BMJ Open Direct inpatient costs and influencing factors for patients with rectal cancer with low anterior resection: a retrospective observational study at a three-tertiary hospital in Beijing, China

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ABSTRACT

Objectives The aim of the study was to investigate the direct inpatient cost and analyse influencing factors for patients with rectal cancer with low anterior resection in Beijing, China.

Design A retrospective observational study.

Setting The study was conducted at a three-tertiary oncology institution.

Participants A total of 448 patients who underwent low anterior resection and were diagnosed with rectal cancer from January 2015 to December 2016 at Peking University Cancer Hospital were retrospectively identified. Demographic, clinical and cost data were determined.

Results The median inpatient cost was ¥ 89 064, with a wide range (¥ 46 711–¥ 191 329) due to considerable differences in consumables. The material cost accounted for 52.19% and was the highest among all the cost components. Colostomy (OR 4.17; 95% CI 1.79 to 9.71), complications of hypertension (OR 5.30; 95% CI 1.94 to 14.42) and combined with other tumours (OR 2.92; 95% CI 1.12 to 7.60) were risk factors for higher cost, while clinical pathway (OR 0.10; 95% CI 0.03 to 0.35), real-time settlement (OR 0.26; 95% CI 0.10 to 0.68) and combined with cardiovascular disease (OR 0.09; 95% CI 0.02 to 0.52) were protective determinants.

Conclusions This approach is an effective way to relieve the economic burden of patients with cancer by promoting the clinical pathway, optimising the payment scheme and controlling the complication. Further research focused on the full-cost investigation in different stages of rectal cancer based on a longitudinal design is necessary.

BACKGROUND

Colorectal cancer (CRC) is the most common gastrointestinal malignancy. In China, the incidence rate of CRC ranks third in malignant tumours and is still in the rising stage, and the mortality rate ranks fifth.^{1–3} According to the overall death of cancers, colorectal neoplasm ranks second and accounts for 10.5%.⁴ Approximately 70% of CRC is rectal cancer, and approximately 70% of CRC occurs in the middle and low position.^{5 6} The treatment is

Strengths and limitations of this study

- This was a study with a large sample size designed for low anterior resection, so our findings are likely to be representative of patients in China.
- The analyses were based on existing data from hospital information systems. Demographic, diagnosis and treatment characteristics were precisely gathered.
- Forest plot is an efficient graphical display for presenting estimated effect sizes and their CIs; therefore, we applied forest plot to visualise the associations between the indicators and the direct medical costs.
- We focused solely on direct medical costs and did not examine indirect costs; thus, full-cost investigation at the regional or national level should be considered in future research.

mainly based on surgery.^{7 8} There are many types of surgical approaches, and the sphincter-saving procedure is currently considered to be the mainstay of therapy, including low anterior resection (LAR), intersphincteric resection and transanal excision. LAR is widely applied to CRC.^{9 10}

LAR is principally carried out on the CRC above the peritoneal reflection. According to previous researchers,^{8 11 12} the local recurrence rate of patients after LAR was 7.14%, the distant metastasis rate was 11.9% and the 3-year postoperative survival rate was 68.6%. Compared with other surgeries, the outcome of LAR is more satisfactory.¹³ Previous studies focused primarily on the selection of surgical approaches, the extent of operation, prognosis and quality of life,^{14–17} while studies addressing its economic burden are relatively lacking.

To address this gap, we conducted this study to analyse the direct hospitalisation

expense and its cost structure for patients with rectal cancer receiving LAR within a representative Beijing oncology hospital. Furthermore, influencing factors of the hospitalisation cost that were measured by regression analysis and depicted by forest plot were identified. These results may contribute to a better understanding of the economic burden of rectal cancer in Beijing and help to pave the way for a healthcare payment system reform and its economic evaluation.

MATERIALS AND METHODS

Study design and setting

This is a retrospective study that does not involve ethical issues. The study was not designed as a clinical efficacy investigation for LAR; thus, no sample size calculation or non-inferiority test was conducted. All data were retrospectively collected from the hospital-based information system. Conducted at Peking University Cancer Hospital (PUCH), which received patients with CRC from all over the country, the study had enough cases for cost analysis.

Study participants

From January 2015 to December 2016, 1596 cases with a primary diagnosis of rectal cancer (International Classification of Diseases 10th revision: C20) were identified. The criteria for exclusion were as follows: (1) lacking detailed surgical records; (2) length of stay (LOS) less than 3 days or more than 24 days, which went beyond 90% CI of LOS; (3) without tumour, node, metastases stage and (4) non-LAR surgery. Finally, we obtained a total of 448 cases. Figure 1 shows the retrieval procedure.

Patient and public involvement

No patients or public were involved in this study. Nor were they involved in developing plans for the design or implementation of the study. There are no plans to disseminate the results of the research to study participants.

