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Cost and related factors analysis for patients undergoing colon polyp surgery based on DRG mode

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Abstract. – OBJECTIVE: The aim of the study was to analyze the hospitalization costs of patients with intestinal polyps undergoing colonic polyp surgery and associated influencing factors and to explore the entry point of cost control and the way of fine management.

PATIENTS AND METHODS: One year before (2021) and one year after (2022) the implementation of the Diagnosis Related Grouping (DRG), the patients receiving APC, CSP and EMR in GK39 (colonoscopy operation) group were included in a second Affiliated Hospital in Nanjing according to the Nanjing grouping scheme. Descriptive analysis method and multiple linear regression method were used for analysis.

RESULTS: After the implementation of DRG in 2022, the average hospitalization cost of patients decreased by 19.46% compared with the same period last year. Before and after the implementation of DRG, medical technology costs accounted for the highest proportion of hospitalization costs. Age, hospitalization days, number of polyps, number of clamps and clinical pathway had statistically significant effects on hospitalization cost ($p<0.05$), among which hospitalization days, number of polyps, and number of clamps had the greatest impact on hospitalization cost, followed by age and clinical pathway.

CONCLUSIONS: The implementation of DRG has a positive effect on guiding hospitalization cost control. It is suggested to realize accurate cost control by analyzing the cost structure of the disease group. Clinical pathway completion rate has a direct impact on the implementation effect of DRG, including cost control. It is suggested to refine clinical pathway management and achieve scientific cost control through continuous optimization and improvement of clinical pathway management.

Key Words:
DRG, Intestinal polyp, Hospitalization cost, Clinical pathways.

Introduction

Colorectal cancer (CRC) is the third most common cancer in the world[1]. The incidence of CRC is on the rise, and the disease burden of CRC is significantly increasing[2]. Polypectomy of colon polyps has been shown to reduce the risk of CRC development[3,4]. There are many surgical methods for colorectal polyps, which are mainly divided into three categories: colonoscopic resection, transanal resection, and laparotomy. Common colonoscopic resection can be divided into: argon plasma coagulation (APC), forceps resection, cold snare polypectomy (CSP), endoscopic mucosal resection (EMR), and endoscopic submucosal dissection (ESD). In recent years, with the improvement of residents' health awareness, colonoscopy has been popularized among healthy people, and the detection rate of colon polyps has also been continuously improved[5]. The medical insurance expenditure caused by the treatment of colon polyps has also increased. In January 2022, the reform of Diagnosis Related Grouping (DRG) payment mode was fully implemented in Nanjing, and the inpatients of medical insurance for urban and rural residents and medical insurance for employees in secondary or above medical institutions of the city shall be settled and paid by DRG payment. Most hospitals are in the transition period of DRG policy adaptation. How to achieve the goal of cost control to ensure medical quality and safety is the focus of everyone's attention. In this study, hospitalized patients with intestinal polyps who entered GK39 according to DRG group were mainly studied, the cost-related factors of APC, CSP and EMR were explored, and the entry point of cost control was explored so as to provide the basis for fine management.

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Patients and Methods

Data Sources and Exclusion Criteria

One year before (2021) and one year after (2022) the implementation of the DRG, GK39 (colonoscopy operation) disease group was enrolled in the second Affiliated Hospital in Nanjing according to the Nanjing Diagnosis Related Grouping (NJ-DRG) grouping scheme. The GK39 disease group included patients undergoing APC, CSP, and EMR. Medical records were screened through the DRG information platform and relevant information was obtained. The basic information, clinical characteristics information, cost and its cost structure information were obtained through the medical record HISEE system. Information related to surgery was obtained through medical record system and colonoscopy report.

Inclusion criteria: 1) Patients with intestinal polyp; 2) Patients undergoing APC, CSP, and EMR; 3) Patients aged more than 18 years old.

Exclusion criteria: 1) Patients with other diseases and receiving treatment; 2) Patients with transfer of departments during hospitalization; 3) Patients with other operations or surgeries (such as gastric EMR, ultrasonic gastroscopy); 4) Medical records with missing important information and abnormal data; 5) Due to the patient or family and other factors, the hospitalization process is incomplete; 6) Ultra-long hospital stay (longer than 1 times the average hospital stay of the disease group); 7) Serious complications and complications occurred during hospitalization, and the consumption of medical resources/hospitalization days was greater than the cost/time consumption of intestinal polyp treatment.

