
	Medical benefit (1)	4686 (89.5)	551 (10.5)	5208 (99.4)	29 (0.6)	4946 (94.4)	291 (5.6)
	Medical benefit (2)	979 (88.8)	124 (11.2)	1087 (98.5)	16 (1.5)	1031 (93.5)	72 (6.5)
	General insurance	3456 (88.5)	448 (11.5)	3869 (99.1)	35 (0.9)	3573 (91.5)	331 (8.5)
	Etc.	223 (86.4)	35 (13.6)	257 (99.6)	1 (0.4)	230 (89.1)	28 (10.9)
	Unknown	472 (89.4)	56 (10.6)	525 (99.4)	3 (0.6)	474 (89.8)	54 (10.2)
	Total	78576 (85.3)	13500 (14.7)	91040 (98.9)	1036 (1.1)	84024 (91.3)	8052 (8.7)
×2		3917.43***		518.44***		2144.59***	

*** $p < .001$

interventional radiology procedures, and blood transfusions based on the type of medical insurance. Occupational injury insurance (54.6%) and automobile insurance (21.6%) had relatively high proportions of surgeries. Occupational injury insurance (4.8%) and automobile insurance (2.1%) were

associated with a higher proportion of interventional radiology procedures. Finally, in terms of blood transfusions, occupational injury insurance (25.4%) and automobile insurance (14.6%) had relatively higher proportions, whereas other insurance (10.9%) showed a lower proportion (Table 3).

Table 4. Difference between the degree of disability before and after injury according to the type of medical insurance

Variable	M		SD		t	p
	Pre-damage score	Post-damage score	Pre-damage score	Post-damage score		
National health insurance	1.0335	1.8820	.19992	1.43498	-142.057	.000***
Car insurance	1.0048	2.0406	0.06944	1.47154	-104.658	.000***
Industrial accident insurance	1.0026	2.1540	0.06031	1.34679	-37.499	.000***
Medical benefit (1)	1.0800	1.7911	0.30198	1.32968	-39.212	.000***
Medical benefit (2)	1.0209	1.5250	0.15527	1.12596	-14.937	.000***
General insurance	1.0126	2.7212	0.12021	1.83889	-58.132	.000***
Etc.	1.0388	1.9651	0.21257	1.35619	-11.079	.000***
Unknown	1.0172	2.8836	0.13005	1.82289	-23.312	.000***

*** $p < .001$

*Disability score

1 = No mentioned disability

2 = Moderate disability

3 = Severe disability

4 = Vegetative state

5 = Expired

*Exclude unknowns

D. Difference in Pre-injury Disability Level and Post-injury Disability Level according to Type of Medical Insurance

Analysis of the difference in disability scores based on the type of medical insurance revealed that for national health insurance, the pre-injury score had a mean of 1.03, whereas the post-injury score had a mean of 1.882, indicating an increase of 0.85 in the disability score. For occupational injury insurance, the pre-injury score had a mean of 1.00, while the post-injury score had a mean of 2.15, showing an increase of 1.15 in the disability score. For general insurance, the pre-injury score had a mean of 1.01, whereas the mean post-injury score was 2.72, indicating the highest increase of 1.71 in the disability score (Table 4). Among general insurance, the proportion of deaths was significantly higher in post-injury disability, whereas occupational injury insurance showed relatively higher proportions of severe disability, moderate disability, and vegetative state than the other insurance types.

IV. DISCUSSION

This study aimed to analyze the utilization patterns of emergency departments by patients with severe trauma using the health insurance system and identify their characteristics and areas for improvement. The research findings revealed that the most common cause of injury among patients with severe trauma in the emergency department was traffic accidents, accounting for 33.1% (30,474 cases), followed by falls and slips at 30.3% (27,906 cases), and contact with

chemicals or other substances at 18.1% (16,675 cases). Although these percentages were higher than those reported in a previous study by Jeong Tae-Wook et al. [6], who focused on major cities and found rates of 24.2% for traffic accidents and 26.8% for falls and slips, the fact that traffic accidents remained the leading cause of injury was consistent. Previous research by Park Chang-won et al. [7] established a correlation between overcrowding in emergency rooms, initial treatment, and mortality rates among patients with severe trauma, with approximately 69% of injuries resulting from car accidents. This trend is also reflected in the mortality statistics for 2019, which indicated high rates of traffic accidents, falls, and slips as causes of death [8]. It is worth noting that despite traffic accidents being responsible for 33.1% of injuries, only 24.0% of patients were covered by automobile insurance, while 61.9% were covered by national health insurance. Automobile insurance is necessary not only for property damage but also to compensate for bodily injuries sustained by both the at-fault party and victim. However, the extent of coverage is determined by insurance premium levels. Additionally, high-risk drivers such as paid delivery motorcycle operators often operate without insurance coverage. Ma and Schmit [9] and Tennyson and Weiss [10] highlight the impact of a driver income on insurance enrollment [11]. Nevertheless, Kim's research [11] suggests that these factors can be addressed through system-based approaches, such as insurance premium support. Considering that traffic accidents are the leading cause of severe trauma, adopting a comprehensive strategy that includes accident prevention measures and systemic improvements in automobile insurance coverage is essential to address the high incidence of severe trauma resulting from traffic acci-

dents. The independent test results for surgical intervention, trauma embolization, and blood transfusion according to the type of health insurance showed higher rates of utilization for work-related and automobile insurance. Given the high severity of trauma among patients covered by work-related and automobile insurance, these individuals require crucial treatments such as surgery, trauma embolization, and blood transfusion. While work-related insurance may have discrepancies due to classifications based on occupation and an evaluation of the appropriateness of medical expenses relative to national health insurance may be insufficient [13], automobile insurance, which has a well-established foundation due to economic development and industrialization, also faces various challenges, such as diminished compensation for victims due to the expansion of the insurance market and government regulations. Severe trauma is a major cause of death in young adults [14], and it is an important issue in emergency medical systems. However, most studies in this field focus on clinical aspects such as evaluation, treatment, and transportation, and there is a lack of research on insurance systems and related aspects such as medical expenses. Therefore, despite its limitations, this study holds significant value. Although it presents limited results based on the analysis of publicly available data, it highlights the potential of utilizing such data. Examination and research on insurance within emergency medical systems are socially meaningful. This study is expected to serve as a catalyst for various other studies on insurance in emergency medical systems.

V. CONCLUSION

This study investigated the relationship between disability after injury, treatment (surgery, trauma embolization, and blood transfusion), and the type of health insurance. The research findings showed differences in the degree of disability after injury and the implementation of treatment (surgery, trauma embolization, and blood transfusion) based on the type of health insurance. Specifically, there is a need for a specific and substantial review of automobile and occupational injury insurance in patients with severe trauma. To achieve appropriate levels of insurance premiums, financial stability, and the monitoring of factors such as the adequacy of medical expenses and overutilization, ongoing examinations from various perspectives are necessary for the health insurance system, which plays a crucial role in the well-being of the population. Concrete improvement measures should be proposed to address these considerations.

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