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RESEARCH ARTICLE

# Early Impact on Outpatients of Mandatory Adoption of the Diagnosis-Related Group-Based Reimbursement System in Korea on Use of Outpatient Care: Differences in Medical Utilization and Presurgery Examination

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**Objective.** To explore the impact of mandatory adoption of diagnosis-related groups (DRGs) on the use of outpatient care in Korea.

**Data Sources.** National Health Claim data from 2,022 hospitals and 1,029,101 admission cases during 2011–2014: tonsillectomy/adenoidectomy, inguinal/femoral hernia operation, and hemorrhoidectomy.

**Study Design.** Outcome variables included probability of outpatient visit, number of outpatient visits, and outpatient medical expenditures within 30 days. Presurgery examination before hospitalization for surgery, including basic and other examination, was conducted to evaluate a possible shift in health care service. A difference-in-difference research design was used to evaluate the impact of the DRG system on the use of outpatient care.

**Principal Findings.** Before the introduction of the DRG system, 384,609 (91.1 percent) participants used an outpatient clinic either before or after hospitalization. In our study, the number of outpatient visits and outpatient medical expenditures within 30 days increased after mandatory adoption of the DRG system. After adoption of the DRG system, volume and costs for presurgery examinations increased before hospitalization.

**Conclusion.** We observed a spillover effect after mandatory adoption of the DRG system. A future payment system should be designed for spillover effects, and the introduction of a new payment system that expands the DRG-based reimbursement system should be considered.

**Key Words.** Diagnosis-related group, spillover effect, outpatient, medical service utilization

Development of new medical technology has led to increased health expenditures, and over the decades, expenditures have exceeded economic growth (OECD/World Health Organization 2014). This was considered as a major problem to policy makers and other stakeholders, and several attempts, such as limits on the number of hospital beds and reductions in medical technology, were experimented with to control health expenditures in the early 1970s in the United States, although such tries were ineffective and costs increased (Hill 2000). As a result, other methodologies to control the growth of health expenditures and improve management were developed to change reimbursement systems.

Prospective payment systems (PPSs) based on diagnosis-related groups (DRGs) were developed as one alternative to reimbursement systems to control health expenditures in the 1980s. The first was developed at Yale University, and the U.S. federal government made the decision to introduce this payment system to the Medicare program in 1983, changing the reimbursement system from retrospective to PPS (Feinglass and Holloway 1991; Hill 2000). This payment system was applied to inpatient care, which classified patients into DRGs, paying predefined flat rates for each case. At that time, this was induced to decrease the length of stay as well as costs; however, it also brought unintended consequences due to cost disparities between acute care of inpatients and postacute care (McCall et al. 2003; Sood et al. 2011). As postacute care functioned by paying the costs of services provided to patients, this payment disparity induced patient shifts from acute care to postacute care, increasing costs in postacute care. To solve this problem, the PPS system was mandatorily adopted to postacute care, but the cost imbalance was maintained due to separate reimbursement systems by each postacute care setting (Sood et al. 2011; Grabowski et al. 2012). Although varied attempts were introduced, none resulted in an integrated approach of use to health care providers, as they lacked communication or coordination with each other. As a result, new attempts at a more integrative payment system are warranted to achieve coordinating care and improve quality of care.

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Payment bundling based on episodes was introduced to reduce costs, as well as to improve quality of care (Fisher et al. 2009; Sood et al. 2011; Froimson et al. 2013). This payment system expands the scope of services, compared to DRG-based payment systems, and it involves reimbursements as a fixed amount of costs covering a set of services (Painter 2012). The bundled payment system involves compensation by episodes of care, meaning that it includes hospitalization and postacute care, including the use of outpatient care (Mechanic and Altman 2009). Pilot programs for the bundled payment system have been applied according to patient status, appearing in various types of reimbursement models in the United States (Painter 2012). In addition, many European countries have also adopted the DRG-based payment system to improve efficiency and control the growth of health expenditure, but it is not an episode-based bundled payment system (Busse, Geissler, and Quentin 2011).

In Korea in the 1990s, many problems were present regarding the poor health care delivery and growth of health care expenditures. Access to care was improved after rapid adoption of the National Health Insurance (NHI) system, although new problems occurred regarding the shortage of facilities and disputes about health care costs between insurers and health care providers (Kwon 2003; Kim, Park, and Hahm 2012). To solve these problems, the government decided to adopt DRG-based reimbursement in 1997. After several years of the pilot program, in 2002, the payment system was applied to seven disease groups (lens operation, tonsillectomy/adenoidectomy, appendectomy, inguinal/femoral hernia operation, hemorrhoidectomy, uterine/adnexa operation, cesarean delivery) through voluntary participation. Since then, DRG-based payment has paid hospitals a single amount for all of the hospital care provided for an entire inpatient admission. The scope of health services expenditures in the DRG-based payment system was comprehensive except for the following: meals, MRI, sonogram, extra charges for specialist physicians, and certain sizes of rooms (e.g., private rooms; Kwon 2003). Similar to the early PPS model in the United States, the DRG-based payment system was applied to a separate reimbursement system, meaning that postacute care, including the use of outpatient care, was applied to costs per provided health service to patients. Before and after surgery hospitalization, patients visited outpatient clinics for their symptoms and were classified into one of the seven DRG classification systems. Afterward, they themselves or the physicians could decide whether to conduct surgery or palliative care. During the use of outpatient care, hospitals were reimbursed under a fee-for-service payment system. Once patients were hospitalized for surgery, the DRG-based

payment system paid hospitals including all health expenditures except the items listed above and the additional pharmaceutical fee after discharge from hospital.

