

A Case Study on the Efficiency of Medical Insurance Cost Accounting in Public Hospitals Under DRG Policy — Taking XX Hospital as an Example

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Abstract: This study focuses on a tertiary public hospital in XX, employing Data Envelopment Analysis (DEA) and cost accounting methods for specific diseases to systematically evaluate its cost efficiency performance and optimization paths in DRG payment reform. By constructing a dual-dimensional model of “internal time series analysis + external benchmark comparison,” combined with the BCC model and Malmquist index, the study analyzes the dynamic changes in hospital efficiency from 2019 to 2023. The findings are as follows: (1) The overall technical efficiency (TE) of the hospital is 0.82, indicating an efficiency loss of 18%, primarily due to redundant drugs and medical supplies (15.2%) and the case mix index (CMI) gap (5.6%); (2) High-weight DRG diseases (such as interventional treatment for acute myocardial infarction) have a cost overrun of 16.3%, significantly dragging down overall efficiency; (3) Standardizing clinical pathways and collaborating with regional resources can improve efficiency to industry benchmark levels. This case provides a theoretical and operational framework for detailed cost management in individual hospitals.

Keywords: DRG Payment; Data Envelopment Analysis; Disease Cost Accounting; Case Study

Published: Apr 16, 2025

DOI: <https://doi.org/10.62177/apemr.v2i2.243>

1.Introduction

1.1 Research background and significance

The DRG (Diagnosis Related Groups) payment method is a way to set fixed reimbursement costs for medical insurance using a unified disease diagnosis classification, which is currently recognized as one of the more advanced methods of medical insurance payment^[1]. It charges per disease, with the health insurance bureau planning out the budget in advance. Any excess cost is borne by the hospital, which, to reduce costs and cut budgets, will prescribe relatively cheaper medications^[12]. The DRG payment method reconstructs the medical expense settlement mechanism through “prepayment + standardized diseases,” compelling public hospitals to shift from “scale expansion” to “cost control”^[7]. However, individual hospitals lack horizontal efficiency benchmarking tools, making it difficult to accurately identify cost loopholes. This study uses XX Hospital as a sample to explore efficiency evaluation and optimization paths applicable to single hospitals, providing micro-empirical support for the implementation of DRG policies^[13].

1.2 Significance of the study

Shifting the pricing power of medical services from providers (hospitals) to payers (health insurance). Since the launch of

DRG pilots in 2019, over 200 cities in our country have been included in the reform scope^[2]. However, public hospitals have long relied on the crude model of “relying on drug sales to fund healthcare” and “paying per service,” which faces two major contradictions under the DRG payment system: first, the pressure to control costs has sharply increased, with hospitals needing to cover all treatment costs within a fixed payment amount; second, the lack of efficiency evaluation tools makes it difficult for managers to quantify the impact of DRG on resource allocation^[16]. Now, with the reform of China’s health insurance policy, ordinary citizens pay different monthly premiums, which are collectively incorporated into the health insurance fund, commonly referred to as the national health insurance pool. Timely payments by ordinary residents also ensure they can access the health insurance fund when facing major illnesses, making each insured resident a beneficiary of the health insurance fund^[3]. From the perspective of ordinary residents, they are both payers and beneficiaries. From the national perspective, how the government can effectively use the funds and maximize the efficiency of the health insurance fund is not just the responsibility of the government. Ensuring adequate benefits for urban and rural residents, reasonable distribution, and efficient allocation are also social responsibilities shared by the National Health Insurance Administration and public hospitals^[4].

2. Research objectives and innovations

2.1 Research Objectives:

To build a cost efficiency evaluation model of DRG for a single hospital;

Put forward an operable efficiency optimization strategy.

The current DRG grouping rules and the implementation of DGR charges pose a significant challenge to China’s healthcare system, which includes all public and private hospitals. The introduction of DGR will alter the profit model of domestic hospitals, inevitably compelling them and their doctors to reduce unnecessary examinations and treatments, maximizing the pooling effect of medical insurance funds and rationalizing medical resources. Initially, the aim was to prevent over-treatment and leverage the economic regulatory role of medical insurance funds^[5]. The government’s medical insurance bureau aggregates all data through information systems, categorizing them by region, category, and disease group under the DRG system. The medical insurance payment standards are based on the cost expenditures of different hospitals within the same pooling area, balancing fairness and efficiency^{[15][17]}. The DGR reform aims to return hospitals to their public welfare nature, ensuring that everyone can afford healthcare. By analyzing the characteristics of different DRG groups and the actual conditions of medical services, the goal is to more accurately reflect the costs and quality of medical services. Expanding universal health coverage is just the beginning, not the end, as once this is achieved, costs still need to be controlled and quality improved. Adjustments to the medical insurance payment ratio are necessary to better align with the latest cost structures of each treatment group^[8]. For high-cost, high-risk disease groups, the medical insurance should appropriately increase the payment ratio. Special attention must be paid to establishing a payment system. Once problems arise, this will have an opposite stimulating effect, leading to many incorrect medical services, ultimately weakening the overall quality of health services. For low-cost, low-risk disease groups, the payment ratio should be moderately reduced. This will ultimately achieve the dual optimization goals of controlling medical costs and optimizing medical resource allocation^[6].

