An Evaluation of the Patient Clinical Complexity Level (PCCL) Method for the Complexity Adjustment in the Korean Diagnosis-Related Groups (KDRG)

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Research

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Abstract

Objective

To evaluate the performance of the Patient Clinical Complexity Level (PCCL) mechanism, which is the patient level complexity adjustment factor within the Korean Diagnosis-Related Groups (KDRG) patient classification system, for explaining the variation of resource consumption within Age Adjacent Diagnosis-related groups (AADRGs).

Methods

We used the inpatient claims data from a public hospital in Korea from January 1, 2017 to June 30, 2019, with 18,846 claims and 138 Age Adjacent Diagnosis-related groups (AADRGs). The differences in the total average payment between the four PCCL levels for each AADRG was tested using ANOVA and Duncan's post-hoc test. The three patterns of the differences with R-squared were: the PCCL reflected the complexity well (Valid); the average payment of PCCL 2, 3, 4 was greater than PCCL 0 (Partially Valid); the PCCL did not reflect the complexity (Not Valid).

Results

There were 9 (6.52%), 26 (18.84%), and 103 (74.64%) ADRGs included in VALID, PARTIALLY VALID and NOT VALID, respectively. The average R-squared in VALID, PARTIALLY VALID, and NOT VALID was 32.18%, 40.81%, and 35.41% respectively, with the average R-squared for all patterns of 36.21%.

Conclusions

Adjusting using PCCL in the KDRG classification system exhibited low performance to explain the variation of resource consumption within Age Adjacent Diagnosis-related groups (AADRGs). As the KDRG classification system is used for reimbursement under the New DRG-based PPS pilot project with plans for expansion, there should be an overall review of the validity of the complexity and rationality of using the KDRG classification system.

1 Background

1.1 The importance of complexity adjustment in diagnosis-related groups

Many countries have been concerned about the performance of the Diagnosis-Related Groups (DRG) system for payment accuracy. In the United States, for example, many studies evaluated whether other variables than the diagnosis variable could be used for the DRG or the predictive performance of cost between various types of case-mix measurement systems (1–7). Many other countries have also adopted and applied variables such as types of hospitalization/discharge other than diagnosis or methodologies that can detect variations within patient groups, taking into account their healthcare context (8–11).

1.2 Healthcare system and payment method in Korea

In Korea, more than 90% of hospitals are privately owned (12) with more complex patient case-mix in private hospitals than public hospitals. The main method for payment is the fee-for-service model with no separate payments between hospitals and doctors by the National Health Insurance System.

There are two types of DRG payment systems for patient classification in Korea that roots from the same patient classification system(13, 14): (1) the mandatory DRG-based Prospective Payment System (PPS) for seven diseases, and (2) the new DRG-based PPS for public hospitals. The mandatory DRG-based PPS, including payments for both hospitals and doctors, targets seven relatively simple surgical disease groups and was introduced first in July 2012 to certain clinics and hospitals. It has since been extended to all medical institutions since July 2013. Under the pilot project, the New DRG-based PPS targeted public hospitals with doctors' procedures, expensive therapeutic materials, and some expensive drugs paid separately by fee-for-service payment in the system. Since 2018, the New DRG-based PPS has been extended to private hospitals through voluntary participation.

1.3 Overview of the complexity adjustment of the Korean Diagnosis-Related Groups

The mechanisms for reflecting the complexity of the Korean Diagnosis-Related Groups (KDRG) system, which was developed based on the United States Refined DRG (US RDRG) and the Australian Refined DRG (AR-DRG), are as follows (15, 16); (1) The patient's complications and comorbidities (CC) are assigned a severity score based on the CC list, (2) If there are multiple secondary diagnoses, remove the duplicates by applying an exclusion list, and (3) adjust the severity of the disease group and refine the disease group using the patient clinical complexity level (PCCL) calculation formula that calculates the cumulative effects of the multiple diagnoses. The PCCL was designed to prevent similar diseases being calculated more than once and intended to reflect the cumulative effect of patient’s comorbidities (17, 18). The PCCL value is calculated per patient episode, and Refined DRG (RDRG) per Age Adjacent DRG (AADRG) is determined by considering the statistical criteria and the minimum number of counts (15, 16).

