

# Grouping effects and cost influencing factors of DRG in orthopedic spine surgery cases

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## Research Article

**Keywords:** Cases of spinal surgery, Grouped by disease diagnosis related, Group effects, Influencing factor

**Posted Date:** April 18th, 2022

**DOI:** <https://doi.org/10.21203/rs.3.rs-1556058/v1>

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# Abstract

## Objective:

Analyzing the grouping effect of DRG in orthopedic spine surgery and influencing factors of hospitalization expenses, so as to provide the basis for DRG payment reform and control of medical expenses.

## Methods:

The information of 248 cases of spinal surgery in sample hospitals was analyzed statistically, the grouping effect of DRG was evaluated by the coefficient of variation, and the influencing factors of hospitalization expenses were analyzed by single factor analysis and multiple stepwise regression analysis.

## Results:

Patients who underwent orthopedic spine surgery were divided into three DRG groups: IB19, IB21 and IB23, with CV values of 0.37, 0.47 and 0.44, respectively, all of which were less than 0.5. Univariate analysis showed that age, comorbidities, hospital stay, critical illness and anesthesia mode affected hospital expenses, and the differences were statistically significant ( $P < 0.05$ ). Payment method and gender did not affect the hospitalization expenses, and the difference was not statistically significant ( $P > 0.05$ ). Stepwise regression analysis showed that comorbidities, hospitalization time, dying or seriously ill, anesthesia method and age were the main influencing factors of hospitalization expenses.

## Conclusion:

The grouping of DRG in spine surgery cases can objectively reflect the level of medical resource consumption. Hospitals should use DRG payment reform as a breakthrough to promote clinical pathway management, standardize diagnosis and treatment procedures, shorten hospital stay, and control the unreasonable growth of medical expenses.

## 1 Background

Spinal column disease is a common disease, manifested as cervical spondylosis and lumbar disc herniation. According to statistics, the overall annual median incidence of spinal column diseases in South Korea is 15,877 person-times per 100,000 people [1]. In the population with spinal column diseases, some patients have severe symptoms, which lead to pain, paralysis or deformity of the trunk or limbs [2]. The pain experience caused by spinal column disease will reduce the activities of daily living and the quality of life [3]. With the advancement of medical technology, more and more spinal diseases are effectively treated through surgery. However, the high cost of treatment places a heavy economic burden on the patient's family and society.

Diagnosis Related Groups (DRG) is currently an internationally widely used in patient classification system, which is used to describe the types of patients managed by the hospital and compare the resources required during hospitalization [4]. DRG classifications group inpatient cases with similar clinical processes or comparable resource consumption into groups base on the primary diagnosis, treatment type, individual case characteristics, discharge status, and complications or comorbidities. DRG method is a valuable information tool for hospital management decision-making and result evaluation [5]. DRG is widely used in Europe [6] and has attracted more and more attention in China's health services [7]. In order to reduce the medical burden on patients and effectively control the unreasonable growth of medical expenses, 30 cities in China were designated as national pilot cities for the reform of DRG payment method in 2019 [8]. In this study, the grouping effect of DRG in orthopedic spine surgery cases of a 3A hospital in Panzhihua City, a national pilot city, was taken as the research object, and the grouping effect of DRG was evaluated through the coefficient of variation. The influencing factors of hospitalization expenses were analyzed by single factor analysis and multivariate stepwise method, so as to provide the basis for DRG payment reform and control of medical expenses.

## 2 Data And Methods

### 2.1 Source

According to the grouping scheme of the National Medical Insurance Disease Diagnosis Related Subgroups (CHS-DRG), orthopedic spine surgery cases are divided into three groups according to the conditions of complications and comorbidities: IB19— spine fusion surgery; IB21— Spine surgery other than spinal fusion with important complications and comorbidities; IB23-Spine surgery other than spinal fusion without complications and comorbidities. In this study, the data of orthopedic spinal surgery cases from January 1,2020 to December 31,2021 in the sample hospital was collected to collect data from the home page system and DRG inpatient medical system. Inclusion criteria: (1) A total of cases with the ICD-9-CM-3 code of 80.0–80.9 for surgical procedures was collected. (2) The grouping codes of DRG are IB19, IB21 and IB23, and the exclusion criteria are as follows: ☒ cases are diagnosed as non-spinal diseases clinically; ☒ Cases in which the relevant information between the clinical diagnosis and ICD-10 and between the surgical operation and ICD-9-CM-3 were obviously not matched; ☒ Inpatient data error or incomplete information cases. A total of 248 effective cases was obtained.