Recently, changes in the reimbursement system through mandatory adoption of the DRG system were phased in beginning on July 1, 2012. From this date, the DRG system became mandatory in hospitals and clinics and was applied to general hospitals and tertiary hospitals beginning on July 1, 2013. Changing reimbursement systems may affect medical service utilization, as well as medical practice (Moreno-Serra and Wagstaff 2010). One possible effect, similar to effects associated with adoption of DRGs in the United States, is an increase in outpatient care. DRGs, regardless of how high the DRG payments are set, provide an incentive to shift care to outpatient settings where it will be separately reimbursed and increase revenue.

Previous studies have suggested benefits of the DRG system, such as reductions in health care costs and length of stay (Böcking et al. 2005; Cheng, Chen, and Tsai 2012). Other studies have suggested that the DRG system is associated with quality of care (Forgione et al. 2003; Busse et al. 2013). Additional concerns include unexpected effects of the DRG system, such as increasing patient visits and early discharge (Busse, Geissler, and Quentin 2011). Many studies on the association between quality of care and the DRG system have been reported in Korea (Choi et al. 2010; Shon et al. 2011; Choi 2012). However, few studies have been performed to examine the effects of the DRG system on the use of outpatient care. This is of significant policy interest, given that changes in the reimbursement system may affect health service in the use of outpatient care. Moreover, the DRG system is widely believed to increase the use of outpatient care, thus reducing hospitalization services.

We studied whether the adoption of the DRG system affected several measures of outpatient utilization and costs for patients receiving inpatient surgeries. As the adoption of DRGs can create incentives to move care partially outside surgery hospitalization or create incentives to send patients home from hospitals earlier and necessitate additional postsurgery outpatient care, we studied whether patients received any outpatient visits in the 30 days before surgical hospitalization or any visits in the 30 days following surgical hospitalization. We also studied the number of visits received before and after hospitalization. To assess the impact of changes in outpatient utilization on spending, we studied outpatient expenditures in the 30 days prior to hospitalization and in the 30 days after hospitalization. Finally, we examined whether

the adoption of the DRG system affected the probability of surgical patients receiving presurgery examinations including basic and other examinations, and the probability of patients receiving these tests in outpatient settings before surgical hospitalization. The DRG system may create incentives to reduce the use of these services during surgical hospitalization.

## METHODS

### *Database and Data Collection*

We used three datasets from NHI data. The main data were hospitalization data that included patient admissions from July 2011 to July 2014. The second dataset included detailed medical treatment performed during hospitalization that was obtained from medical codes. The third dataset was outpatient data that were included in the detailed medical record at each visit. First, we selected participants who were admitted for a tonsillectomy/adenoidectomy, inguinal/femoral hernia operation, or hemorrhoidectomy from the main data (DRG codes: D1111, D1112/G0950, G0961, G0962, G0963, G0970, G0981, G0982, G0983/G1020, G1040, G1050, G1060). We excluded patients receiving Medicaid, because they are not suitable subjects for the DRG system in Korea. Second, we selected data for clinical diagnosis tests according to each hospitalization from the second dataset. Third, we selected participants who had visited as an outpatient from June 2011 to August 2014 in the third dataset. Finally, we merged all the data.

There are four types of hospitals, classified according to medical law in Korea: clinic, hospital, general hospital, and tertiary hospital (Song 2009). Criteria for classification are based on number of beds, medical service departments, functions, and certain certifications. The distinction between clinics and hospitals is based on the number of beds; additionally, most clinics have only one medical service department, and the size of a clinic is relatively smaller than that of a hospital. General hospitals provide a higher level of care for patients and must be a certain size (over 100 beds and seven medical department), with specialists in each medical service department. Tertiary hospitals are designated among general hospitals by the Ministry of Health and Welfare every 3 years. These hospitals must fulfill the necessary conditions based on the selection standards of the Ministry of Health and Welfare according to the number of beds, medical equipment, and human resources and the presence of over 20 medical service departments. Although there was no defined surgery for each type of hospital, patients with severe clinical condition or

multiple complication prefer to visit big size of hospital. Reimbursement and out-of-pocket money were different by type of hospital; incentive by type of hospital was paid to hospital (incentive was largest in tertiary and smallest in clinic). The proportion of out-of-pocket money was largest in tertiary hospitals and smallest in clinics (Song 2009). We included all types of hospitals in our analysis that have facilities for inpatient surgeries. A total of 2,022 hospitals were examined in our study to analyze outpatient visits and presurgery examinations. A total of 1,029,101 hospitalizations were included in our analysis. The unit of analysis was the hospitalization case.