Collecting Case Information

The collected information included: 1) Basic information: gender, age, marital status, medical insurance type, admission route; 2) Management factors: clinical route; 3) Clinical characteristics: hospitalization days, preoperative days; 4) Cost information: total hospitalization cost, bed cost, examination cost, treatment cost, medicine cost, consumables cost, nursing cost; 5) Surgical information: Postoperative methods, number of polyps, maximum diameter of polyps, number of sealing clamps.

Statistical Analysis

A processing database was established. EXCEL was used to establish database, and the data were screened and processed. SPSS Version 22.0 (IBM Corp., Armonk, NY, USA) software was used for data analysis. The basic information of patients was analyzed by descriptive method, and the regression model was established by multiple linear regression method. In hypothesis testing, $p<0.05$ was considered to be statistically significant.

Results

Component Ratio Analysis of Hospitalization Cost

The hospitalization cost was divided into six parts: bed cost, nursing cost, treatment cost, medical technology cost, medicine cost and consumable cost. In 2022, the component with the highest average cost ratio is medical technology (laboratory + imaging + pathology), treatment (operation + treatment), consumables, and medicines were 31.56%, 26.82%, 23.38%, and 11.56%, respectively. Compared with 2021, the average cost of each component decreased in 2022 (Table I).

Basic Information Analysis

In 2022, 469 cases were included in the CK39 group, including 312 males (68.44%). The majority of cases were middle-aged and elderly, and the number of cases over 50 was the largest (76.12%). 353 cases

Table I. Component ratio analysis of hospitalization cost.

Items	2021 (517 cases)		2022 (469 cases)	
	Average cost/yuan	Percentage/%	Average cost/yuan	Percentage/%
Medical technology cost	2,408.03±1,122.70	31.90	1,927.60±808.54	31.56
Treatment cost	1,828.59±615.46	24.23	1,637.72±597.04	26.82
Consumable cost	1,826.01±946.66	24.19	1,427.60±786.14	23.38
Medicine cost	1,066.35±493.58	14.13	706.30±243.52	11.56
Bed cost	267.65±97.20	3.55	250.23±99.12	4.10
Nursing cost	150.93±50.61	2.00	157.54±61.28	2.58
Total cost	7,547.56±2,285.58		6,106.98±1,603.9	

(75.27%) were mainly employees' basic medical insurance. 418 patients (89.13%) were mainly admitted as outpatients; the average preoperative days were 2.00 days, and the ratio of 2 days before surgery was 40.94%. The average length of hospitalization was 5.36 days, mainly concentrated in 5-8 days (60.13%). To analyze surgical information, multiple surgical combinations were used. The maximum diameter of polyps was 0.5-1.0 cm, the number of polyps was 3-9, and the number of clamps was 3-6 (Table II).

Table II. Basic information analysis.

Items	Number of cases/cases	Total hospitalization expenses (Yuan)	*t/F* value	*p*-value
Gender			2.445	**0.015**
Male	312	6,234.68±1,732.68		
Female	157	5,853.19±1,275.61		
Age			12.057	**<0.001**
<50 years	112	5,637.84±1,428.74		
50-59 years	188	5,994.42±1,431.47		
≥60 years	169	6,543.10±1,782.47		
Medical insurance category			-1.573	0.116
Basic medical insurance for employees	353	6,040.34±1,645.69		
Basic medical insurance for urban and rural residents	116	6,309.75±1,453.83		
Admission route			-2.398	**0.017**
Outpatient service	418	6,045.28±1,573.53		
Emergency treatment	51	6,612.67±1,764.07		
Preoperative days				
1 day	179	5,803.11±1,222.34	21.058	**<0.001**
2 days	192	5,940.34±1,474.16		
≥3 days	93	7,023.84±2,121.26		
Hospitalization days			65.796	**<0.001**
1-4 days	158	5,445.80±1,183.34		
5-8 days	282	6,212.37±1,408.83		
≥9 days	29	8,684.33±2,392.71		
Surgical method			11.809	**<0.001**
EMR	177	5,859.12±1,557.09		
APC	26	4,947.90±1,244.31		
CSP	37	5,724.74±1,504.17		
Combination of multiple surgical methods	229	6,491.91±1,582.15		
Maximum diameter of the polyp			13.486	**<0.001**
<0.5 cm	21	5,250.73±1,191.92		
0.5-1.0 cm	348	5,968.60±1,435.03		
>1.0 cm	100	6,768.36±1,994.73		
Number of polyps			22.864	**<0.001**
1-2	196	5,582.13±1,288.06		
3-9	204	6,352.40±1,672.07		
≥10	68	6,887.28±1,744.49		
Number of clamps			52.636	**<0.001**
1-2	168	5,751.52±1,434.18		
3-6	191	6,118.73±1,324.83		
≥7	49	8,126.06±1,809.00		
Clinical pathway			2.012	0.045
Incomplete	300	6,218.42±1,777.17		
Complete	169	5,909.14±1,215.07		

