Intervention and Effectiveness Evaluation of Clinical Pharmacists in High-Cost Ratio Cases in the Intensive Care Unit (ICU)

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Abstract: Objective: To evaluate the impact of clinical pharmacist interventions on the treatment efficacy and cost-effectiveness of high-cost ratio cases (unspecified bacterial pneumonia) in ICU wards under the Diagnosis-Intervention Packet (DIP) policy, and to provide references for the transformation plan of clinical pharmacist roles under the DIP policy. Methods: For the disease "unspecified bacterial pneumonia" (ICD-10 code: J15.9) with a high proportion of high-cost ratio cases in our ICU, interventions including developing clinical pharmacy pathways, conducting medical insurance pharmacy rounds, and reviewing excess disease group medical orders were implemented. Clinical efficacy and the proportion of high-cost cases before and after the intervention were compared. Cost-effectiveness analysis was used to evaluate the economic impact of the intervention. Results: There was no statistically significant difference in clinical efficacy before and after the intervention. However, the proportion of high-cost cases decreased significantly (from 60% to 23.3%), and the post-intervention cost-effectiveness ratio (174.09 CNY per 1% efficacy) was lower than the pre-intervention ratio (205.76 CNY per 1% efficacy). Conclusion: Clinical pharmacist interventions did not significantly alter clinical outcomes for the high-cost disease group but demonstrated clear economic advantages by reducing costs while maintaining efficacy. This highlights the potential of clinical pharmacists in optimizing cost control under the DIP policy.

***Keywords*:** clinical pharmacist; DIP policy; high-cost ratio cases; ICU; cost-effectiveness

1. Introduction

The Diagnosis-Intervention Packet (DIP) payment model, a key component of China's healthcare payment reform, integrates big data with point-based payment and regional budget caps to optimize resource allocation, reflect healthcare workers' labor value, and ensure sustainable medical insurance fund management[1]. Under DIP, rational drug use plays a critical role in cost control, demanding higher standards for hospital pharmacists[2]. This study explores innovative pharmaceutical services by clinical pharmacists in the ICU, focusing on interventions for the high-cost ratio disease group "unspecified bacterial pneumonia." The clinical and economic impacts of these interventions were evaluated to assess their role in improving healthcare quality and cost control under DIP.

2. Materials and Methods

2.1 Case Data

According to the Shanghai Medical Insurance DIP payment rules, cases with total costs exceeding twice the payment standard are defined as "high-cost ratio cases." Their payment standard is calculated as the standard payment for ordinary cases multiplied by (the total medical cost of the case / the average cost per case for that disease - 1) and settled based on actual costs. Therefore, being classified as a high-cost ratio case results in additional payments for the hospital.

This study is based on 2023 medical insurance feedback data from the intensive care unit (ICU) of Baoshan District Hospital of Integrated Traditional Chinese and Western Medicine in Shanghai (hereinafter referred to as "our hospital"). The research focuses on "unspecified bacterial pneumonia" (disease code "J15.9," with primary diagnoses of "community-acquired pneumonia, non-severe" and "community-acquired pneumonia, severe"), which had a relatively high proportion of high-cost ratio cases (hereinafter referred to as the "study disease"). Hospitalized cases classified under this study disease from January to December 2024 were selected as the study subjects.

Starting in July 2024, the researchers implemented pharmaceutical interventions for ICU-admitted patients with the study disease. Following the principle of baseline characteristic matching, 30 cases from the same disease group admitted between January and June 2024 were randomly selected as the control group for analysis.

The exclusion criteria for this study were:

① Cases that had already undergone hospitalization before ICU transfer;

② Patients who voluntarily discharged or transferred to another hospital;
③ Cases involving self-paid medications.

2.2 Pharmaceutical intervention

Based on the relevant regulations of the medical insurance Diagnosis-Intervention Packet (DIP) payment system and the hospital's medical insurance cost-control objectives, pharmaceutical intervention measures were established. The specific interventions include:

Developing Clinical Pharmacy Pathways: Clinical pharmacists utilized evidence-based pharmacy methodologies, integrating clinical guidelines, expert consensus, evidence-based medical data, and medical insurance reimbursement standards to establish targeted clinical pharmacy pathways for over-budget disease groups [3]. During pathway development, each evidence-based question was rigorously defined according to evidence-based pharmacy principles, followed by comprehensive literature reviews and the assignment of specific recommendation grades [4]. Clinical pharmacists collaborated extensively with clinical experts from relevant departments to optimize the practicality of these pathways while aligning with real-world clinical practices.