1.4 Follow-up study for previous research

Our previous study reported only 114 (19.03%) out of 599 Adjacent DRGs (ADRGs) had valid Comorbidities and Complications Level (CCL) (19). However, we were not able to evaluate the accuracy of payment at the patient level. As the New DRG-based PPS extends to private hospitals that have more complex patients than public hospitals in Korea, ensuring accurate payment at the patient-level is of an importance. As such, this follow-up study aims to validate the accuracy of payment at the patient-level using the New DRG-based PPS in a public hospital.

2 Methods

2.1 Data

We used a general hospital inpatient claim data, a public hospital, consisting of about 600 beds in Seoul, Korea (January 1, 2017 to June 30, 2019). A total number of 26,784 claims was available in raw data. The PCCL score and DRG code per episode were automatically assigned through the DRG Grouper distributed by the Health Insurance Review and Assessment Service (HIRA), which is responsible for the development of the KDRG classification system. To evaluate the validity of the PCCL method, we used the PCCL scores and payment amount based on fee-for-service, which is proxy measurement for cost.

In KDRG, the Adjacent DRG (ADRG) is determined by a combination of primary diagnosis and main surgical or procedure of a patient, and then classified by age as AADRG. Then, the AADRG is classified as RDRG reflected by the severity of the secondary diagnoses. In the general DRG classification structure, ADRG is split into RDRG, but the classification structure in KDRG follows the order of ADRG-AADRG-RDRG. In this paper, AADRGs can be understood as the same concept as ADRG of the general DRG.

The total number of AADRGs in the KDRGv1.2 classification used for the New DRG-based PPS is 811, excluding Early death DRG, Error DRGs, and Pre-MDC. Of the 26,784 claims in the general hospital claims database, there were 532 AADRGs (Fig. 1). Only 204 AADRGs contained PCCL scores of 0, 2, 3, and 4 of PCCL in 20,609 claims. We estimated the appropriate number of samples using Gpower 3.1 (20) in each AADRG and chose data on 138 AADRGs in 18,846 claims as analysis data.

2.2 Statistical analyses

The general characteristics of the data were reported as mean ± SD or as proportions for gender, age, types of insurance, length of stay, and payment amount. We also showed data characteristics according to Major Diagnostic Category (MDC) in KDRG.

Only the AADRGs that has adequate sample sizes were selected to report. We used Gpower 3.1 (20) to calculate the minimum sample sizes per AADRGs. The alpha was set to 0.05 and the power to 0.8. Effect size was estimated from standard deviation within each group of each AADRG, the sample size, and mean of log-transformed payment amount from the actual data. For example, in AADRG I6821 where the number of groups = 4, SD within each group = 0.2656, the average log-transformed payment amount of 6.32068, 6.45057, 6.7249 and 7.03847, and sample size of 97, 20, 7, 3, respectively. The estimated effect size was 0.5360507 and the minimum sample size was 44. AADRG I6821 was selected to report because the actual sample size of was 127.

To evaluate the performance of the PCCL scores to explain the complexity of the patient, we performed a one-way Analysis of Variance (ANOVA) and Duncan's post-hoc test using PCCL scores as an independent variable and the log-transformed payment amount as the dependent variable (Supplement 1: The diagram of analysis method). The R^2 value of the ANOVA was presented for the explanatory power of the PCCL on the payment amount.

2.3 Pattern analysis

Based on the same criteria as our previous research, we categorized the results of the Duncan's post-hoc test by AADRGs into three different validity patterns: Valid, Partially valid, and Not valid (Supplement 2: Criteria used to classify validity patterns).