Data collection

According to the inclusion and exclusion criteria, we reviewed the medical records of those patients from the Hospital Electronic Patient Records System (HEPRS). The HEPRS entitled us to acquire the real-time query of patients' records. The main variables included demographic characteristics (age, gender and payment), diagnosis (complication, pathological type, differentiation and neoplasm stage), treatment (operation strategy, colostomy, clinical pathway, planned readmitted and specialty) and direct medical expenses. Although China has developed a mixed health insurance system, such as urban employees basic medical insurance, urban and rural residents basic medical insurance and supplementary catastrophic disease health insurance, patients pay for all medical expenses when they choose cross-regional medical care. Given the regional blocks, these patients need to return to their place of residence for reimbursement. Therefore, we divide the 'payment' into a cash

Figure 1 Retrieval procedure of LAR surgery for patients with rectal cancer in PUCH. After these steps, we excluded 1148 cases and identified 448 patients precisely. ICD, International Classification of Diseases; LAR, low anterior resection; LOS, length of stay; PUCH, Peking University Cancer Hospital; TNM, tumour, node, metastases.

payment group and a real-time settlement group. The former refers to patients who were reimbursed at their place of residence, and the latter refers to patients who were reimbursed in Beijing. We considered cardiovascular disease, hypertension, diabetes and other tumours (including colon, liver, ovarian, cervix and lung cancer) as 'complication'. The operation strategy was divided into open surgery and laparoscopic surgery. 'Clinical pathway' referred to whether the patient followed the standard digital clinical pathway provisions, and 'Y' means a clearly defined protocol of care. 'Planned readmitted' referred to whether patients were hospitalised that had planned previously, and 'Y' means elective surgery. 'Specialty in' referred to whether patients were treated in a professional and designated department, and 'Y' means a specialist colorectal unit.

Cost measurements

The study only calculated the direct medical cost, that is, the total treatment cost in the process of inpatient service. According to HEPRS, direct hospitalisation cost can be accumulated into four categories: drug cost, material cost, examination and treatment cost and other costs. In 2016, the Consumer Price Index of Beijing was 101.4, and we think of 1.014 as the discount rate. Additionally, inpatient cost was statistically divided into four grades by means of quartiles (0%–25%, 25%–50%,

50%–75% and 75%–100%), that is, costs were divided into below ¥73 281 (group 1), ¥73 281–¥89 065 (group 2), ¥89 065–¥106 438 (group 3) and above ¥106 438 (group 4) sequentially. Cost data were not normally distributed, so we used the median and IQR to describe the cost situation.

Statistical analysis

SPSS V.22.0.0.0 software was used for data analysis and all statistics. The median and IQR of costs were calculated in our study. Pearson χ^2 or Fisher's exact test was performed to compare the differences within inpatient characteristics. The influencing factors were analysed by ordinal logistic regression, and the ORs were illustrated by forest plot. All statistical approaches were applied assuming a two-sided test based on a 5% level of type I error. $P < 0.05$ was considered to be statistically significant.

RESULTS

General characteristics

A total of 448 hospital clinical files were collected. The age group of 51–60 accounted for 33.5% of all patients. Males accounted for 63.6%. In stage III, 39.3% were moderately differentiated, and 83.7% were moderately differentiated. A total of 334 cases belonged to the real-time settlement, accounting for 74.6%. A total of 57.8%

were given consent to the colostomy. Additionally, 32.1% were combined with other neoplasms. A total of 30, 114, 57 cases had complications with cardiovascular disease, hypertension or diabetes. Approximately 7.1%, 81.2% and 94.2% of patients received laparoscopic surgery, clinical pathway or specialty treatment, respectively. The data compilations are shown in table 1.

Direct medical costs

The direct medical cost for LAR inpatients ranged from ¥46 711 to ¥191 329, with a median cost of ¥89 064. The cost distribution histogram is shown in figure 2, in which the medical cost between ¥76 000 and ¥100 000 occupied the maximum proportion. The cost structure is shown in table 2. The results showed that material cost accounted for 52.19% and drug cost accounted for 30.75%.

