

Clinical Article



Significance of Applying the New Diagnosis-Related Group Payment System in Patients With Mild Traumatic Brain Injury

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Conflict of Interest

The authors have no financial conflicts of interest.

ABSTRACT

Objective: The new diagnosis-related group (NDRG) payment combines the original diagnosis-related group (DRG) and the fee-for-service (FFS) system, covering basic hospital services through fixed hospitalization costs based on the DRG assigned to the patient, while separate fees were applied for surgical and procedural interventions by physicians. This study aimed to evaluate the impact of payment methodology on medical costs and outcomes in patients with mild traumatic brain injury (TBI).

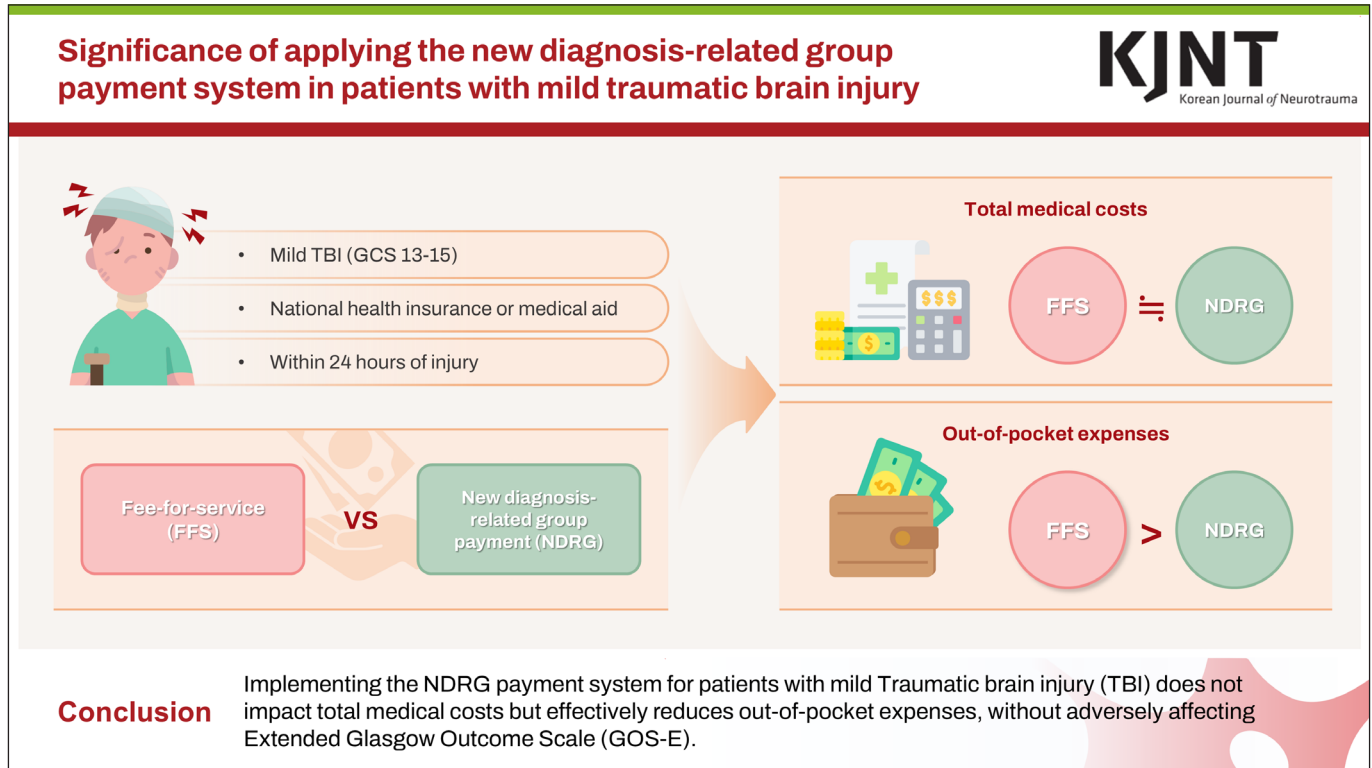
Methods: This retrospective study included 1,247 patients who underwent inpatient neurosurgical treatment at a single regional trauma center from January 2016 to December 2022. Since the implementation of the NDRG payment system in 2019, patients were classified into the FFS and NDRG payment groups. Outcomes were evaluated using the Extended Glasgow Outcome Scale (GOS-E) at discharge and 3 months post-traumatic event; admission days were also assessed. Total medical and out-of-pocket expenses incurred at the time of discharge were also analyzed.