### *Variables*

The outcome variables were outpatient visits within 30 days, which included those before and after hospitalization. Outpatient visits were categorized as: (1) whether an outpatient visit occurred within 30 days, (2) number of outpatient visits within 30 days, and (3) outpatient expenditures within 30 days. First, we matched the patient's major diagnosis at the first hospitalization and outpatient visit. Next, we calculated the number of outpatient visits according to before hospitalization and after the discharge from the hospital. For example, a participant who had visited the outpatient clinic four times before admission within 30 days had four records. Then, the number of outpatient visits was calculated as four times before hospitalization. Finally, an outpatient was defined as visiting the outpatient clinic within 30 days before or after hospitalization, based on the first admission day and discharge day, respectively. Participants who had ever visited the outpatient clinic within 30 days were defined as "Yes" for outpatient visits. For each patient, we analyzed the actual medical costs, which included all patient costs except uninsured items. Uninsured items not submitted by the hospital do not exist in our data. Additionally, outcome variables for presurgery examination were evaluated using volume and costs of examination, and it was divided into basic and other examination. Basic examination included blood tests (blood count, liver function, and electrolytes), EKG, and chest X-ray based on the index of quality measurement in the Health Insurance Review & Assessment Service. Other examinations included all other examinations except basing examination, including radiological examinations such as computed tomography.

We extracted patient data and matched hospital data for the hospital to which the patient had been admitted. Participants in the DRG system were divided into newly introduced organizations and continuously adopted organizations. Newly introduced organizations were hospitals with mandatory

adoption of the DRG system. Continuously adopted organizations were defined as hospitals that applied the DRG system voluntarily. In the case of clinics and hospitals, they were required to introduce the DRG system in their hospital by July 1, 2012. Both general hospitals and tertiary hospitals were required to participate in the DRG system by July 1, 2013. Thus, introduction of the DRG system was divided into before and after based on the different type of hospital and the period. Hospital characteristics included hospital type (tertiary hospital, general hospital, hospital, clinic), ownership status (private, public), teaching status (teaching, nonteaching), size (number of beds), and hospital location (urban, rural). The case mix index was the sum of the total cost weights of all inpatients per a defined time period divided by the number of admissions, and it was measured to reflect different disease severities between the hospitals. Human resources (number of doctors per 100 beds, number of nurses per 100 beds) were included to reflect differences in staffing intensity. To minimize confounding measured differences in hospitals, we adjusted for patient volume per hospital. Patient characteristics included patient ID, sex, age, Charlson comorbidity index (0, 1, 2, 3+), length of stay, route of hospitalization (ER, outpatient clinic), and type of surgery (tonsillectomy/adenoidectomy, inguinal/femoral hernia operation, and hemorrhoidectomy).

*Statistical Analysis*

The distribution of each categorical variable was examined by an analysis of frequencies and percentages, and chi-square tests were performed to examine associations with outpatient visits within 30 days. Analysis of variance was also performed to compare the average values and standard deviations for continuous variables. To estimate the effects of the DRG system on outpatient visits within 30 days, we applied a difference-in-difference model that was adjusted for hospital characteristics, patients, and participation in the DRG system. Policy variables in the model were included before and after the introduction of the DRG system. A binary variable for whether the DRG system adoption was voluntary or mandatory in the hospital was used in our study. Hospitals with mandatory adoption of the DRG system constituted the case group, while the control group was the voluntary adoption group; we refer to them as the organization effect. In the model, the interaction among these indicators provided the net policy effects and the effects of introduction of the DRG system on outpatients. DRG effects (DE) were calculated according to the following equation:

$$\Delta^{DE} = \left[H^{After-DRG,\,Newly\,adopted} - H^{Before-DRG,\,Newly\,adopted}\right] - \left[H^{After-DRG,\,Continuously\,adopted} - H^{Before-DRG,\,Continuously\,adopted}\right].$$

Generalized estimating equation models that included both inpatient and hospital variables were used to examine the association with outpatient visits within 30 days and introduction of the DRG system. We used the Poisson regression model for evaluating the number of outpatient visits before and after hospitalization, and volume of health examination. The gamma generalized linear model based on the log link function was used to evaluate outpatient health expenditure differences before and after mandatory adoption of the DRG system. In addition, subgroup analyses were performed according to the type of surgery and hospital. All statistical analyses were performed using *SAS* statistical software version 9.4 (SAS Institute, Inc., Cary, NC, USA); $p$-values $<.05$ were considered indicative of statistically significant differences.