Univariate analysis

A total of 448 cases were divided into four cost categories according to the cost volume. Table 3 shows that cost group 4 accounted for 31.9% in the age group of >70 years, and 31.7% of patients were in cost group 1 in the non-colostomy group. In cost group 4, stage IV accounted for 45.8%. According to the univariate analysis, there were no significant differences between age, gender, payment, operation strategy, planned readmitting and differentiation with cost group ($p > 0.05$). Nevertheless, differences between complications

Table 1 Basic situation of selected cases

Variables	No cases	%	Variables	No cases	%
Age			Clinical pathway		
<50	86	19.2	Y	364	81.2
51–60	150	33.5	N	84	18.8
61–70	143	31.9	Planned readmitted		
>70	69	15.4	Y	74	16.5
Gender			N	374	83.5
Female	163	36.4	Specialty in		
Male	285	63.6	Y	422	94.2
Payment			N	26	5.8
Cash payment	334	74.6	Pathological type		
Real-time settlement	114	25.4	Adenocarcinoma	420	93.8
Complications			Others	28	6.3
Other tumours	144	32.1	Differentiation		
Cardiovascular disease	30	6.7	Undetermined	24	5.4
Hypertension	114	25.4	Poorly differentiated	45	10.0
Diabetes	57	12.7	Moderately differentiated	375	83.7
Operation strategy			Well differentiated	4	0.9
Open surgery	416	92.9	Neoplasm stage		
Laparoscopic surgery	32	7.1	I	90	20.1
Colostomy			II	158	35.3
Y	259	57.8	III	176	39.3
N	189	42.2	IV	24	5.3

Figure 2 Cost distribution histogram for low anterior resection surgical inpatients (unit: ¥1000). The interval of grouping was set to ¥25 000, and thus all cases were categorised into seven groups.

of hypertension, colostomy, clinical pathway and neoplasm stage with cost group were recognised ($p < 0.05$).

Multivariate analysis

Based on the results of the univariate analysis, the identification of influencing factors that affected the cost group was analysed by ordinal logistic regression. The X^2 goodness-of-fit test of the model was 70.913, and the p value was 0.000; thus, the model was effective. The results of the ORs of multivariate regression are shown in figure 3. The figure revealed that combined cardiovascular disease, clinical pathway and real-time settlement were protective factors for inpatient cost. Meanwhile, colostomy, combined with other tumours and hypertension were risk factors. Numerically, the risk of incremental inpatient costs for colostomy was 4.17 times higher than that of non-colostomy patients, and the risk of hypertension was 5.30 times larger than that of non-hypertension.

DISCUSSION

This study analysed the direct medical cost of LAR surgery for patients with rectal cancer over the past 2 years in the Beijing healthcare setting. There was a wide range in costs (¥46 711–¥191 329) among those selected patients, mainly

because of the discrepant drugs and disposable medical materials for surgery, which accounted for upwards of 80% of the total direct cost. Similarly, Mohd-Dom *et al*¹⁸ and Son *et al*¹⁹ concluded that the higher costs were largely due to the more expensive consumables. Our results showed that the cost was mainly concentrated in the range from ¥50 000 to ¥100 000. The cost of material accounted for the highest composition (52.19%), followed by drug cost (30.75%). Considering the per hospitalised cost with rectal cancer, we concluded that the cost of material is higher than the other²⁰ for the following reasons: First, compared with other treatments, the demand for medical materials is typically larger in the surgical procedure.¹² Second, with the extensive replacement of new and delicate medical materials, the corresponding price is on the rise.²¹ Third, it may be related to the inclusion and exclusion criteria of this study. Therefore, we can conclude that increasing the cost-consciousness of consumables,²² reducing intermediate links in material circulation, strengthening price control and intensifying clinical rational use are all essential ways for medical institutions to reduce the cost of treatment.

Combined cardiovascular disease was a protective factor. Many scholars have discussed the interaction between cardiovascular disease and tumours, in which cardiovascular disease limits the treatment of a tumour and the tumour limits the treatment of cardiovascular disease as well.^{23–25} PUCH is a cancer-focused hospital in which cardiovascular disease is not our specialised field. There were reports^{23,24} that certain drugs were considered to be conducive to increasing the surgical patient's tolerance compared with these cardiac patients. These explanations could explain why patients with cancer combined with cardiovascular disease had a relatively lower inpatient cost. However, scientifically, the specific mechanism is not yet clear and requires further in-depth study. We found that hypertension and other neoplasms were risk factors for the higher cost. Nasserinejad *et al* found that hypertension adds the risk of mortality in patients with CRC.²⁶ It is widely confirmed that hypertension is an important health issue and is likely to have an impact on expenditure.^{27,28} For other tumours, multivisceral resection is gradually applied,²⁹ increasing medical expenses directly. Regarding diabetes, we did not find a statistically significant expenditure difference. Although diabetes mellitus was referred to as a possible determinant for progression-free survival in localised CRC,³⁰ there is no robust evidence between CRC adverse impact and pre-existing diabetes.³¹

Standardised clinical pathway and real-time settlement could both reduce overall hospitalisation costs, which were consistent with other researchers.^{32,33} Studies have shown that the clinical pathway can effectively contribute to the reduction of the LOS,^{34–36} eventually leading to less direct medical expense. Sylvester and George conducted an integrative review and found that the asthma care pathway for patient with asthma could reduce the hospitalisation cost.³⁵ Ellis *et al* also demonstrated that the clinical pathway is a tool for assisting oncology practice in decreasing costs.³² The previous study showed that insurance benefit design could control care utilisation

Table 2 The cost structure for low anterior resection surgical inpatients (unit: ¥1)

Cost structure	Median	IQR*	%
Drug cost	24 583	17 386	30.75
Material cost	48 657	17 564	52.19
Examination and treatment cost	13 627	4 478	15.52
Other cost	1 110	660	1.54
Total cost	89 064	33 157	100

*IQR referred to the IQR statistically. The reason for using median and IQR was because of its abnormal distribution.