The VALID pattern included the AADRGs, in which the average payment amount increased significantly along with increase in the PCCL scores. B6623 in Supplement 3 is a good example. For the PARTIALLY VALID pattern, the average payment amount of PCCL 0 was significantly less than the lowest average payment amount of other PCCLs. Duncan's post-hoc test for the payment amount of E7202 in Supplement 3 showed that the average payment amount of PCCL 3 and PCCL 4 were not statistically different from that of PCCL 2, but different from that of PCCL 0. We considered them inappropriate, but better than NOT VALID. In the NOT VALID pattern, the average payment amount of PCCL 0 is statistically equal to or greater than the average payment amount of other PCCLs. J6002 in Supplement 3 showed that the average payment amount of PCCL 0 is statistically same as that of PCCL 2.

3 Results

3.1 General characteristics

The number of AADRGs and inpatient claims in the raw and analysis data at the MDC level is shown in Table 1. Of the 532 AADRGs, 138 (25.94%) AADRGs were included for analysis in 18,846 (70.36%) claims.

Table 1
The number of Age Adjacent Diagnosis-related groups and claims between raw and analysis data at major diagnositic characteristic level

MDC	MDC title	No. of AADRGs on raw data, n (%)	No. of AADRGs on analysis data, n (%)†	No. of discharge cases on raw data, n (%)	No. of discharge cases on analysis data, n (%)‡
MDC 01	Diseases and Disorders of the Nervous System	66 (12.41)	14 (21.21)	1,994 (7.44)	1,209 (60.63)
MDC 02	Diseases and Disorders of the Eye	9 (1.69)	0 (0.0)	615 (2.30)	0 (0.0)
MDC 03	Diseases and Disorders of Ear, Mouth and Throat	38 (7.14)	2 (5.26)	1,011 (3.77)	299 (29.57)
MDC 04	Diseases and Disorders of the Respiratory System	41 (7.71)	18 (43.90)	4,207 (15.71)	3,404 (80.91)
MDC 05	Diseases and Disorders of the Circulatory System	38 (7.14)	12 (31.58)	2,353 (8.79)	1,843 (78.33)
MDC 06	Diseases and Disorders of the Digestive System	58 (10.90)	23 (39.66)	3,862 (14.42)	3,036 (78.61)
MDC 07	Diseases and Disorders of the Hepatobiliary System and Pancreas	28 (5.26)	12 (42.86)	1,646 (6.15)	1,543 (93.74)
MDC 08	Diseases and Disorders of the Musculoskeletal System and Connective Tissue	69 (12.97)	20 (28.99)	3,073 (11.47)	2,223 (72.34)
MDC 09	Diseases and Disorders of the Skin, Subcutaneous Tissue	25 (4.70)	5 (20.00)	875 (3.27)	220 (25.14)
MDC 10	Endocrine, Nutritional and Metabolic Diseases and Disorders	15 (2.82)	3 (20.00)	963 (3.60)	809 (84.01)
MDC 11	Diseases and Disorders of the Kidney & Urinary Tract	32 (6.02)	15 (46.88)	1,893 (7.07)	1,720 (90.86)
MDC 12	Diseases and Disorders of Male Reproductive System	14 (2.63)	1 (7.14)	286 (1.07)	49 (17.13)

MDC: Major Diagnostic Category; AADRG: Age Adjacent Diagnosis-Related groups; KRW: Korean Won;

† The denominator of the ratio is No. of AADRGs on raw data.

‡ The denominator of the ratio is No. of discharge cases on raw data.