## RESULTS

The data used in this study consisted of 1,029,101 hospitalization cases and 2,022 hospitals. Before the introduction of the DRG system, 384,609 (91.1 percent) participants used outpatient clinics either before or after hospitalization. After the introduction of the DRG system, 558,499 (92.0 percent) participants visited the outpatient clinic either before or after hospitalization. The average number of outpatient visits within 30 days was 3.46 times before and 3.92 times after introduction of DRG. The number of outpatient visits within 30 days was higher after discharge from the hospital both before and after introduction of the DRG system (before: $2.55 \pm 2.40$; after: $3.10 \pm 2.46$). Average outpatient medical expenditures were 100,161 KRW (1$ = 1091.4 KRW/1GBP = 1707.71 KRW) before introduction of the DRG system and 94,926 KRW after introduction of the DRG system. Average costs for use of outpatient care were higher before hospitalization compared with after discharge from hospital both before and after the introduction of the DRG system. The percentage of presurgery examinations was higher before hospitalization than during hospitalization for blood tests, EKG, and chest X-ray. According to the type of surgery, a higher proportion of inpatients for hemorrhoidectomy were seen both before and after introduction of the DRG system (before: $n = 304{,}492$, 72.1 percent; after: $n = 524{,}427$, 86.4 percent; Table 1).

Table 1: General Characteristics of Participants ($n$ = 1,029,101) (Unit: N/M, %/SD, KRW)

| | *Introduction of DRG* | | | | |
|---|---|---|---|---|---|
| | *Before (n = 422,153)* | | *After (n = 606,948)* | | *p-Value* |
| *Outcome variable (any outpatient visits within 30 days)* | | | | | |
| Outpatient visit within 30 days | | | | | |
| Total | 384,609 | (91.1) | 558,499 | (92.0) | <.0001 |
| Before hospitalization | 276,825 | (65.6) | 375,425 | (61.9) | <.0001 |
| After discharge from hospital | 354,693 | (84.0) | 537,509 | (88.6) | <.0001 |
| Number of outpatient visit within 30 days (before and after hospitalization) | | | | | |
| Total | 3.46 | ±2.58 | 3.92 | ±2.66 | <.0001 |
| Before hospitalization | 0.91 | ±0.91 | 0.82 | ±0.85 | <.0001 |
| After discharge from hospital | 2.55 | ±2.40 | 3.10 | ±2.46 | <.0001 |
| Outpatient medical expenditure within 30 days* | | | | | |
| Total | 100,161 | 95,837 | 94,926 | 72,459 | <.0001 |
| Before hospitalization | 62,285 | 72,318 | 51,723 | 60,164 | <.0001 |
| After discharge from hospital | 37,876 | 61,719 | 43,203 | 39,380 | <.0001 |
| Presurgery examination before hospitalization | | | | | |
| Volume | | | | | |
| Basic examination(blood test, EKG, chest X-ray) | 8.65 | ±9.40 | 7.70 | ±8.93 | <.0001 |
| Other examination | 5.36 | ±6.37 | 4.22 | ±5.27 | <.0001 |
| Costs | | | | | |
| Basic examination(blood test, EKG, chest X-ray) | 13,159 | 14,609 | 11,348 | 13,531 | <.0001 |
| Other examination | 25,122 | 33,695 | 21,110 | 28,040 | <.0001 |
| *Patients characteristics* | | | | | |
| Sex | | | | | |
| Male | 256,987 | (60.9) | 362,200 | (59.7) | <.0001 |
| Female | 165,166 | (39.1) | 244,748 | (40.3) | |
| Age | 38.18 | ±19.24 | 40.43 | ±16.90 | <.0001 |
| CCI | | | | | |
| 0 | 218,258 | (51.7) | 302,940 | (49.9) | <.0001 |
| 1 | 85,486 | (20.3) | 132,490 | (21.8) | |
| 2 | 61,797 | (14.6) | 99,167 | (16.3) | |
| ≥3 | 56,612 | (13.4) | 72,351 | (11.9) | |
| LOS | 3.47 | ±2.28 | 2.89 | ±1.50 | <.0001 |
| Route of hospitalization | | | | | |
| ER | 738 | (0.2) | 3,006 | (0.5) | <.0001 |
| Outpatient clinic | 421,415 | (99.8) | 603,942 | (99.5) | |
| Type of surgery | | | | | |
| Tonsillectomy and adenoidectomy | 67,002 | (15.9) | 44,357 | (7.3) | <.0001 |
| Inguinal and femoral hernia operation | 50,659 | (12.0) | 38,164 | (6.3) | |
| Hemorrhoidectomy | 304,492 | (72.1) | 524,427 | (86.4) | |

*1$ = 1091.4 KRW/1GBP = 1707.71 KRW, adjusted for gross price inflation—that is, as if the gross-to-cost ratio had stayed constant since 2011.
CCI, Charlson comorbidity index; EKG, electrocardiogram; LOS, length of stay.