Argon plasma coagulation (APC), cold snare polypectomy (CSP), endoscopic mucosal resection (EMR).

Table III. Influencing factors of hospitalization cost in each group.

Factors	Partial regression coefficient	Standard error	Standardized regression coefficient	*t*-value	*p*-value
Gender	-174.427	142.788	-0.051	-1.222	0.223
Age	227.960	89.082	0.108	2.559	**0.011**
Medical insurance category	-48.062	150.815	-0.013	-0.319	0.750
Admission route	400.073	207.279	0.078	1.930	0.054
Preoperative days	204.752	108.692	0.093	1.884	0.060
Hospitalization days	790.740	146.694	0.270	5.390	**<0.001**
Surgical methods	-89.002	58.938	-0.080	-1.510	0.132
Maximum polyp diameter	27.476	164.054	0.007	0.167	0.867
Number of polyps	765.658	128.633	0.329	5.952	**<0.001**
Number of clamps	684.642	107.514	0.282	6.368	**<0.001**
Clinical pathway	-272.309	134.007	-0.082	-2.032	**0.043**

Influencing Factors of Hospitalization Costs

Influencing factors of hospitalization cost in each group

Gender, age, medical insurance category, admission route, preoperative days, hospitalization days and surgical methods, maximum polyp diameter, number of polyps, number of clamps, and clinical pathway were independent variables, and hospitalization cost was used as dependent variables for multiple linear regression analysis. The results showed that age, hospitalization days, number of polyps, number of clamps, and clinical pathway had statistical significance on hospitalization costs ($p<0.05$). Among them, hospitalization days, number of polyps, and number of clamps had the greatest impact on hospitalization cost, followed by age and clinical pathway (Table III).

Analysis of influencing factors of clinical pathways in each group

Evaluation for enrollment rate of clinical pathway: the overall enrollment rate of the intestinal polyp pathway was 35.24%, among which the enrollment rate of multiple surgical combinations was the highest (41.48%).

The influence of clinical pathways on the cost of various surgical procedures

In patients undergoing the combination of multiple surgical methods, the clinical pathway significantly affected the total cost, consumable cost, and average hospitalization days (Table IV).

Discussion

DRG Implementation Has a Positive Effect on Guiding Hospitalization Cost Control

With the gradual release of residents' medical demand, medical costs are also rising, and the excessive growth of medical costs also increases the expenditure pressure of medical insurance funds with each passing day[6]. Our study showed that since the implementation of DRG in 2022, the average hospitalization cost of patients in the GK39 group of hospitals sample has decreased by 19.46% compared with that in 2021, and the cost control effect was evident. The results show that the rational use of DRG can effectively control the growth of medical costs, which is in line with the health insurance reform that does not reduce the income of hospitals, reduces the burden on patients and controls the health insurance fund. This result is consistent with the results of Altman et al[7] analysis of healthcare cost control measures in the United States. The conclusion of Wahler et al[8] and Peng et al[9] was in agreement with this finding, indicating that DRG payment can enhance standardized management, boost medical service quality, and effectively control hospitalization expenses. Under the DRG model, the difference between what a patient actually spends and the standard payment for his clinical pathway group determines the hospital's surplus or loss. The payment feature of "remaining surplus, not covering overspending" economically encourages the hospital to rationally use medical resources, reduce operating costs, and seek the most reasonable treatment process while providing necessary and appropriate medical services. This puts forward higher requirements for hospital management.

Table IV. Analysis of influencing factors of clinical pathways in each group.