MDC	MDC title	No. of AADRGs on raw data, n (%)	No. of AADRGs on analysis data, n (%)†	No. of discharge cases on raw data, n (%)	No. of discharge cases on analysis data, n (%)‡
MDC 13	Diseases and Disorders of the Female Reproductive System	23 (4.32)	3 (13.04)	629 (2.35)	192 (30.52)
MDC 14	Pregnancy, Childbirth and Puerperium	14 (2.63)	1 (7.14)	722 (2.70)	303 (41.97)
MDC 16	Diseases and Disorders of the Blood and Blood Forming Organs and Immunological Disorders	4 (0.75)	2 (50.00)	244 (0.91)	232 (95.08)
MDC 17	Neoplastic Disorders (Haematological and Solid Neoplasm)	9 (1.69)	2 (22.22)	1,586 (5.92)	1,530 (96.47)
MDC 18 – 2	Infectious and Parasitic Diseases	16 (3.01)	1 (6.25)	158 (0.59)	26 (16.46)
MDC 19	Mental Diseases and Disorders	16 (3.01)	2 (12.50)	376 (1.40)	81 (21.54)
MDC 20	Alcohol/Drug Use & Alcohol/Drug Induced Organic Mental Disorders	1 (0.19)	0 (0.0)	42 (0.16)	0 (0.0)
MDC 21 – 2	Injuries, Poisoning & Toxic Effects of Drugs	14 (2.63)	2 (12.49)	242 (0.90)	127 (54.48)
MDC 22	Burns	2 (0.38)	0 (0.0)	7 (0.03)	0 (0.0)
Total		532 (100)	138 (25.94)	26,784 (100)	18,846 (70.36)

MDC: Major Diagnostic Category; AADRG: Age Adjacent Diagnosis-Related groups; KRW: Korean Won;

† The denominator of the ratio is No. of AADRGs on raw data.

‡ The denominator of the ratio is No. of discharge cases on raw data.

3.2 The validity pattern analysis

The summary of the validity pattern analysis evaluated for the validity of the PCCL scores is shown in Table 2. The average payment amount increased significantly with increase in the four PCCL scores (0, 2, 3, 4) or had a 'VALID' pattern in nine AADRGs (6.52%). There were 26 AADRGs (18.84%) that were 'PARTIALLY VALID' or had average payment amount of PCCL 0 that was significantly less than the lowest average amount of other PCCL scores and the 103 AADRGs as 'NOT VALID' (74.64%) that did not reflect

the complexity between average payment and PCCL score or not valid suggesting that average amount of PCCL 0 was not significantly different from those of other PCCLs.

Table 2
The results of validity pattern analysis

Validity pattern	Total N (%)	R-Squared† (%)
Valid	9 (6.52)	32.18
Partially valid	26 (18.84)	40.81
Not valid	103 (74.64)	35.41
Total (n)	138 (100)	36.21

† The R^2 of AADRGs belonging to each of pattern groups were counted on average.

If we consider the 'VALID' and 'PARTIALLY VALID' patterns as acceptable results in the current four PCCL scores reflecting the variation in average payment amount within AADRGs, the average payment amount of the 103 AADRGs (74.64%) is not accounted for by the current four PCCL scores. On the other hand, if we consider only the 'VALID' pattern as an acceptable result, the average payment for 129 AADRGs (94.5%) is not associated to the four PCCL scores. The average R^2 for the payment amount of AADRGs by the four PCCL scores in the 'VALID', 'PARTIALLY VALID', and 'NOT VALID' pattern was 36.21%. The average R^2 of the 'VALID' pattern between the average payment amount of AARDGs per PCCL scores was 32.18%, which was lower than the average R^2 of 'PARTIALLY VALID' or 'NOT VALID' pattern.

4 Discussion

This is the first study to evaluate the mechanism of patient level complexity adjustment in KDRG. Our results showed that using PCCL for the new DRG-based PPS exhibited low performance. A study conducted in Australia reported a newly developed complexity adjustment mechanism, since the existing PCCL measure developed using limited data on length of stay had not been revised since its first introduction of usage(18). Similarly to our study, this study also reported poor performance using PCCL complexity adjustment on their hospital cost data.

Low performance of PCCL adjustment in determining average payment using the KDRG may potentially be due to various factors used to calculate PCCLs, such as the CC list, CCLs (15) and CC exclusion list (21), which have not been updated since the introduction of such things, as stated in the our previous study (19). Another reason for the poor performance of PCCL adjustment may be due to inaccuracy of secondary diagnoses coding (22). The current coding guideline used in Korea is based on other countries for statistical purpose to find out the prevalence and mortality of the disease and not for DRG-based payments (23). It is currently revised and issued by National Statistical Office under the Ministry of

Economy and Finance, not by the Ministry of Health and Welfare. This administrative structure makes it difficult to reflect clinical reality in various healthcare fields in the guideline.

