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Original Research

Application and effectiveness evaluation of the information system-based RBRVS performance allocation model in a digestive endoscopy center

Lai jifeng, Ying Huang*, Yue Li, Hongxiang Gu, Huifeng Lai, Side Liu

Department of Gastroenterology, Nanfang Hospital, Southern Medical University, Guangzhou 510515, China

*Corresponding: 371016792@qq.com

Abstract:
Objective: To improve work enthusiasm and medical service quality for gastrointestinal endoscopists. Taking the Resource Based Relative Valae Scale (RBRVS) performance allocation model as a reference, we used the informatization graphic workstation as a basis to construct and implement a performance appraisal system which is suitable for our Endoscopy Department. Subsequently, we assessed the application results of the performance reform.

Methods: Based on the RBRVS theory, the informatization graphic workstation was used to automatically calculate physician workload and conduct quantitative assessment. One gastroscopy was used as the minimum workload unit and every endoscopic diagnosis and treatment was quantified into multiple gastroscopies according to different technical levels. Next, the actual value of each gastroscope was assessed based on different job titles. Then we compared the work efficiency before and after the reform.

Results: Following informatization performance reform, the number of endoscopy examinations and number of surgeries significantly increased, while the length of hospital stay of gastrointestinal endoscopy patients was significantly shortened ($P < 0.05$).

Conclusion: Informatization performance reform improves department work efficiency, reflects the labor value of gastrointestinal endoscopists. The principles of more work leading to more reward, equality, and fairness, and should be promoted.

Keywords: Performance reform, Bonus allocation, Workload, RBRVS, Gastrointestinal endoscopist

In March 2019, the General Office of the State Council issued the Opinions of the General Office of the State Council on Strengthening Performance Appraisal of Tertiary Public Hospitals, which emphasizes performance appraisal, to promote transformation from the scale expansion model to a quality benefit model in tertiary public hospitals. This change will allow transformation from extensive administrative management to comprehensive performance management, as well as the promotion of a more science-based and fairer income allocation method to achieve higher efficiencyand quality and promote integrated public hospital reform policies [1, 2]. At the same time, with the

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rapid development of medical informatization, more and more hospitals in China are accelerating the implementation of the overall construction of the Hospital Information System (HIS) based on the informatization platform, in order to improve the service level and core competitiveness of hospitals. Medical informatization improves the accuracy of information statistics and promotes the improvement of medical service quality in public hospitals [3].

Gastrointestinal endoscopy centers are medical technology rooms with unique characteristics and are mainly used for gastrointestinal endoscopy examinations and surgeries. The physician bonus allocation in many hospitals has largely adopted the traditional allocation method based on job title and does not fully realize the labor value of physicians [4]. The traditional distribution method of the center mainly takes the length of service and professional title as the main distribution factors. Fixed salary accounts for a high proportion, while the workload assessment weight is low, which does not fully reflect the post value of doctors, and to some extent reduces the enthusiasm of doctors. Based on the actual situation of the gastrointestinal endoscopy center, our department started referencing the resource-based relative value scale (RBRVS) performance allocation model for bonus allocation in endoscopists from January 2017 onwards. The RBRVS is a payment system that objectively evaluates the labor value of medical staff based on resources consumed in diagnosis and treatment services and scientifically and rationally verifies the relative value of each service through comparison of the resource cost investment when medical staff provide diagnostic and treatment services to patients. The service volume and the total budget for service fees are used to calculate the enumeration for physicians for each diagnosis and treatment item [5-8]. This is combined with the informatization graphic workstation to automatically calculate the physician workload and achieve efficient performance calculation. After 5 years of practice, the new performance reform has encouraged work enthusiasm and service awareness in physicians, improved endoscopy workload and department benefits, and obtained good results.

1. Participants and methods

1.1 Study participants

Our hospital is a grade A tertiary hospital with ten gastrointestinal endoscopy centers. There are nine resident endoscopists, of which one is a senior endoscopist, one is vice-senior endoscopists, four are attending physicians, and three are resident physicians.

1.2 Bonus allocation method

1.2.1. Establishment of the bonus allocation group

The members of the bonus allocation group include the chief and deputy chief of administration, head nurse, deputy chief of operations, and performance appraisal members. Decision-making, discussion, and implementation of the departmental bonus allocation scheme was conducted.