Results: The NDRG payment group demonstrated poorer results in GOS-E at discharge and 3 months post-TBI. However, the admission days were notably shorter. Out-of-pocket expenses were significantly lower in the NDRG payment group. While age, total medical expenses, and out-of-pocket expenses were significantly associated with the GOS-E at discharge, the NDRG payment did not correlate with the GOS-E at discharge. Notably, only the NDRG payment was significantly correlated with lower out-of-pocket expenses.

Conclusion: Implementing the NDRG payment system for patients with mild TBI does not impact total medical costs but effectively reduces out-of-pocket expenses, without adversely affecting the GOS-E.

Keywords: Diagnosis-related groups; Health expenditures; Brain injury, traumatic; Glasgow Outcome Scale

GRAPHICAL ABSTRACT



Informed Consent

This study waived the requirement for informed consent due to its retrospective nature.

Ethics Approval

The Institutional Review Board (IRB) of Ulsan University Hospital approved this study (IRB No. 2024-04-015).

INTRODUCTION

The diagnosis-related group (DRG) payment system is a pivotal policy introduced in South Korea's healthcare system. This system charges a predetermined fee for all medical services a patient receives from admission to discharge, irrespective of the treatment type, length of hospital stay, or medical interventions required. Initially designed to address issues such as overtreatment and medical accidents prevalent in the fee-for-service (FFS) system, the DRG payment system has been recognized as a vital alternative to sustain the health insurance system.⁵⁾ Despite being easily implemented initially by focusing on simple disease groups, it faced challenges in broader application²⁾ due to the potential for reduced treatment, limitations in the flexible system operation, and constraints on new medical technologies, resulting in the development of the new DRG (NDRG) payment system.³⁾

The NDRG payment combines the original DRG approach and the FFS system, covering basic hospital services through fixed hospitalization costs based on the DRG assigned to the patient while applying separate fees for surgical and procedural interventions by physicians. This system applies to nearly all national health insurance, medical aid, and veteran patients, except for certain groups such as newborns and organ transplant recipients. It includes 603 disease categories but excludes patients under auto insurance or worker's compensation insurance, as their medical fees are calculated based on the FFS system. Since 2009, a pilot project has been implemented to evaluate the functions of this new payment system in practice, and a recent report from the Health Insurance Review and Assessment Service of South Korea indicated that the NDRG payment system had been adopted by a total of 93

institutions as of March 2024. Despite this, comprehensive research on the actual impact of this system on patients' care experience and outcomes is still lacking.

The incidence and mortality rates of traumatic brain injuries (TBIs) are high among trauma patients; thereby, both the involved society and individuals are suffering from substantial medical cost burdens.¹⁾ Moderate to severe TBIs are more likely classified as major trauma and are often excluded from the NDRG payment due to the high costs of care. Therefore, this study aimed to evaluate the impact of payment methodology on medical costs and outcomes in patients with mild TBI, for whom the NDRG payment is more likely applicable.

MATERIALS AND METHODS

Ethics statement

The Institutional Review Board (IRB) of Ulsan University Hospital approved this study (IRB No. 2024-04-015) and waived the requirement for informed consent due to its retrospective nature.