4.1 Limitations

There are limitations to this study. The results of this study are not generalizable to total patient population paid for New DRG-based PPS, since the inpatient claims were derived from a single medical institution, which was a general hospital and one of the reference institutions based on calculating the base DRG fee for the New DRG-based PPS pilot project. Our research showed poor performance of complexity adjustment mechanism in the KDRG system, despite the hospital conducted this research has a greater proportion of patients with more common and moderate complexity diseases than tertiary hospitals. This suggests that the performance may be worse in hospitals with more complex patient case-mix.

Furthermore, not all of the AADRGs were evaluated because we were limited to the number of DRGs found in our inpatient claims database. Lastly, we assessed the validity of using the PCCL adjustment with the KDRG system on the medical charges and not the cost. The charge for fee-for-service has set up including payments for hospital and doctor under government control and used as a proxy to identify resource consumption in Korea. Furthermore, due to the small sample sizes included per AADRGs, we may have overestimated AADRGs with NOT VALID pattern analysis. However, we calculated the appropriate size of data by AADRGs using Gpower ensuring statistical power.

4.2 Significance

In most countries, DRG is mainly used as a basis for budget allocation (24). In Korea, however, predetermined DRG fee for each disease group is used to directly pay health care providers for their services. As of 2020, there are 37 private hospitals participating in the new DRG-based PPS pilot project with the government providing up to 30% policy participation incentives to hospitals. By 2022, however, participation incentives for the new DRG-based PPS is expected to decrease. Thus, hospitals will be reimbursed for inpatient services solely on the DRG-specific fees calculated based on the cost currently being collected by government. The most accurate and appropriate compensation using the new DRG-based PPS can be determined with stable patient classification system and a reasonable complexity adjustment mechanism. Experts argue for quickly replacing the fee-for-service system with the New DRG-based PPS to stabilize the rapid increase of national medical expenditure and increase health insurance coverage (25). With increasing participation of private hospitals in the New DRG-based PPS pilot project and expansion of the new DRG-based PPS to 200 medical institutions by 2022, there is importance in ensuring payment accuracy using the new DRG-based PPS (26).

5 Conclusion

Poor performance of PCCLs, a mechanism for the patient-level complexity adjustment, in the KDRG system suggest that there should be an overall review of the validity and rationality of using the PCCLs in

the KDRG classification system for reimbursement. According to hospitals that have participated in the pilot project, the hospitals have negative revenue after excluding participation incentives. This can be interpreted as that the compensation for the provision of medical services is not covered the medical charges calculated using the PCCL adjustment in the KDRG classification system, but rather by the participation incentive money that is to be discontinued in the near future.

Although changes in the payment mechanism for providers is inevitable, but stabilization and rationality of the system's components must be ensured, as the payment system is a factor that can affect the providers, insurers and ultimately the patients. Therefore, when designing systems and implementing policies, policy makers should take a more cautious approach considering their long-term impact.

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and materials

The datasets generated during and/or analysed during the current study are not publicly available due the characteristic of data owned by the medical institution but are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors’ contributions

SJ is the first author of the paper, reviewed related papers, analyzed the data, and wrote most part of the paper. BY and KH contributed to the data management, data analysis and interpretation of the results. SM reviewed and gave helpful comments on English version of the paper. SI directed the overall study and is the guarantor for the study. All authors read and approved the final manuscript.