Surgical methods	Pathway condition	Case	Total cost (Yuan)	Consumable cost (Yuan)	Medicine cost (Yuan)	Average hospitalization days
EMR						
	Incomplete	115	5,945.66±1696.58	1,616.87±849.04	695.18±228.44	5.52±1.62
	Complete	62	5,702.51±1264.05	1,463.59±570.22	681.02±166.86	5.06±1.31
t-value			0.995	1.281	0.432	1.908
p-value			0.321	0.202	0.666	0.058
CSP						
	Incomplete	26	5,928.27±1,564.09	844.18±479.56	839.23±403.18	6.08±2.51
	Complete	11	5,243.66±1,291.08	942.35±330.70	686.37±156.79	4.73±1.01
t-value			1.276	-0.617	1.211	1.713
p-value			0.210	0.541	0.234	0.096
Combination of multiple surgical methods						
	Incomplete	134	6,753.29±1,794.41	1,639.51±813.07	733.45±295.85	5.72±2.16
	Complete	95	6,123.22±1,131.67	1,383.03±621.60	673.68±142.28	5.04±1.19
t-value			3.022	2.585	1.824	2.757
p-value			0.003	0.010	0.069	0.006

A total of 26 patients receiving APC did not complete the clinical pathway. Cold snare polypectomy (CSP), endoscopic mucosal resection (EMR).

The Implementation of DRG Promotes the Transformation of Hospital Fine Management, and the Analysis and Regulation of Cost Structure Helps To Realize Accurate Cost Control

The implementation of DRG has shifted payment from the traditional gross budget, which is characterized by sub-average cost indicators regardless of disease, to diagnose-based groupings, which means that hospitals need to manage cost structures more fine-grained. The grouping method of DRG makes that the clinical characteristics of patients in the same group have great similarity, and also makes that the characteristics of cost consumption have great comparability. Therefore, by deeply understanding the cost composition and changes in various stages of the treatment process for patients in the same group, we can identify the advantages or problems of cost control and promote the transformation of hospitals from scale expansion and extensive management to quality efficiency and refined management[10]. The study showed that the medical technology cost (examination cost, inspection cost) accounted for the highest proportion, followed by the treatment cost, consumables proportion, and medicine proportion. With the expansion of centralized drug procurement from the "4+7" pilot cities to the whole country, high-value medical consumables have been gradually promoted, and the prices of short-listed drug consumables have been greatly reduced. After a series of major actions implemented by the National Medical Insurance Administration, the proportion of drugs and consumables has decreased. However, it is noteworthy that after the implementation of DRG, the proportion of examination costs in the disease group is always higher than the proportion of treatment costs. The analysis of its causes includes (1) the needs of the disease itself; the diagnosis of digestive system diseases is relatively difficult, need to carry out a number of tests to determine the cause. In order to ensure the safety of surgery, for example, some elderly patients and patients with underlying diseases need to improve preoperative cardiac color ultrasound, lung function determination, and other examinations, increasing the proportion of examination costs. (2) Patient factors: in some cases, patients may choose to undergo certain examinations or multiple examinations for their own needs or other reasons, which increases medical costs. (3) Excessive examination: in order to rule out possible causes, doctors may conduct too many examinations, which increases the expenditure of medical expenses, and the violation of "support doctors through examinations" is not excluded. To solve the problems mentioned above, we can strengthen the training of doctors and update their professional knowledge, and improve the diagnostic level and accuracy of doctors. Also, we could establish standardized examination guide-

lines to help doctors select necessary examinations according to the symptoms and signs of patients and reduce the situation of excessive examination, as well as reduce unnecessary examinations and expenses by carrying out health education and publicity for patients. By continuously optimizing the hospitalization cost structure, avoiding duplicate and unnecessary medical examinations, etc., we aim to increase the proportion of technical surgeries among medical personnel and reflect their technical value[11]. In short, through the analysis and regulation of cost structure, hospitals can accurately control hospitalization costs, improve medical quality and efficiency, and provide better medical services for patients.