### 2.2 Methodology

The database was established by using Excel2010 and SPSS23.0 software for data processing and statistical analysis.  $P < 0.05$  indicated that the difference has statistical significance.. Intra-group consistency evaluation of hospitalization expenses was conducted by using coefficient of variation CV. The smaller the CV value, the smaller the degree of data dispersion would be, and the smaller the cost difference among the patients in the same DRG group would be. The Kruskal-Wallis H test was used to determine whether there was a significant difference in the expenses of each group ( $P < 0.05$ ). If the difference in the expenses of each group has statistical significance, Nemenyi test was used for pairwise comparison. Through literature review and expert consultation, combining with the clinical situation, the

influencing factors of hospitalization expenses in orthopedic spine surgery cases were explored through using single factor analysis and multiple stepwise regression analysis.

### 3 Results

#### 3.1 Basic characteristics of cases of orthopedic spine surgery

The 248 cases included in the DRG study, 123 cases (49.59%) were aged from 31 to 60 years old, 111 cases (44.75%) were over 60 years old, and 14 cases (5.65%) were under 30 years old, besides 125 cases (50.41%) were male and 123 cases (49.59%) were female. Among the payment methods, there were 146 cases (58.87%) of urban workers, 90 cases (36.29%) of urban residents, and 12 cases (4.84%) of other payment methods. The hospitalization days were mainly from 11 to 20 days, 132 cases (53.23%) in total ; 111 cases (44.76%) were critically ill or seriously ill during the hospitalization; 217 cases (87.50%) were with complications; 240 cases (96.77%) were under general anesthesia.

#### 3.2 grouping effect of DRG in orthopedic spine surgery cases

In spine surgery cases, DRG was classified into IB19, IB21 and IB23, and the enrollment rate of IB19 was up to 56.85%. The cost CV values for the DRG subgroups in spine surgery cases were all less than 0.5, indicating good intra-group consistency (Table 1).

Table 1  
Case grouping effects of orthopedic spine surgery in sample hospitals

DRG grouping	Number of cases (n)	Constituent ratio (%)	Hospitalization expenses			
			median	average value	Standard deviation	CV
IB19	141	56.85%	55,123.53	58,917.09	22,057.66	0.37
IB21	36	14.52%	35,183.50	33,764.07	15,832.01	0.47
IB23	71	28.63%	14,924.85	17,968.87	7,878.67	0.44

#### 3.3 Distribution and test of grouping costs of DRG in orthopedic spine surgery cases

The median group hospitalization cost of DRG in orthopedic spine surgery cases was 42,934.245 yuan, and the median of the average hospitalization days was 16 days. The hospitalization expenses of each subgroup passed the K-S test and showed skewed distribution. By applying the Kruskal-Wallis test ( $\chi^2 = 151.007, P < 0.001$ ), the difference in the expenses of DRG subgroups was statistically significant (Table 2).

Table 2  
Percentage distribution of grouping cost and test results of DRG in orthopedic spine surgery cases

DRG grouping	Hospitalization expenses		Cost distribution		K-S test	
	P25	P75	kurtosis	skewness	D	P
IB19	45744.145	64477.05	20.268	3.599	0.159	0.000
IB21	19135.025	41052.575	3.235	1.307	0.168	0.012
IB23	13048.14	19378.38	1.589	1.578	0.194	0.000

To further determine the difference in hospital costs among the groups, Nemenyi was used. Through statistical analysis, the differences in hospital costs between IB19–IB23 and IB19–IB21 groups were statistically significant ( $P < 0.05$ ). By analyzing the difference in the median hospital costs among the groups, it was concluded that DRG grouping could objectively reflect the consumption level of medical resources (Table 3).

Table 3  
Subgroup cost of DRG in orthopedic spine surgery cases Nemenyi test results

Comparison group	Inter-group median difference (yuan)	P
IB19-IB21	19940.035	0.04
IB21-IB23	20258.645	0.36
IB19-IB23	40198.68	0.00

### 3.4 Single factor analysis of hospitalization expenses of orthopedic spine surgery cases

Through consulting the literature and experts, combining with the actual situation of the impending bed, we selected seven cases of spinal surgery cost influencing factors for single factor analysis. It was found that age, comorbidities, hospital stay, critical illness and anesthesia affected hospital expenses, and the differences have statistical significance ( $P < 0.05$ ). Payment method and gender did not affect the hospitalization expenses, and the differences have not statistical significance ( $P > 0.05$ ). In terms of age distribution From the view of age distribution, the average hospitalization expenses of cases in the high age group were higher than those in the low age group. From whether it has the complications, the number of cases with complications was higher than that without complications and the cost was relatively high. From the view of hospitalization days, the hospitalization days were mainly from 11 to 20 days, and the shorter the hospitalization time was, the lower the hospitalization cost would be. Judging from the critical illness situation, the hospitalization expenses of critically ill patients were relatively high.