Hospitals that have implemented the DRG payment system primarily use the average medical cost of cases to set up the DRG payment system, without paying more attention to the actual medical resources consumed during the treatment process^[9]. This approach lacks a corresponding cost budget and cannot effectively control resource consumption. For example, within the same case group, individual differences among patients lead to variations in the medical resources used^{[10][18]}. If the average cost under the DRG payment model is blindly adopted as the standard for cost accounting, it may result in unnecessary losses of medical resources^[19].

2.2 Innovation points:

Integrating DEA efficiency decomposition and activity-based costing (ABC) to break through the limitations of single hospital data;

The virtual reference set (national hospital mean) is introduced to solve the problem of missing efficiency frontier.

3. Application of DEA in medical efficiency evaluation

Advantages of the model: suitable for nonparametric efficiency analysis with multiple inputs and outputs (Charnes et al., 1978);

Medical field: mainly used in hospital bed, operating room and other resource allocation research (Hollingsworth, 2008).

3.1 Research positioning

It breaks through the limitation of “horizontal comparison” of traditional DEA, and reveals the internal mechanism of efficiency change through time series analysis and disease cost decomposition.

4. Research methods and data

4.1 DEA model construction

4.1.1 Model selection and mathematical expression

Using the BCC model (variable returns to scale) and the Malmquist index:

$$\left\{ \begin{array}{l} \min \theta \\ \text{s.t. } \sum \lambda_j x_{ij} \leq \theta x_{i0}, \\ \sum \lambda_j y_{rj} \geq y_{r0}, \\ \sum \lambda_j = 1, \lambda_j \geq 0 \end{array} \right\}$$

θ : Comprehensive technical efficiency (TE), decomposed into pure technical efficiency (PTE) and scale efficiency (SE)

Malmquist Index:

$$\text{Malmquist} = \sqrt{\frac{D^t(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)} \times \frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^{t+1}(x^t, y^t)}}$$

Divided into technical efficiency change (EFFCH) and technological progress (TECHCH)

4.1.2 reference set construction

Virtual DMU: The input-output mean of 200 tertiary hospitals nationwide was introduced as the benchmark of efficiency frontier;

Data processing: The data of XX Hospital and virtual DMU were standardized (Z-score) to eliminate the dimensional difference.

4.2 Cost accounting method by disease type

Disease screening: select high-value diseases with DRG weight greater than or equal to 1.2 (such as interventional treatment of acute myocardial infarction) and low-value diseases with DRG weight less than or equal to 1.0 (such as community-acquired pneumonia);

Cost aggregation:

Direct cost: drugs, consumables, examination and inspection fees (extracted from the first page of the medical record);

Indirect costs: management, energy costs (based on clinical pathway hours).

4.3 Data sources and processing

data type	metric	source
Input indicators	Number of medical staff (X1)	Hospital human resources system
	Net value of equipment (X2)	Financial statement of assets
	Expenditure on pharmaceuticals and consumables (X3)	Medical insurance settlement system
Output indicators	Number of DRG groups (Y1)	Medical Insurance Bureau DRG grouping platform
	Medicare settlement cases (Y2)	Statistics on the first page of the medical record
	CMI value (Y3)	DRG platform calculation
External data	Mean of tertiary hospitals at national level	National Health Commission (2023)

Data cleaning:

Missing values: linear interpolation of net equipment value data in 2019;

Abnormal value: drug and material expenditure Winsorize truncated processing (1% percentile).

5. Empirical analysis

5.1 DEA Static Efficiency Analysis (2023)

DMU	TE	PTE	SE	return of scale	Redundancy input rate (X3)	CMI breach
XX hospital	0.82	0.88	0.93	IRS*	15.2%	-5.6%
invented DMU	1.00	1.00	1.00	-	0%	0%

conclusion:

The main causes of efficiency loss were redundant drug consumables (15.2%) and insufficient CMI value (too high proportion of low difficulty cases);

Returns to scale: In the stage of increasing returns to scale, the service volume needs to be expanded to the optimal scale.

5.2 Malmquist Dynamic efficiency (2019-2023)

period	EFFCH	TECHCH	TFP
2019–2021	1.05	1.10	1.16
2021–2023	0.98	1.15	1.13

explain:

TFP growth: 13% per year after the implementation of DRG, with technological progress (such as intelligent coding system) as the main driving force;

Efficiency decline: After 2021, the management efficiency (EFFCH) declined, reflecting the weakening of the initial cost control dividend.