Patients

This retrospective study included 1,247 patients who received neurosurgical inpatient treatment at a single regional trauma center from January 2016 to December 2022. Since the implementation of the NDRG payment system in 2019, patients admitted before and after 2019 were classified into the FFS and NDRG payment groups, respectively. Inclusion criteria were patients who presented to the emergency department with mild TBI, with a Glasgow Coma Scale (GCS) of 13 to 15, who were covered by a national health insurance or medical aid, and who presented within 24 hours of injury. Exclusion criteria were patients covered under auto insurance or worker's compensation insurance, those with polytrauma requiring multidisciplinary treatment, those who were transferred to another department for further treatment, those excluded from the NDRG payment due to tracheostomy, and those with injuries of an unknown mechanism (e.g., chronic subdural hematoma).

Clinical data collection

Medical charts were retrospectively reviewed to obtain data on the patient's clinical factors. The following patient characteristics were analyzed: age, sex, smoking status, the use of antiplatelets or anticoagulants, and the presence of underlying diseases such as hypertension, diabetes mellitus, dyslipidemia, cardiovascular disease (CVD), stroke, and chronic kidney disease. Smoking status was classified as current smokers. Underlying diseases were defined as diagnostically confirmed conditions currently managed with medications. Injury severity was assessed using the GCS, injury severity score, abbreviated injury scale, the presence of shock, and whether surgery was performed. These parameters were measured at the time of arrival at the emergency department. Shock was defined as a systolic blood pressure of <90 mmHg recorded at least once on arrival. Car traffic accident (TA), motorcycle TA, bicycle TA, cultivator accident, fall, slip, head collision, assault, sports-related head injury, or other unspecified mechanisms were considered trauma mechanisms depending on the cause of the traumatic incident. The extended Glasgow Outcome Scale (GOS-E) at discharge and 3 months posttraumatic event was used to evaluate outcomes. Readmission was defined as any readmission for the same diagnosis within 1 month postdischarge. Additionally, the duration of hospitalization along with total medical and out-of-pocket expenses incurred at the time of discharge were also analyzed. Furthermore, according to inpatient treatment guidelines, brain magnetic resonance imaging (MRI) was

performed once during the hospital stay for an accurate evaluation of brain damage. Brain MRI was conducted in most patients, except those with pacemakers or where patient refused. These data were collected and analyzed.

Statistical analysis

Statistical Package for Social Sciences version 21.0 (IBM Corp., Armonk, NY, USA) was used for all statistical analyses. The χ^2 tests, Fisher's exact tests, or linear-by-linear tests were used to analyze categorical variables as appropriate, and Student's *t*-tests or Mann-Whitney *U* tests were used for continuous variables depending on the normality test results. Correlation analysis was performed on significant variables from the baseline characteristics ($p < 0.05$), including total medical costs and out-of-pocket expenses, the focus of the study to explore their relationships. The correlation between these costs and the GOS-E at discharge was assessed by Pearson's correlation analyses. Statistical significance was set at $p \leq 0.05$ in all analyses.

RESULTS

Of the 269 patients, 56 (20.8%) and 213 (79.2%) were in the FFS and NDRG payment group, respectively (**TABLE 1**). No significant differences in baseline characteristics were observed between the two groups for most variables. However, the NDRG payment group had significantly older patients (55.50 ± 15.06 vs. 60.86 ± 15.86 years, $p = 0.024$) and a higher prevalence of CVD (5.4% vs. 15.5%, $p = 0.047$). Regarding injury severity, only GCS scores were significantly lower in the NDRG payment group (14.86 ± 0.40 vs. 14.68 ± 0.61 , $p = 0.009$). Regarding outcomes, the NDRG payment group demonstrated poorer results in both GOS-E at discharge (7.86 ± 0.48 vs. 7.65 ± 1.07 , $p = 0.037$) and 3 months post-TBI (7.78 ± 0.59 vs. 7.54 ± 0.91 , $p = 0.033$). However, the admission days were notably shorter in the NDRG payment group (8.2 ± 3.94 vs. 5.65 ± 4.69 , $p < 0.001$). For medical costs, although no significant differences were observed in the overall medical expenses between the two groups, out-of-pocket expenses were significantly lower in the NDRG payment group (2,704,322 ± 1,230,159 vs. 1,316,418 ± 1,309,527 won, $p < 0.001$).