1.2.2. Allocation scheme

Detailed classification of the number of endoscopic diagnoses and treatments of each physician in the department was conducted using the informatization graphic workstation (Endoscopy medical imaging information management software V5.0, Guangzhou Gaotong Pacs Technology, Guangzhou, China). The statistical results are shown in Table 1 and Table 2. The RBRVS theory was used for departmental performance allocation standards and a single gastroscope was used as the minimum threshold value. Risk, technique, cost, physical strength, and brainpower were used for integrated evaluation of different work quantitative assessments based on the number of tasks completed by staffs. Staffs were directly allocated based on the point value allocation standard [9, 10]. The score coefficient of single gastroscopy is calculated according to the level of professional title, and the corresponding score is set according to the level of professional title. In order to reflect the work value of senior professional title, the corresponding professional title subsidy is given every month. Performance statistical calculation formula: physician performance bonus = workload × score + professional title subsidy + other special subsidies. Table 3 shows the specific point conversion.

1.2.3. Coefficient standard

Different quantitative standards are set for each gastroscopy score coefficient based on the job title, and corresponding adjustments to the base could be made based on the total departmental income.

1.2.4. Service quality.

According to public hospital reform requirements, medical service quality has become one of the core markers in performance reform. To ensure that patients have a good consultation experience, we set up a large display screen to play examination precautions in the waiting area, added a payment window, automatic calling system, and patient opinion box, and set up a public account for the endoscopy center. Corresponding bonuses were given to staff who received commendations from society, media, patients, and the hospital based on the

Table 1. Details of endoscopist operations at the gastroenterology Endoscopy Center

NO.	Name	Gastroscopy	Colonoscopy	Endoscopic ultrasound	Colonoscopic ultrasound	Pancreas ultrasound	double-balloon enteroscopy	EMR	ESD	Ultrasound biopsy	Dilatation of digestive tract	Foreign body removal	...	Total workload
1	Cheng	225	181	5	3			45					...	654
2	Xie	206	147	87	20	13		30	1	4		1	...	884
3	Han	361	346					69	6			1	...	1329
4	Qiao	193	165	15	10	2	5	15	1				...	629
5	Guo	355	251					10					...	775
6	Fang	501	287					53						1094
7	Wang	139	105	62	16	6		8		2			...	572
8	Luo_1	232	186	23	7	3		13	1		1	1	...	713
9	Luo_2	363	359					24	1				...	1003

Table 2. Details of endoscopist Performance at the gastroenterology Endoscopy Center

NO.	Name	professional title	Professional title subsidy	Professional title score	Endoscope volume	Endoscopic performance	ERCP	Tolerance allowance	Annual leave allowance	Duty allowance	Transportation subsidy	bonus
1	Cheng	high professional title	3000	50	654	32700		0	0	0	0	35700
2	xie	Associate senior title	2000	40	884	35360		800	0	0	300	38460
3	Han	attending doctor		30	1329	39870		0	0	400	0	40270
4	Qiao	attending doctor		30	628.759	18863		0	2500	400	100	21863
5	Guo	attending doctor		30	775	23250	160	0	0	100	1400	24910
6	Fang	attending doctor		30	1094	32820					1500	34320
7	Wang	resident doctor		25	572	14294		400	0	300	300	15294
8	Luo_1	resident doctor		25	713	17825	160	0	2500	900	300	21685
9	Luo_2	resident doctor		25	1003	25075		0	0	400	100	25531
	Total		5000	285	7653	240057	320	1200	5000	2500	4000	258077

Table 3. Detailed conversion of workload in gastrointestinal endoscopy centers

Surgery item	Conversion to number of gastroscopies	Surgery item	Conversion to number of gastroscopies
Gastroscopy	1	Polypectomy	3
Colonoscopy	1.5	PJ syndrome/polypectomy	6
Endoscopic ultrasound	2	Gastroesophageal varices surgery	3
Colonoscopic ultrasound	3	Foreign body removal	3
Pancreas ultrasound	4	ERCP surgery	7
Ultrasound biopsy	5	Gastrostomy	4
Double-balloon enteroscopy	8	ESD/ESTD/POEM/NOTES surgery	6
Endoscopy room emergency	4	Stent implantation in the esophagus	3
Nighttime emergency	6	Endoscopic dilation surgery	3
Bedside emergency	6	Endoscopic fistula closure	3
Operating room emergency	6	Endoscopic hemostasis	3

departmental system. Relevant persons-in-charge were responsible for patient complaints or medical malpractice and fines or transfers were given in serious cases.