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Figures

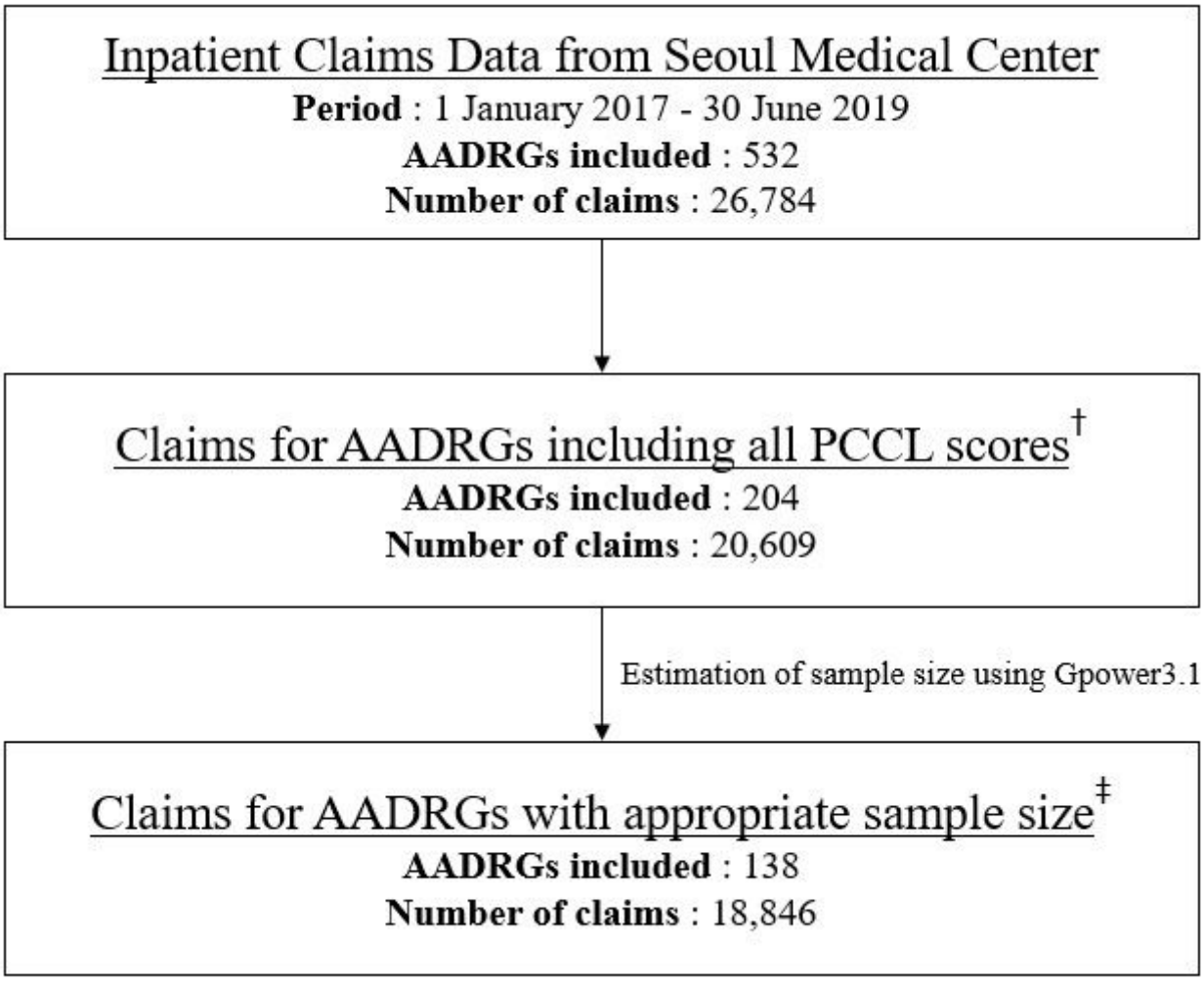

Figure 1

The selection of study data for analysis PCCL: Patient Clinical Complexity Level; AADRG: Age Adjacent DRG; † The PCCL scores consist of 0,2,3 and 4 levels. ‡ The appropriate sample size for ANOVA was analyzed using Gpower according to AADRGs. The sample size means the number of data.

Supplementary Files

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