A total of 1,032 (51.0 percent) hospitals had mandatorily adopted the DRG system. By type of hospital, all tertiary hospitals adopted the DRG system mandatorily and approximately 60 percent of clinics voluntarily adopted the DRG system. By ownership status, most public hospitals adopted the DRG system voluntarily (private: $n = 946$, 47.9 percent; public: $n = 44$, 95.7 percent). A higher proportion of hospitals located in urban areas adopted the DRG system voluntarily (urban: $n = 885$, 50.3 percent; rural: $n = 105$, 39.9 percent [Table 2]).

We used the difference-in-difference model to evaluate the effects of the DRG system on the use of outpatient care. When we controlled for all of the explanatory variables described above, we found that the probability of outpatient before hospitalization significantly increased after the introduction of the DRG system in newly introduced organizations (net effect: odds ratio [OR]: 1.53, 95% confidence interval [CI]: 1.35–1.75). Net effects of the probability of outpatient visits within 30 days after hospitalization increased although the

Table 2: Hospital Characteristics by Participation in the DRG System ($N = 2{,}022$) (Unit: N/M, %/SD)

| | *Participation in the DRG System* | | | | |
|---|---|---|---|---|---|
| | *Newly Adopted Organization* | | *Continuously Applied Organization* | | *p-Value* |
| Type of hospital | | | | | |
| Clinic | 509 | (41.1) | 731 | (59.0) | <.0001 |
| Hospital | 281 | (63.7) | 160 | (36.3) | |
| General hospital | 198 | (66.7) | 99 | (33.3) | |
| Tertiary hospital | 44 | (100.0) | — | (0.0) | |
| Ownership status | | | | | |
| Private | 1,030 | (52.1) | 946 | (47.9) | <.0001 |
| Public | 2 | (4.4) | 44 | (95.7) | |
| Teaching status | | | | | |
| Teaching | 122 | (81.3) | 28 | (18.7) | <.0001 |
| Nonteaching | 910 | (48.6) | 962 | (51.4) | |
| Hospital location | | | | | |
| Urban | 874 | (49.7) | 885 | (50.3) | .0021 |
| Rural | 158 | (60.1) | 105 | (39.9) | |
| Case mix index (CMI) | 0.99 | ±0.41 | 0.82 | ±0.26 | <.0001 |
| Number of beds | 190.67 | ±298.45 | 73.99 | ±138.82 | <.0001 |
| Number of doctor per 100 beds | 16.76 | ±23.05 | 13.74 | ±17.15 | .0009 |
| Number of nurse per 100 beds | 17.31 | ±22.16 | 11.39 | ±17.60 | <.0001 |
| Patients volume per hospital | 805.22 | ±1973.96 | 976.01 | ±1973.29 | .0519 |
| Total | 1,032 | (51.0) | 990 | (49.0) | |

difference was not statistically significant. The number of outpatient visits increased before and after hospitalization (net effects: relative risk [RR]: 1.12, 95% CI: 1.07–1.17). Similar results were also observed in the number of outpatient visits each before and after hospitalization, and these differences were statistically significant. Outpatient medical expenditures increased slightly more before hospitalization (net effect: rate ratio [RR]: 1.12, $p < .0001$). Volume of presurgery examination, which included basic and other examination, significantly increased after the adoption of the DRG system. Regarding costs for presurgery examination, other examinations significantly increased by 11 percent after the adoption of the DRG system (Table 3).

According to the subgroup analysis by type of surgery and hospital, we determined the net effect on each outcome variable. Tonsillectomy/adenoidectomy had decreased outpatient visits and medical expenditures, but the difference was not statistically significant. For the inguinal/femoral hernia operation, probability of outpatient visits within 30 days (OR: 2.12, 95% CI: 1.22–3.67) and medical expenditures (RR: 1.11 95% CI: 1.02–1.22) increased. For hemorrhoidectomy, probability of outpatient visits within 30 days (OR: 1.60, 95% CI: 1.26–2.03) increased and the size of impacts was higher before hospitalization than after discharge from hospitals. The number of outpatient visits and medical expenditures within 30 days increased and the size of the effects was similar before and after hospitalization. By type of hospital, general trends of the use of outpatient care were similar in hospitals, general hospitals, and tertiary hospitals that total outpatient visits and costs increased before and after hospitalization. Regarding clinics, outpatient expenditure before and after hospitalization significantly increased after the adoption of the DRG system (Table 4).

## DISCUSSION

Since the development of the DRG-based payment system, this system was adopted widely as a new alternative payment system that can replace fee-for-service payment. Introduction of the DRG system was considered to allow efficient management of the payment system and is thought to reduce health-related costs (DesHarnais et al. 1991; Böcking et al. 2005). However, an unexpected result of the payment system, a spillover effect, was suggested as one problem (Guterman and Dobson 1986). These problems were caused by cost imbalances between inpatient care (acute care) and outpatient care (postacute

care) and it led to patient shifting to other facilities or outpatient visits (Fitzgerald et al. 1987).