Table 3 Inpatient cost categories and univariate analysis

Variables	Group 1	Group 2	Group 3	Group 4	χ^2 *	P value†
Age					6.799	0.658
<50	25.5	27.9	23.3	23.3		
51–60	28.7	26.0	26.0	19.3		
61–70	23.1	22.4	25.9	28.6		
>70	20.3	24.6	23.2	31.9		
Gender					0.723	0.868
Female	27.0	24.5	25.2	23.3		
Male	23.9	25.2	24.9	26.0		
Payment					5.789	0.122
Cash payment	23.7	24.3	24.3	27.7		
Real-time settlement	28.9	27.2	27.2	16.7		
Complications						
Other tumours	20.8	25.0	22.9	31.3	5.158	0.161
Cardiovascular disease	40.0	20.0	23.3	16.7	4.144	0.246
Hypertension	20.2	17.5	30.7	31.6	9.469	0.024
diabetes	29.8	14.0	35.1	21.1	6.814	0.078
Operation strategy					3.500	0.321
Open surgery	24.2	24.8	25.0	26.0		
Laparoscopic surgery	34.4	28.1	25.0	12.5		
Colostomy					12.108	0.007
Y	20.1	26.3	23.9	29.7		
N	31.7	23.3	26.5	18.5		
Clinical pathway					18.403	0.000
Y	27.7	26.6	24.2	21.5		
N	13.1	17.9	28.6	40.4		
Planned readmitted					0.324	0.956
Y	24.3	23.0	27.0	25.7		
N	25.1	25.4	24.6	24.9		
Specialty in					6.696	0.082
Y	26.1	24.9	25.1	23.9		
N	7.7	26.9	23.1	42.3		
Pathological type					5.790	0.122
Adenocarcinoma	24.5	24.3	25.0	26.2		
Others	32.1	35.7	25.0	7.1		
Differentiation					12.505	0.125
Undetermined	25.0	41.7	8.3	25.0		
Poorly differentiated	33.3	13.3	22.2	31.2		
Moderately differentiated	24.3	25.1	26.4	24.3		
Well differentiated	0.0	50.0	25.0	25.0		
Neoplasm stage					17.848	0.037
I	22.2	27.8	25.6	24.4		
II	22.2	29.1	27.8	20.9		
III	31.8	19.9	22.2	26.1		
IV	4.2	25.0	25.0	45.8		

*All parameters were appropriately compared by χ^2 test with two-sided verification.

†Only hypertension complications, neoplasm stage and applied colostomy and clinical pathway were not found to have statistical differences under 0.05 power.

Figure 3 Multivariate analysis of inpatient cost. Statistical risks of relevant variables were displayed by the forest plot right side. In addition, variables on the left of the cutting line represented the protective factors and on the right represented the risk factors correspondingly.

and save cost.³⁷ Official medical insurance agencies could supervise the patients' hospital costs online, and bills will not be paid if medical behaviours ran counter to the insurance policy, such as faked declaration, drug quantity exceeds reimbursement coverage in one single visit and indiscriminate charge. Thus, it can play a regulatory role in controlling healthcare expenditure. In addition, the implementation of medical insurance could be of benefit to the control of medical expense depending on the joint effort among patient, hospital and government.³³⁻³⁸ Almost three-quarters of patients were in the cash payment group, and the expenditure of those patients was relatively high, which interestingly suggests a feasible direction for the future reform of health insurance policies.

The colostomy was a risk factor for higher cost undoubtedly. Colostomy is an involute procedure, and the separation of adhesion between the abdominal wall and bowel is also complicated³⁹ and consumes more surgical time. Due to occasional excess bleeding control,⁴⁰ the medical consumables will be increased, as well as the labour service of doctors and nurses.

In conclusion, this study showed that colostomy, real-time settlement, clinical pathway and comorbidities are all independent factors that affect the hospitalisation cost of LAR surgical patients with rectal cancer. To alleviate the economic burden of patients with cancer, it suggests

that rationally promoting the clinical pathway, optimising the payment scheme and controlling the complication are effective approaches. Additionally, because of the limitations of the study, further research focused on a full-cost investigation in different stages of rectal cancer based on a longitudinal design is needed.

Consent to participate

Anonymised and de-identified data, as well as no interventions, were used, so informed consent was waived.

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