Further analyses revealed that age (coefficient = -0.243, $p < 0.001$), total medical expenses (coefficient = -0.589, $p < 0.001$), and out-of-pocket expenses (coefficient = -0.257, $p < 0.001$) were significantly associated with GOS-E at discharge (**TABLE 2**). However, the NDRG payment status did not correlate with the GOS-E at discharge. Age was uniquely associated with total medical expenses (coefficient = 0.178, $p = 0.003$) (**TABLE 3**). Notably, only the NDRG payment status was significantly correlated with lower out-of-pocket expenses (coefficient = -0.401, $p < 0.001$) (**TABLE 4**).

DISCUSSION

Following the implementation of the NDRG payment system, the proportion of older patients with CVD and lower initial GCS scores increased. This trend suggests an escalation in the treated injury severity after the trauma center establishment compared with its initial phases, a finding consistent with that of other studies that have documented increases in injury severity over time after the establishment of the trauma center.⁴⁾ However, as our study focused exclusively on patients with mild TBI, the differences, though statistically significant, were not pronounced. Moreover, the NDRG payment group demonstrated poorer outcomes

TABLE 1. Baseline characteristics of enrolled patients

Characteristics	Fee-for-service group (n=56)	NDRG payment group (n=213)	p-value
Patient characteristics			
Age	55.50±15.06	60.86±15.86	0.024
Sex (male)	41 (73.2)	141 (66.2)	0.318
Hypertension	16 (28.6)	90 (42.3)	0.062
Diabetes	14 (25.0)	52 (24.4)	0.928
Smoking	27 (48.2)	83 (39.0)	0.210
Dyslipidemia	8 (14.3)	56 (26.3)	0.060
CVD	3 (5.4)	33 (15.5)	0.047
Stroke	3 (5.4)	23 (10.8)	0.220
CKD	2 (3.6)	9 (4.2)	1.000
Antiplatelets	6 (10.7)	36 (16.9)	0.256
Anticoagulants	4 (7.1)	12 (5.6)	0.750
Injury degree			
GCS	14.86±0.40	14.68±0.61	0.009
ISS	7.98±2.53	8.15±2.95	0.697
AIS (head score)	2.71±0.49	2.63±0.62	0.281
Shock	0	1 (0.5)	1.000
Operation	2 (3.6)	7 (3.3)	1.000
Injury mechanism			
TA	2 (3.6)	5 (2.3)	
Motorcycle TA	0	6 (2.8)	
Bicycle TA	3 (5.4)	11 (5.2)	
Cultivator	0	1 (0.5)	
Slip down	36 (64.3)	130 (61.0)	
Fall down	8 (14.3)	34 (16.0)	
Head collision	3 (5.4)	7 (3.3)	
Assault	1 (1.8)	3 (1.4)	
Sport head injury	0	0	
Others	3 (5.4)	16 (7.5)	
Outcome			
GOS-E at discharge	7.86±0.48	7.65±1.07	0.037
GOS-E at 3 months	7.78±0.59	7.54±0.91	0.033
Admission days	8.2±3.94	5.65±4.69	<0.001
Readmission	0	10 (4.7)	0.128
Medical cost			
Total medical expenses	5,237,497±1,908,059	5,511,501±6,361,941	0.751
Out-of-pocket expenses	2,704,322±1,230,159	1,316,418±1,309,527	<0.001
Noninsured total amounts	1,634,858±832,777	320,415±617,710	<0.001

Values are presented as mean ± standard deviation or number (%).

NDRG: new diagnosis-related group, CVD: cerebrovascular disease, CKD: chronic kidney disease, GCS: Glasgow Coma Scale, ISS: injury severity score, AIS: abbreviated injury scale, TA: traffic accident, GOS-E: Extended Glasgow Outcome Scale.