To explore the impact of the DRG-based payment system on the use of outpatient care after mandatory adoption, we evaluated the probability of outpatient visits, the number of outpatient visits, outpatient medical expenditures,

Table 3: Impact of the DRG System on Use of Outpatient Care and Presurgery Examination (unit: OR/RR)

| | *Before and After Hospitalization* | *Before Hospitalization* | *After Hospitalization* |
|---|---|---|---|
| *Before and after hospitalization (any outpatient visits within 30 days)* | | | |
| Outpatient visit within 30 days[1] | | | |
| Time effects (after DRG adoption) | 1.07 | 0.95* | 1.32* |
| Organization effect (mandatory adoption of DRG) | 0.68* | 0.71* | 0.65* |
| Net effect | 1.19 | 1.53* | 1.13 |
| Number of outpatient visit within 30 days[2] | | | |
| Time effects (after DRG adoption) | 1.04* | 0.99 | 1.05* |
| Organization effect (mandatory adoption of DRG) | 0.83* | 0.99 | 0.76* |
| Net effect | 1.12* | 1.14* | 1.15* |
| Outpatient medical expenditure within 30 days (KRW)[†3] | | | |
| Time effects (after DRG adoption) | 0.99 | 0.98 | 1.00 |
| Organization effect (mandatory adoption of DRG) | 0.89* | 0.99 | 0.85* |
| Net effect | 1.17* | 1.12* | 1.07* |
| *Presurgery examination* | | | |
| Volume[2] | | | |
| Basic examination (blood test, EKG, chest X-ray) | | | |
| Time effects (after DRG adoption) | | 1.04 | |
| Organization effect (mandatory adoption of DRG) | | 0.93 | |
| Net effect | | 1.20* | |
| Other examination(except basic examination) | | | |
| Time effects (after DRG adoption) | | 0.97 | |
| Organization effect (mandatory adoption of DRG) | | 0.96 | |
| Net effect | | 1.24* | |

*Continued*

Table 3: *Continued*

| | *Before and After Hospitalization* | *Before Hospitalization* | *After Hospitalization* |
|---|---|---|---|
| Costs[3] | | | |
| Basic examination (blood test, EKG, chest X-ray) | | | |
| Time effects (after DRG adoption) | | 1.04* | |
| Organization effect (mandatory adoption of DRG) | | 1.12* | |
| Net effect | | 0.99 | |
| Other examination (except basic examination) | | | |
| Time effects (after DRG adoption) | | 0.97 | |
| Organization effect (mandatory adoption of DRG) | | 1.01 | |
| Net effect | | 1.11* | |

*Notes:* Results are based on difference-in-difference estimates. "Time effect" is the impact of the DRG system before and after mandatory adoption. "Organization effect" is the predicted impact on the hospital with no previous adoption of DRG. "Net effect" is the effect of DRG on a newly adopted hospital minus the effects of DRG on a continuously adopted hospital.
Adjusted for age, sex, Charlson comorbidity index, route of hospitalization, length of stay, type of surgery, type of hospital, ownership status, hospital location, teaching status, case mix index, doctors per 100 beds, nurses per 100 beds, hospital beds, and number of hospitalizations.
*Statistically significant, $p < .05$.
†1$ = 1091.4 KRW/1GBP = 1707.71 KRW, adjusted for gross price inflation—that is, as if the gross-to-cost ratio had stayed constant since 2011. The results of exponential values are those from the gamma regression coefficients.
OR[1], odds ratio: Generalized estimating equation model was used in binary outcome variable.
RR[2], relative risk: Poisson regression analysis was used in count variable.
RR[3], rate ratio: Generalized estimating equation model with gamma distribution was used in cost variable, and it was interpretable as percentage changes.

and presurgery examinations. In our study, the probability of outpatient visits, the number of outpatient visits, and outpatient medical expenditures increased after the mandatory adoption of the DRG system in Korea. In particular, the size of effects of the DRG system on the probability of outpatient visits and outpatient medical expenditures were large before hospitalization, compared with after hospitalization. Although the observed effects of the DRG system on the use of outpatient care were smaller than the initial concerns, we considered this result carefully in three aspects. First is the relative smaller size of the effect on outpatient care than initial concerns. Plausible explanations for this may be associated with the hospital environment in Korea. Hospitals in Korea have undergone dramatic changes within the last few decades; they are faced with competition from other hospitals, which has