1.2.5. Risk control

Physicians are prevented from blindly seeking workload , which may cause missed diagnosis or misdiagnosis to occur, thereby harming the interests of the department and patients. Departmental regulations: All diagnosis and treatment are performed according to medical practice, and quality control staff and zone supervisors are present in the department for routine supervision for quality and quantity assurance.

1.2.6. Establishment of the performance statistical informatization system

The appointment nurse and counter nurse use the informatization graphic workstation for unified registration of the operation item content of the endoscopist. Physicians can check the score and work details of daily work. Every month, the department performance appraisal staff and head nurse reviewed the accuracy of endoscopic surgery registration through endoscopy reports and payment, and this is listed as the physician's actual performance after approval. Every month, the performance list is summarized and printed, and each physician verifies and signs their personal performance statistical data, which are then reviewed by the departmental chief.

1.2.7. Rewards and subsidy

To achieve a balanced development of the department's medical level, the department bonus allocation group also provides corresponding subsidies and rewards for routine work, training, teaching, research, shift, annual leave, and special surgeries for physicians.

2. Results and analysis

2.1. Changes in gastrointestinal endoscopy center workload before and after performance reform

The total number of endoscopies, number of examinations, and number of surgeries increased annually after the reform. The daily appointment workload was completed with quality and quantity assurance, and generally without delay. The number of examinations and surgeries in the Gastroenterology Department in 2015 was 35832 and 2850, respectively. The number of examinations and surgeries in the Gastroenterology Department in 2016 was 38200 and 4059, respectively. The number of examinations and operations in the department of Gastroenterology increased year by year from 2017 to 2021. Except for a decline in the number of examinations and operations in 2020 due to COVID-19, the data of other years showed a significant increase compared with the previous year. Detailed statistical data are shown in Table 4-1 and Table 4-2. Overall, the total number of diagnoses and treatments, number of examinations, and number of surgeries in the Gastroenterology Department showed an increasing trend annually.

2.2. Changes in the average length of hospital stay before and after performance reform

Performance reform effectively shortens the length of hospital stay of endoscopy patients. To study the effects of performance reform on the average length of stay, we calculated the average length of stay before performance reform intervention (2015 and 2016) and after performance reform intervention (2017-2021). The average lengths of stay for endoscopic surgery in 2015, 2016, 2017, 2018, 2019, 2020, and 2021 were 7.66 days, 7.45 days, 6.60 days,

Table 4-1. Number of cases of gastrointestinal endoscopic diagnoses and treatments and year-over-year (YoY) growth in 2015-2021

Category	Number of cases in 2015 (n)	2016 Number of cases (n)	2016 YoY growth (%)	2017 Number of cases (n)	2017 YoY growth (%)	2018 Number cases (n)	2018 YoY growth (%)
Examination	35832	38200	6.61	41858	9.58	43086	2.93
Surgery	2850	4059	42.42	4646	14.46	5943	27.92

Table 4-2. Number of cases of gastrointestinal endoscopic diagnoses and treatments and year-over-year (YoY) growth in 2015-2021

Category	Number of cases (n)	2019 Number of cases (n)	2019 YoY growth (%)	2020 Number of cases (n)	2020 YoY growth (%)	2021 Number of cases (n)	2021 YoY growth (%)
Examination	35832	57800	34.15%	34325	−40.61%	54701	59.36%
Surgery	2850	7849	32.07%	5947	−24.23%	7790	30.99%

6.43 days, 6.35 days, 5.98 days, and 5.81 days, respectively. The average length of stay was lower after the implementation of the performance reform compared to before, suggesting that performance reform decreases the average length of stay. Additionally, the average length of stay before intervention in 2016 was lower than that in 2015. After intervention, the average length of stay successively decreased every year, showing that the average length of stay will decrease with time regardless of intervention. Detailed statistical data are shown in Table 5.

To avoid the effect of the time factor on the average length of stay, we used a multivariate linear regression model to examine the independent effects of performance reform on average length of stay. The results are shown in Table 4. The regression coefficient shows the effects of performance reform and time on the length of stay. After correcting for the effects of time, the results show that performance reform is negatively correlated with length of stay, with a corresponding P-value of 0.003, showing that performance reform decreases the length of stay. The corresponding P-value for time was 0.065, showing that the correlation between time and length of stay was not statistically significant. In summary, performance reform is negatively correlated with average length of stay, and performance reform effectively shortens the length of stay of endoscopy patients. Detailed statistical data are shown in Table 6.