TABLE 2. Correlation analysis with Extended Glasgow Outcome Scale

Variables	Coefficient	p-value
Age	-0.243	<0.001
GCS	0.056	0.357
CVD	-0.112	0.067
NDRG payment	-0.085	0.165
Total medical expenses	-0.589	<0.001
Out-of-pocket expenses	-0.257	<0.001

GCS: Glasgow Coma Scale, CVD: cerebrovascular disease, NDRG: new diagnosis-related group.

TABLE 3. Correlation analysis with total medical expenses

Variables	Coefficient	p-value
Age	0.178	0.003
GCS	0.011	0.858
CVD	0.111	0.068
NDRG payment	0.019	0.751

GCS: Glasgow Coma Scale, CVD: cerebrovascular disease, NDRG: new diagnosis-related group.

TABLE 4. Correlation analysis with out-of-pocket expenses

Variables	Coefficient	p-value
Age	-0.034	0.577
GCS	-0.019	0.762
CVD	0.029	0.635
NDRG payment	-0.401	<0.001

GCS: Glasgow Coma Scale, CVD: cerebrovascular disease, NDRG: new diagnosis-related group.

and a higher incidence of readmission, although the difference in readmission rates did not reach statistical significance. These results could be attributed to the higher injury severity, which also contributed to outcome differences.

The duration of hospitalization tended to be shorter under the NDRG system. Generally, poorer post-TBI conditions correlate with longer admission days and one might expect longer hospitalization duration for the NDRG group due to higher severity compared with FFS group; however, the opposite trend was observed. This unexpected trend is likely due to the economic disincentives created by the NDRG system, where extended hospitalizations become financially disadvantageous for healthcare providers. Consequently, a trend toward shorter hospital stay duration was noted after implementation of the NDRG system.

Medical costs between the two groups showed no significant difference in total expenses. However, out-of-pocket expenses were significantly lower in the NDRG payment group. Contrary to expectations that higher severity in the NDRG payment group would increase total and out-of-pocket costs, further subgroup analysis was conducted to investigate the reasons behind these unexpected findings. This analysis revealed that noninsured total amounts were lower in the NDRG payment group (1,634,858±832,777 vs. 320,415±617,710 won, $p<0.001$).

Correlation analysis with GOS-E at discharge indicated that older patients had poorer outcomes, likely due to a higher risk of complications, such as pneumonia, delirium, and cognitive dysfunction.⁶⁾ Both total medical and out-of-pocket expenses were negatively correlated with GOS-E, suggesting that poorer outcomes required more extensive treatment, thus incurring higher costs. In addition, the correlation coefficient for total medical expenses was higher than for out-of-pocket expenses, indicating that increases in total medical costs were proportionally greater than those in out-of-pocket expenses.

In the correlation analysis with total medical expenses, only age was significantly related, indicating that implementing the NDRG payment system did not influence the overall medical expenses. However, the analysis of out-of-pocket expenses revealed that only the NDRG payment system showed a significant correlation, suggesting that while it did not affect the total cost of care, it indeed effectively reduced out-of-pocket expenses. This reduction in personal financial burden could particularly benefit lower-income groups, who are at a higher risk of head injuries due to physical activities associated with their economic status. Thus, the NDRG payment system could enhance access to care for the lower-income population by reducing their out-of-pocket medical expenses.

This study has several limitations. First, its retrospective design may introduce selective bias due to potentially missing data or unrecorded variables, which could influence the results and necessitate caution in result interpretation. Second, this study was conducted at a single center with a relatively small patient cohort. Although our center is the only trauma

center in the region, representing the local patient population, this limitation restricts the result's generalizability. Nevertheless, it also underscores the study's validity within a specific community. Third, patients covered by auto insurance and worker's compensation insurance were excluded from this study. Consequently, the findings do not represent all patient groups, making the application of its results challenging to these specific populations.

CONCLUSION

Implementing the NDRG payment system for patients with mild TBI does not impact total medical costs but effectively reduces out-of-pocket expenses, without adversely affecting GOS-E. This reduction in personal financial burden significantly enhances healthcare accessibility, affirming the NDRG payment system as an effective strategy to alleviate the cost of care for these patients.

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