Table 4: Subgroup Analysis of Outpatient Visits within 30 days According to Type of Surgery and Hospital (Unit: OR, RR)

| | *Before and After Hospitalization* | *Before Hospitalization* | *After Hospitalization* |
|---|---|---|---|
| *Type of surgery* | | | |
| Tonsillectomy and adenoidectomy | | | |
| Outpatient visit within 30 days[1] | 0.78 | 0.78 | 1.10 |
| Number of outpatient visit within 30 days[2] | 0.94 | 0.93 | 0.97 |
| Outpatient medical expenditure within 30 days[3] | 0.93 | 0.97 | 0.97 |
| Inguinal and femoral hernia operation | | | |
| Outpatient visit within 30 days[1] | 2.12* | 1.55* | 1.57 |
| Number of outpatient visit within 30 days[2] | 1.06 | 1.09* | 1.06 |
| Outpatient medical expenditure within 30 days[3] | 1.11* | 1.11* | 1.05 |
| Hemorrhoidectomy | | | |
| Outpatient visit within 30 days[1] | 1.60* | 1.98* | 1.30* |
| Number of outpatient visit within 30 days[2] | 1.28* | 1.29* | 1.29* |
| Outpatient medical expenditure within 30 days[3] | 1.28* | 1.16* | 1.15* |
| *Type of hospital* | | | |
| Clinic | | | |
| Outpatient visit within 30 days[1] | 0.73 | 1.22 | 0.66* |
| Number of outpatient visit within 30 days[2] | 1.01 | 1.07 | 0.99 |
| Outpatient medical expenditure within 30 days[3] | 1.14* | 1.15 | 1.02 |
| Hospital | | | |
| Outpatient visit within 30 days[1] | 1.28 | 1.46* | 1.02 |
| Number of outpatient visit within 30 days[2] | 1.16* | 1.15* | 1.19* |
| Outpatient medical expenditure within 30 days[3] | 1.13* | 1.09* | 1.05 |
| General hospital | | | |
| Outpatient visit within 30 days[1] | 1.41* | 1.23* | 1.33 |
| Number of outpatient visit within 30 days[2] | 1.05* | 1.06* | 1.05 |
| Outpatient medical expenditure within 30 days[3] | 1.07* | 1.05 | 1.05 |
| Tertiary hospital[†] | | | |
| Outpatient visit within 30 days[1] | 1.36* | 1.30* | 1.90* |
| Number of outpatient visit within 30 days[2] | 1.12* | 1.09* | 1.16* |
| Outpatient medical expenditure within 30 days[3] | 1.07* | 1.05* | 1.01 |

*Notes:* "Net effect" is the effect of DRG on a newly adopted hospital minus the effects of DRG on a continuously adopted hospital.

Expenditure: Adjusted for gross price inflation—that is, as if the gross-to-cost ratio had stayed constant since 2011. The results of exponential values are those from the gamma regression coefficients.

Adjusted for age, sex, Charlson comorbidity index, length of stay, type of surgery, type of hospital, ownership status, hospital location, teaching status, case mix index, doctors per 100 beds, nurses per 100 beds, hospital beds, and number of hospitalizations.

*Statistically significant.

[†]*Tertiary hospital*: We suggested time effects in tertiary hospital. Because it was not a voluntarily adopted DRG system in a previous time and it was not suitable for applied difference-in-difference model: The result is change after DRG adoption in tertiary hospital.

OR[1], odds ratio: Generalized estimating equation model was used in binary outcome variable.

RR[2], relative risk: Poisson regression analysis was used in count variable.

RR[3], rate ratio: Generalized estimating equation model with gamma distribution was used in cost variable, and it was interpretable as percentage changes.

led them to change their systematic structure to improve hospital profit and management. To increase management efficiency, hospitals in Korea have tried to increase the turnover ratio of beds with early discharge; however, this may lead to increases in other types of health care, such as outpatient visits or readmissions (Riegel et al. 1996; Hendren et al. 2011). These phenomena have existed in the past before the mandatory adoption of the DRG-based payment system; thus, the impacts of the DRG system on outpatients existed, but the system did not seriously affect hospitals.

Second, we considered the positive effects of the DRG system by cost savings of inpatient care. At the time the United States adopted the DRG system in the reimbursement system, similar results of the spillover effects were observed; however, this expenditure was offset by cost savings from inpatient care. This infers that the net cost saving was observed under the DRG system due to decreased length of stay and health service during hospitalization (Sloan, Morrisey, and Valvona 1988). We also considered cost savings from inpatient care; however, the cost setting was different in Korea because the DRG payment was set on an average of 23.8 percent greater than the fee-for-service level when it was first introduced as a pilot program (Kwon 2003). In addition, the DRG system was adopted as a mandatory system and costs for the DRG system also increased with the expansion of predefined health services. Thus, we considered per diem costs for inpatients to evaluate the exact effects of the DRG system on inpatient care. In our analysis, per diem cost for inpatient increased after the adoption of the DRG system (net effects: 11 percent of per diem costs for inpatient increased; see Appendix SA2). However, we could not suggest that the DRG system had no net cost savings using this result, because we evaluated short-term effects rather than long-term effects of the DRG system and more time would be needed for exact evaluation.