Shortening Hospitalization Days Can Effectively Reduce Hospitalization Costs

The impact of four aspects, namely, patient general information, clinical characteristics, surgical information, and management methods, on the cost, were analyzed in this study. By analyzing the influencing factors, the entry point of clinical management was found, which was conducive to further standardizing medical behaviors, controlling operating costs, and improving management efficiency after the reform of DRG. It was found that the total hospitalization cost of GK39 group had significant differences in age, hospitalization days, number of polyps, number of clamps, and clinical pathways. The influence of age on hospitalization cost was significant, which indicated that elderly patients need more nursing care and consume more medical resources in treatment. The number of clamps was related to the number of polyps and the difficulty and complexity of the operation. The more difficult the operation, the more expensive the treatment will be. Medical factors less influence the above factors. However, in clinical work, it is necessary to develop a more rational treatment plan and to adequately assess the difficulty and risk of surgery before surgery to prevent complications. It will reduce the complexity of surgery and lower the cost of treatment. This study showed that the hospitalization days had a significant impact on the cost of hospitalization. The hospitalization day was an indicator that directly reflects the hospital management level, quality of medical care, work efficiency, and benefit[12]. The hospitalization day was directly related to the treatment effect and recovery speed of patients but also related to the utilization efficiency of hospital medical resources. From patients' perspective, long-term hospitalization will also increase the cost of nutrition, nursing, daily necessities, and other aspects of patients. At the level of in-hospital DRG payments, the hospital stay is longer, the use of medical resources is greater, the medical costs required are higher, and the surplus (or loss) based on the group's payment criteria is smaller. Therefore, reducing hospitalization days is necessary to reduce the burden on both patients and hospitals.

Fine Clinical Pathway Management is the Key to Control Hospitalization Costs

This study confirmed that the clinical pathway has a certain influence on hospitalization cost control under DRG mode, but the influence of the clinical pathway on hospitalization cost is weaker than other factors. Further analysis found the following problems: 1. The overall completion rate was not high (36.03%), among which, the completion rate of the APC group was 0, and the completion rate of multi-surgical combination group was the highest (70.90%). 2. Only in the multi-surgical combination group, the completion rate of the clinical pathway had a significant impact on hospitalization costs, consumables costs, and average hospitalization days. Low clinical pathway completion rates did not result in a significant effect of clinical pathway completion on costs and hospital days ($p>0.05$). The completion rate can reflect the rationality of the development of clinical pathway management and the overall situation of the implementation of clinical pathway management. The starting point of the clinical pathway is mainly "cost control" and "efficiency improvement[13]", so the completion rate of the clinical pathway has a direct impact on the implementation effect of DRG, including cost control. According to Yu et al[14], Li et al[15], and Milcent[16], there is a strong synergistic effect between actual clinical pathway management and DRG. In the DRG payment mode, it is necessary to carry out fine management of the clinical pathway. The reduction of unnecessary examination and treatment can effectively shorten the length of hospitalization, improve medical efficiency and reduce hospitalization costs[17].

Conclusions

The implementation of the fine management of clinical pathways requires the cooperation of all medical staff. It is necessary to strengthen the understanding training of medical staff on the significance, objective, and content of clinical pathways and improve their attention. If medical staff have

an insufficient understanding of clinical pathways, it is difficult to promote and implement them. The content of the clinical pathway is too simple and lacks individuality, which is an important reason for the low completion rate of the clinical pathway. Although the three surgical methods of intestinal polyps and their combination forms belong to the same DRG group, the surgical process and postoperative care of different surgical methods are different, so it is suggested to establish the path management of different surgical types so that medical staff can better manage and care according to the pathways. At the level of hospital management, a clinical pathway management team and evaluation steering group should be established. It is necessary to carry out regular evaluations and feedback on the implementation of clinical pathways, timely discover problems and improve plans, and promote the continuous optimization and improvement of clinical pathway management.

Informed Consent
All participants, or their legally authorized representatives, provided written informed consent upon enrollment.

Ethics Approval
The study was approved by the Medical Ethics Committee of Nanjing Pukou District Central Hospital (Ethics No. 2022-SR-013).

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Authors' Contributions
Y. Zhao edited the manuscript and was the guarantor of the integrity of the entire study. Y. Zhao and X. Yan collected data. Y. Zhao and C. Zhu processed the data and the statistics. X. Li and C. Zhu gave the support in everything we needed. Y. Zhao and X. Li designed the research, provided critical comments, and revised the manuscript. All authors contributed to the article and approved the submitted version.

Data Availability
The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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Conflict of Interest
The authors declare that they have no competing interests.

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