From the aspect of anesthesia mode, general anesthesia was adopted for the majority, and the cost was higher than that of local anesthesia (Table 4).

Table 4  
univariate analysis of influencing factors of orthopedic spine surgery cases cost

<b>factor</b>	<b>Number of cases</b>	<b>Mean Average Hospitalization Expenses</b>	<b>Standard deviation of mean hospitalization expenses</b>	<b>F</b>	<b>P</b>
Payment method				2.256	0.107
Basic medical insurance for residents	90	39976.1810	20564.90711		
Medical insurance for workers	146	46356.5725	28904.90810		
other	12	36057.4783	15610.72487		
gender				0.864	0.354
man	125	42031.9513	23892.56231		
woman	123	45078.1439	27621.35942		
age				8.308	0.000
Under 30 years	14	46640.2879	41809.08613		
31–60 years	123	37054.4722	21854.48487		
Over 60 years old	111	50341.8153	25761.63933		
complication				32.775	0.000
without	31	20182.8361	11681.94106		
have	217	46879.8972	25550.68876		
LOS				31.065	0.000
Less than 10 days	forty-four	27106.4852	12373.86459		
11–20 days	132	39055.5165	19469.43116		
21–30 days	50	55335.4638	20620.48462		
More than 31 days	22	76537.2223	44676.85037		
Critically ill				26.451	0.000
be	111	52456.3852	22675.41899		
no	137	36320.7799	25997.15631		

factor	Number of cases	Mean Average Hospitalization Expenses	Standard deviation of mean hospitalization expenses	F	P
Anesthesia method				5.717	0.018
general anaesthesia	240	44345.8460	25785.52602		
local anaesthesia	eight	20951.5157	10048.18340		

### 3.5 Analysis of multiple factors affecting hospitalization expenses of orthopedic spine surgery cases

In order to further analyze the influencing factors of hospitalization expenses in orthopedic spine surgery cases, the results of single factor analysis were included in the multiple stepwise regression analysis model to analyze multiple factors affecting the hospitalization expenses. Due to the skewed distribution of hospitalization expenses, logarithm (Y) was adopted to normal distribution approximately, and the factors were coded as follows: payment method (X1), age (X2), gender (X3), comorbidity (X4), Hospital stay (X5), critically ill or seriously ill (X6), and mode of anesthesia (X7). The multicollinearity test of the model shows that the VIF values in the model are all greater than 1 and close to 1, indicating that there is no collinearity problem and there is no correlation among the selected sample data, so the model is good. According to the standardized regression coefficient, it is concluded that the factors influencing the significant difference of hospitalization expenses in orthopedic spine surgery cases are as follows: age (X2), comorbidity (X4), hospitalization time (X5), critical illness or serious illness (X6), and anesthesia method (X7). According to the non-standardized regression coefficient, the multiple stepwise regression equations were established as follows:  $Y = 20343.025 + 5,201.670X_2 + 13,983.596X_4 + 15,334.923X_5 - 13,708.299X_6 - 18,457.492X_7$ , as shown in Table 5.

Table 5  
Regression model for influencing factors of case cost of orthopedic spine surgery

Variables and constants	Unnormalized coefficient		Normalization coefficient			Collinearity statistics
	coefficient of regression	Standard error	Beta	t	P	VIF
payment types/methods	753.306	2,287.687	0.016	0.329	0.742	1.055
age	5,201.670	2,592.558	0.101	2.006	0.046	1.086
gender	3,539.039	2,284.518	0.082	1.549	0.123	1.184
complication	13,983.596	4,117.487	0.178	3.396	0.001	1.169
LOS	15,334.923	1,552.974	0.498	9.875	0.000	1.085
Critically ill or seriously ill	-13,708.299	2,568.693	-0.265	-5.337	0.000	1.055
Anesthesia method	-18,457.492	7,622.568	-0.119	-2.421	0.016	1.034
constant term	20343.025	11575.262		1.757	0.080	

## 4 Discussion

DRG grouping in orthopedic spine surgery cases can objectively reflect medical resource consumption, and analysis of influencing factors of its cost can effectively regulate medical behavior. The CV values of the inpatient costs in the DRG subgroup of orthopedic spine surgery cases were all less than 0.5, indicating good consistency within the group and similar levels of resource consumption. The results of non-parametric test showed that the differences of DRG group costs have statistical significance.. It could be considered that DRG group could objectively reflect the medical resource consumption and reflect the purpose of DRG payment reform. The implementation of DRG group could effectively control medical expenses, standalized medical behavior, promoted the hospital to strengthen management and provided high-quality and efficient services for patients. This study analyzed the influencing factors of medical expenses, which was conducive to hospitals to further standardize medical behavior, control medical costs, improve medical efficiency, and effectively control the unreasonable growth of medical expenses after the implementation of the DRG payment reform.