2.3. Changes in gastrointestinal endoscopy center bonus before and after performance reform

By comparing the traditional performance appraisal and new performance appraisal systems in 2015–2018, we calculated the bonuses received by endoscopists with different job titles. The results are shown in Table 7. Compared to the traditional performance appraisal system, the bonus growths of Chief Physicians, Associate Chief Physicians, Attending Physicians, and Resident Physicians based on the new performance appraisal system were 10.86%, 82.37%, 75.16%, and 105.78%, respectively. The new performance appraisal system increased the performance of endoscopists with different job titles; particularly, the bonuses of young physicians who do most of the work were significantly increased.

Table 5. Average length of stay for surgeries in the Gastroenterology Department in 2015-2021

Category	Before implementation		After implementation				
	2015	2016	2017	2018	2019	2020	2021
Number of inpatients (n)	986	909	1923	2355	3066	3065	3826
Average length of stay (days)	7.66 ± 5.47	7.45 ± 5.57	6.60 ± 3.08	6.43 ± 2.41	6.35 ± 2.57	5.98 ± 2.24	5.81 ± 2.10

Table 6. Regression analysis of the effects of performance reform on average length of stay

Regression coefficient						Model summary				*ANOVA*	
Model	Non-standardized coefficient		Standardized coefficient	*t*	P-value	*R*	R^2	Adjusted R^2	Standard estimation error	*F*	P-value
	B	Standard error	*Beta*								
Constant	369.802	196.206		1.885	0.060						
Reform	−0.682	0.227	−0.082	−3.002	0.003	0.129	0.017	0.016	3.81	52.023	< 0.001
Time	−0.180	0.097	−0.050	−1.846	0.065						

Table 7. Comparison of two bonus allocation methods for endoscopists with different job titles

Job title	Traditional bonus (RMB)	New bonus (RMB)	Growth (%)
Chief Physician	14004.38 ± 2528.07	15478.21 ± 7411.95	10.86 ± 51.09
Associate Chief Physician	12055.60 ± 2161.16	21320.55 ± 9808.40	82.37 ± 93.03
Attending Physician	10007.38 ± 1673.83	17631.04 ± 8535.75	75.16 ± 78.39
Resident Physician	7809.68 ± 1403.35	15834.01 ± 6233.64	105.78 ± 82.61

Next, we performed analysis of variance (ANOVA) to further compare the differences in bonus growth between endoscopists with different job titles. From ANOVA, the F-value was 11.824 and the corresponding P-value was < 0.001, showing statistically significant differences in the bonus growths between endoscopists with different job titles. We performed LSD multiple comparison to identify which job titles showed differences in bonus growth. The bonus growth comparison results were senior physicians < vice-senior physicians < senior resident physicians < attending physicians. The bonus of senior physicians was the highest, but the bonus growth was the lowest, while resident physicians had the lowest bonus but highest bonus growth. There was no significant difference in bonus growth for vice-senior physicians and attending physicians. Detailed statistical data are shown in Table 8.

Table 8. LSD multiple comparison of bonus growth between different job titles

Job title 1	Job title 2	Standard error	P-value	95% CI
Chief Physician	Associate Chief Physician	16.51	< 0.001	(−104.019, −38.993)
	Attending Physician	21.896	0.004	(−107.419, −21.181)
	Resident Physician	15.982	< 0.001	(−126.388, −63.443)
Associate Chief Physician	Attending Physician	19.025	0.705	(−30.261, 44.672)
	Resident Physician	11.746	0.047	(−46.541, −0.278)
Attending Physician	Resident Physician	18.569	0.1	(−67.183, 5.952)

3. Discussion

In recent years, it is one of the important tasks to deepen the comprehensive reform of public hospitals to accelerate the study of the performance distribution scheme which accords with the characteristics of the medical and health industry. In May 2015, The State Council proposed in the Guiding Opinions on the Pilot Comprehensive Reform of Urban Public Hospitals that pilot cities should explore ways to determine the total amount of performance-based pay in public hospitals, improve the performance-based pay system, achieve more work, more pay for high performance, and give priority to front-line clinical and business backbone personnel, so as to reasonably widen the income gap. Taiwan is the first place in China to introduce RBRVS as a performance allocation method. Later, third-class medical institutions in China, such as Cancer Prevention Center of Sun Yat-Sen University and West China Hospital of Sichuan University, also formed their own performance management methods based on RBRVS. However, in each stage of implementing localized RBRVS, medical institutions still need to solve many difficulties, which need to be explored and improved in practice [9].