5.3 Cost accounting by disease type

Case 1: DRG-123 (interventional treatment of acute myocardial infarction, weight 1.45)

Cost item	XX Hospital (former)	Industry benchmark (yuan)	Overhead rate	Root cause analysis
Drug costs	9,800	8,200	+19.5%	Antibiotics are used beyond guidelines
high-value consumable	52,000	45,000	+15.6%	Imported brackets account for 70%
total cost	66,300	57,000	+16.3%	The payment standard is 65,000 yuan

Quantitative impact: cost overruns for this disease resulted in an overall decrease in efficiency of about 0.12 ($p < 0.05$).

Case 2: DRG-456 (community-acquired pneumonia, weight 0.92)

Cost item	XX Hospital (former)	Industry benchmark (yuan)	Balance rate	successful experiences
Drug costs	1,200	1,500	-20%	Strictly follow the antibiotic guidelines
total cost	2,000	2,500	-20%	The payment standard is 2,300 yuan

6. Discussion and policy recommendations

6.1 Problems existing in cost management of public hospitals:

The cost management system is inadequate. The actual treatment costs of hospitals are disconnected from the calculated costs, increasing the operational costs of public hospitals and leading to severe waste of medical resources, making the effectiveness of cost management less than satisfactory. Moreover, in some hospitals, the specific aspects of cost management are poorly organized, with responsibilities not clearly defined for personnel at different levels. This results in a lack of close cooperation and efficient communication among staff, posing potential risks to the hospital's cost management work.

Cost analysis and evaluation lack detail. Cost analyses in public hospitals mostly rely on basic data from various departments, with low requirements for data authenticity and completeness. There is no in-depth analysis of the issues reflected by the data, which hinders cost control. For example, within the same case group, individual differences among patients lead to variations in the medical resources used^[20].

Taking XX Hospital as an example, after the full implementation of DRG in 2021, its CMI (case combination index) value dropped from 1.12 to 1.08, reflecting the decrease in the difficulty of treating cases, while the expenditure on drugs and materials increased by 9.5% during the same period. Such behavior will exacerbate the mismatch of medical resources and damage the long-term sustainability of the medical insurance fund.

6.2 Efficiency optimization path

Under the DRG framework, hospital cost optimization involves using information technology to dynamically monitor medical practices. First, in conjunction with DRG cost accounting results, standardize charging standards for each department and develop detailed cost management rules based on the requirements of medical services, avoiding systems that become mere formalities. Promptly remind and record any unreasonable medical expenses that have occurred in the knowledge base to prevent recurrence. Focus on monitoring changes in controllable costs and timely collect cost accounting data.

Members of the cost accounting team should maintain close contact with clinical departments and communicate promptly. In conjunction with resource consumption in medical business processes, they must strictly adhere to cost accounting principles. Public hospitals should estimate the procurement volume for the month based on actual surgical consumption in each department, reasonably design procurement volumes, and ensure timely supply to formulate a rational procurement cycle, effectively reducing procurement costs. Additionally, the National Medical Security Administration continuously introduces new agency procurement policies. After the issuance of new volume-based documents, hospitals should promptly halt in-house procurement execution plans and implement national volume-based material policies. Meanwhile, the medical supplies market is constantly evolving, requiring procurement personnel to stay updated with market changes and timely grasp the supply status and price information of various medical supplies.

Cost Management of Disease Types: Mandatory use of centrally procured consumables for high-value DRG groups (such as DRG-123), with penalties for non-compliance. Strengthen the management and control of controllable costs, promptly alerting to excess expenses to prevent overruns. Adopt a scientific performance distribution method, shifting from a coarse allocation approach to one that strongly links performance evaluations with cost management. Enhance the integration and analysis of patient settlement fees, delving into the factors that constitute medical expenses to identify controllable points in cost management, continuously refining the management of medical expenses. The fundamental purpose of performance distribution is to reflect fairness in management; a scientific performance distribution method can effectively motivate healthcare workers, guide their work direction, and improve management efficiency. Personal income for healthcare workers should not be tied to drug and consumable costs; instead, emphasis should be placed on cost factors, focusing on medical efficiency and quality. Additionally, it is necessary to adjust performance distribution rules, formulating targeted performance distribution methods, refining income distribution mechanisms, reducing the proportion of cost items, and increasing the share of income from medical service projects and medical quality assessments. A scientific performance distribution method can continuously motivate employees and enhance medical efficiency.

The DRG grouping rules implemented are based on the “law of large numbers,” aiming to leverage the economic regulatory role of health insurance funds in a fair environment. The personal income of healthcare providers should not be tied to drug and consumable costs; instead, emphasis should be placed on cost factors, focusing on medical efficiency and quality. Case-specific characteristics are reflected through variables such as primary diagnosis, surgery, and other diagnoses listed on the first page of medical records.

6.3 Research limitations and prospects

Limitations: the sample is from a single hospital, and the conclusion should be promoted with caution;

Outlook: Optimize resource allocation by integrating AI prediction models and explore the linkage mechanism between DRGs and performance-based compensation. Hospital efficiency optimization should follow a three-tier path: prioritize

controlling high-weight disease costs, then reduce indirect costs through inter-departmental collaboration, ultimately achieving Pareto improvement of hospital-wide resources.

Funding

no

Conflict of Interests

The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

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