Patients' age, comorbidities, hospitalization time, critical illness and anesthesia mode affect hospitalization expenses. The patient's age and comorbidities are personality characteristics of spine surgery cases. Data analysis showed a positive correlation between the age of patients and the costs of patients undergoing spinal surgery, with the older the patient, the higher the hospitalization costs. On the one hand, the elderly patients have relatively poor physical health quality and a greater chance of complications; On the other hand, the elderly patients are often in the advanced stage when diseases are

found due to the lack of health examination and disease screening awareness, resulting in increased difficulty in treatment and more cost of medical resources. Therefore, early detection and treatment are great significance to control medical expenses. The research results show that the hospitalization expenses of spine surgery cases with comorbidities are relatively high, which consumes more medical resources. so from the perspective of medical resources and patients' perspective, the occurrence of complications and comorbidities should be reduced, and the safe recovery of patients should be ensured. On the one hand, hospitals should pay attention to discipline construction and medical technology improvement to reduce patients' complications and complications to reduce patients' medical expenses; On the other hand, we should further promote the reform of payment method of DRG, guiding physicians to standardize clinical diagnosis and treatment from the perspective of humanized medical treatment, rather than from the perspective of cost, to ensure medical safety and effectively through this way to reduce the hospitalization expenses.

In the clinical features, the length of stay have a higher impact on the hospitalization expenses. The length of stay is affected by the patient's own factors such as age, disease severity and other uncontrollable factors. At the same time, it is also have a direct reflection of the level and quality of hospital medical care, reflecting the efficiency and effectiveness of hospital management indicators. It can be said that the length of stay directly reflected the level of hospital management to a certain extent. On the premise of making full use of hospital beds, speeding up the turnover of beds and shortening the hospitalization days can effectively reduce the hospitalization expenses. The case type reflected the severity of the disease to some extent. The severer the case, the more health resources it consumed and the higher the hospitalization cost. Therefore, medical industry internal need to establish clinical pathway management and assessment mechanism, and should establish the basis, structure, the end of the whole process of supervision mechanism to ensure the effective implementation of the clinical pathway, effectively regulating the behavior of diagnosis and treatment, shortening the length of stay in hospital; Hospitals should also take the opportunity of DRG payment reform and combine the concept of process reengineering to continuously improve work efficiency and shorten the average length of stay to reduce hospital costs. It is recommended that hospitals adopt the idea of case grouping, actively implement the DRG-based health insurance payment, formulate corresponding clinical pathways and charging standards for hospitalized patients with endometrial cancer with different characteristics, reasonably allocate health resources, and shorten the hospital stay on the premise of ensuring the quality of medical services, so as to achieve the purpose of controlling the increase in hospital costs.

## **5 Research Limitations**

This study is only based on the case data of orthopedic spine surgery in a single hospital, which is unrepresentative. Further research will be conducted through expanding the sample hospital data in the future.

## **6 Conclusions**

Orthopedic spine surgery cases were divided into three DRG groups, with good consistency within the group. Age, comorbidities, hospital stay, critically ill and anesthesia affect hospital costs; Payment method and gender will not affect hospitalization expenses. Comorbidities, hospitalization time, critically ill or seriously ill, anesthesia method and age are the main influencing factors of hospitalization expenses. The grouping of DRG in spine surgery cases can objectively reflect the level of medical resource consumption. The hospital should use DRG payment reform as a breakthrough to promote clinical pathway management, standardize the diagnosis and treatment process, shorten the hospitalization days, and control the unreasonable growth of medical expenses.

## 7 Declarations

Ethics approval and consent to participate

This experimental plan was approved by the Ethics Committee of Panzhihua Central Hospital. As this study was retrospective in design, there is no need for consent to participate to be obtained.

Consent for publication

All authors have approved the manuscript and agree with its submission.

Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Funding

The study was supported by the by the Panzhihua Central Hospital in 2021.

Authors' contributions

This study was designed by Ming-yang Luo. The data in this study were collected and analysed by Ming-wei Luo. All authors contributed equally to this paper.

Acknowledgements

Language editorial assistance sought from the Nature Research Editing Service.

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