The Center of Digestive endoscopy is subordinate to the Department of gastroenterology in major hospitals. However, with the development year by year, the diagnosis and treatment methods of liver, biliary and pancreatic diseases have been carried out, gradually forming an independent discipline. With the continuous increase of digestive endoscopy in China, a total of 7470 medical institutions carried out digestive endoscopy diagnosis and treatment in 2019, and the annual treatment volume was 38.73 million cases. The increasing demand for medical treatment also increases the number of physicians, and the diagnosis and treatment items of digestive endoscopy are also diversified. Therefore, it is unreasonable to continue to implement the traditional performance-based salary management in endoscopy centers. In order to highlight the technical content of endoscopists, the new performance-based salary management system is an inevitable choice for public hospitals to achieve high-quality economic development. In this study, the comprehensive deployment of our informationized graphic workstation, clear assessment indicators and diagnosis and treatment items, and the relative workload assessment by using simple electronic gastroscopy as the standard operation have increased the feasibility of performance reform of RBRVS in the department of digestive endoscopy of our hospital. At the same time, we set up an efficient performance appraisal team to ensure the application effect of the new performance reform.

In this study, we evaluated the application effect of RBRVS performance distribution model through 5 years of practice. First of all, Performance reform improves gastroenterology economic benefits. The performance reform has significant results on increasing the total workload and number of endoscopic surgeries in the gastrointestinal endoscopy center. Especially after the performance reform, its year-on-year growth rate is significantly higher than that of the first two years of the performance reform. The increase in the number of surgeries not only promotes the development of the department but also increases the overall medical level of the hospital. Moreover, it further reflects the technical labor value of physicians and increases physician salary and overall department income. Secondly, the hospital stay of patients undergoing endoscopic surgery was shortened after the reform. It was reduced from 7.66 days to 5.81 days. In order to avoid time as a confusing factor, the multivariate linear regression model was used to analyze the negative correlation between the independent influencing factors and the average length of stay before

and after the reform. the length of stay of inpatients endoscopic surgery was shortened. The shortening of hospital stay not only makes reasonable use of medical resources, but also effectively reduces the cost of hospitalization, alleviates the economic pressure of patients, and improves the satisfaction of medical staff and inpatients [10]. Third, the performance reform makes the bonus distribution of departments scientific and rational. The bonus of endoscopy physicians with different titles will increase correspondingly in strict accordance with the prescribed distribution method. Although the resident physicians have a lower title, they can get a significant increase of 105.78% by completing the corresponding workload. The work of gastrointestinal endoscopists is of high intensity and high risk. The workload-based reform scheme changes the traditional allocation concept as it not only considers workload but also the responsibilities, skills, difficulties, and risks of other positions and is a fairer "more work leading to more reward" allocation system [11]. This overcomes the shortcoming of equalitarianism in traditional bonus allocation, enabling the value of every endoscopist to be fully reflected, and allowing more scientific and rational departmental bonus allocation, thereby improving work efficiency and work enthusiasm in gastrointestinal endoscopists [12]. Finally, Performance reform reflects teamwork. After performance reform, the work system of endoscopists changed from a passive system to an active system, which also increases the cohesion between the departmental staff. In times of heavy workload, most endoscopists are willing to stay and complete work, which relieves the pressure on on-duty physicians and avoids physical and mental exhaustion in on-duty physicians due to long overtime. Endoscopists generally are not late for work, do not knock off work early, and are more proactive when encountering emergency and surgery patients.

Although performance reform has many benefits there are some risks in the performance appraisal. As bonuses are intimately associated with workload, it is inevitable that some physicians seek to increase workload blindly for the bonus. The performance appraisal scheme requires accurate statistical data and proper supervision, and physicians must control the risk of diagnosis and treatment and not blindly pursue speed, which may cause missed diagnosis or misdiagnosis. To achieve proper supervision, an experienced professor in the department is in-charge of daily inspection, technical guidance, and reviewing endoscopy diagnosis and treatment reports to provide technical support for young physicians and control risk. During the daily handover in the department, special case discussions and safety quality control assessments are conducted to increase medical safety diagnoses and treatment awareness and continuously increase the technical diagnosis and treatment levels of the department. The department has also developed related rewards and punishment measures to control and prevent medical hazards. Since the performance reform has been implemented for 2 years, effective supervision of various aspects of the department has been conducted and no medical errors or malpractice have occurred. With the rapid advances in endoscopy, we will continuously improve the performance appraisal and indicators in practice. In summary, this performance reform has some promotion value.

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