Third, in our study, the volume and costs for outpatient care increased, even though the costs for reimbursement increased with mandatory adoption of DRG-based payment system. These phenomena of increases in outpatient care might result from a price–marginal cost gap (Stano 1987). According to Dranove, a "cost shift" can occur when the costs was not charging the highest price that the market could endure. For example, Medicare cuts to its payments will affect health care providers, potentially choose to other methods to recover some of their lost profits (Dranove and Satterthwaite 2000). Evans also proposed a "physician-induced demand" model in which physicians will recommended health services beyond the optimal level to increase their income (Evans 1974; Frank 2004). In addition, McGuire mentioned that there

is no alternative model to "profit maximization," explaining physicians' motivations (Frank 2004).

In Korea, physicians believed that the NHI does not sufficiently reimburse the costs for their health services. Fee schedules for the physicians and hospital were set low when the NHI was introduced: There was a lack of financing for expanding universal coverage, and as a result, initial costs were set low in health service. After introduction of the NHI system, fees were regulated by the NHI. To balance profit margin and costs (regulated fee under NHI), physicians had an increased volume of health services and expanded uninsured medical services that were not regulated by NHI (Kwon 2003). Since the mandatory adoption of DRG-based payment system, the costs for health services have increased; however, physicians still believe that a price–marginal cost gap exists. Nevertheless, there is no longer an incentive to increase volumes of health services and uninsured health services, as costs are not flexible under the DRG-based payment system. It has induced increases in outpatient care covered under fee-for-service payment. This separated reimbursement system may affect physician behavior, as stimulating increases in outpatient care to maximize their profits.

In our study, we found spillover effects in two aspects. First, an increasing number of outpatient visits was seen after discharge from the hospital. Second, presurgery examination that may have been provided during hospitalization in the past was shifted to outpatient care. Although the magnitude of the spillover was small, increasing spillover is a possible long-term effect of the DRG system in Korea. Increasing outpatient medical expenditures may be considered a major problem related to the DRG system, because it was initially introduced to control health care expenditures.

To solve the problem, we have to consider the new attempt by the alternative reimbursement model or the modification of the DRG system in Korea. Various attempts to develop the payment system would be needed to find a suitable system in Korea and a bundled payment system can be considered as one alternative model. Episode-based bundled payment provides a fixed cost in a specific period and includes inpatient and outpatient health care services, reducing cost disparities between health care providers. Although we may learn from the results of bundled payment system in the United States, we need to carefully interpret and adopt this system due to different characteristics in the health care system. Specifically, the U.S. reimbursement system and the Korean system are different in terms of combined reimbursement to doctors and hospitals. In addition, we also considered several aspects for the development of bundled payment system, such as disease selection, definition

of episode, performance, payment rates, and incentive to hospital (Sood et al. 2011; Froimson et al. 2013). To find a suitable payment system in Korea, pilot programs considering different models in the payment system will be needed. This can be achieved through long-term efforts to improve the payment system, and our results will be important for evaluating and developing a payment system in Korea. In addition, our results are meaningful to other countries that have adopted DRG-based payment, and it can provide evidence to policy makers about the necessity of a bundled payment system.

Our study has several limitations. First, we used claim data, and thus, we could not measure other characteristics of the patients, such as education and income levels, which could affect outpatient visits. Second, our study included patients admitted for hemorrhoidectomy, herniotomy, and tonsillectomy, and the results may be different for other diseases under the DRG system. Third, we only included outpatient visits within 30 days and did not evaluate other periods of outpatient visits. Finally, we did not evaluate uninsured items that were not included with our data. Thus, we could not measure the absolute growth of outpatient expenditures.

Despite several limitations, our study has strengths. First, we used NHI claim data, which include almost all patients and hospitals in Korea. Thus, the results were meaningful and representative of the whole nation. Second, to the best of our knowledge, our study is the first to evaluate outpatient visits, outpatient expenditures, and presurgery examination after the mandatory introduction of DRG in Korea. While many studies have been published concerning the association between the DRG system and quality of care, only a few studies have been conducted to investigate spillover effects. Third, we investigated the short-term effects of the DRG system on outpatients and suggested factors to improve the payment system in the future. Finally, we used the difference-in-difference method to evaluate the net effects of the DRG system in Korea. Our results have important implications for policy makers.

In conclusion, our results showed a shift in health care services from inpatients to outpatients and changes in medical service utilization after mandatory adoption of the DRG system in Korea. Our study suggests that in the future, a more suitable payment system is needed to reduce health expenditures and overutilization. Policy makers should consider changes in hospital health utilization when developing and adopting a new payment system. In addition, evaluation related to the payment system requires investigation of both long-term and short-term effects to improve the reimbursement system. Thus, further studies are needed to evaluate the long-term effects of the DRG system in Korea.

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## SUPPORTING INFORMATION

Additional supporting information may be found online in the supporting information tab for this article:

Appendix SA1: Author Matrix.
Appendix SA2: The Effects of the DRG System on Inpatient Care.