Medical Insurance Pharmacy Ward Rounds: Clinical pharmacists conducted specialized ward rounds focused on medical insurance compliance to support rational medication decisions. While prioritizing therapeutic efficacy, pharmacists emphasized drug pricing, insurance-approved indications, and treatment duration limits during both initial treatment planning and subsequent adjustments. For initial regimens, pharmacists recommended selecting medications within insurance coverage for therapeutic equivalents. During treatment modifications, they evaluated alternative drugs' insurance restrictions, projected cost impacts on the DIP group, and incorporated insurance compliance and cost-effectiveness analyses into adjustment recommendations [5].

Disease Group-Specific Order Reviews: Clinical pharmacists performed holistic medication order evaluations for targeted disease groups, leveraging their dual expertise in clinical practice and pharmaceutical science. Beyond identifying standard pharmaceutical irregularities, they proposed optimized treatment strategies from a comprehensive clinical perspective. This included addressing non-compliant practices regarding insurance-approved indications, treatment durations, and medication settings, ultimately delivering integrated improvement recommendations to minimize inappropriate orders [6].

During the 6-month intervention period, this study implemented the above methods for the "unspecified bacterial pneumonia" diagnosis group (primary diagnoses: "non-severe community-acquired pneumonia" and "severe community-acquired pneumonia"). A dedicated pharmaceutical pathway was developed, with each enrolled patient receiving continuous pharmaceutical monitoring, timely medication adjustments, and therapeutic outcome assessments. Concurrently, 12 specialized order review sessions (biweekly) and 12 medical insurance pharmacy ward rounds (biweekly) were conducted, accompanied by feedback mechanisms. Pre- and post-intervention analyses of clinical outcomes and cost-effectiveness were performed to evaluate the interventions' efficacy and economic impact.

2.3 Evaluation Indicators

2.3.1 Clinical Effectiveness

This study used overall patient clinical outcomes as effectiveness indicators. Referencing the Chinese Expert Consensus on Clinical Practice for Severe Pneumonia in Emergency Medicine, clinical outcomes were defined as follows:

Cured: Complete resolution of cough and sputum production, disappearance of lung crackles, and normalization of laboratory and imaging findings.

Markedly Effective: Significant improvement in cough, sputum production, and lung crackles, with notable improvement in laboratory and imaging results.

Effective: Improvement in cough, sputum production, and lung crackles, with observable improvement in laboratory and imaging results.

Ineffective: No improvement or worsening of cough, sputum production, or lung crackles, with no improvement in laboratory or imaging findings.

2.3.2 High-Cost Case Ratio

The proportion of high-cost cases within the studied disease group was compared before and after the intervention to evaluate the impact of the measures on hospital cost control.

2.3.3 Cost-Effectiveness Analysis

The primary treatment cost for severe pneumonia was defined as direct hospitalization costs during ICU stays, while other indirect costs were relatively minimal. This study performed a cost-effectiveness analysis using total medical costs

during ICU hospitalization as the cost indicator and clinical effectiveness rate as the outcome measure to assess economic differences before and after the intervention.

2.4 Statistical Methods

Data were analyzed using SPSS statistical software. Intergroup comparisons were performed using t-tests, ranked data were analyzed with the Mann-Whitney U test, and categorical data were expressed as n (%) and analyzed using the χ^2 test. A $P < 0.05$ was considered statistically significant.

3. Results

3.1 Baseline Characteristics

A total of 60 cases were enrolled, with 30 in the control group and 30 in the intervention group. Disease severity was assessed using the Acute Physiology and Chronic Health Evaluation-II (APACHE-II) score prior to admission. There were no statistically significant differences between the two groups in baseline characteristics, disease severity, or comorbidities, indicating comparability (see Table 1).

Table 1. Pre-treatment general condition and disease severity scores of enrolled cases

	Control group (n=30)	Intervention group (n=30)	P-value
Gender (Male)	19 (63.33%)	18 (60.00%)	0.690
age	64.47±7.93	65.23±6.82	0.690
APACHEII	24.83±4.36	26.13±4.92	0.283
COPD	7 (23.33%)	6 (20.00%)	0.754
Cardiovascular disease	3 (10.00%)	4 (13.33%)	0.688
Diabetes	6 (20.00%)	5 (16.67%)	0.739
Hypertension	9 (30.00%)	7 (23.33%)	0.559

3.2 Comparison of clinical efficacy

According to the rank-sum test, the clinical efficacy of the observation group and the control group was similar, and the difference was not statistically significant (Z=1.898, P=0.229), as shown in Table 2.

Table 2. Comparison of clinical efficacy between two groups

Group	n	Cured	Markedly Effective	Effective	Ineffective	Effective rate/%
Control	30	10	8	7	5	83.33
Intervention	30	9	9	6	6	80.00

3.3 Proportion of high-rate cost cases in the two groups

Compared with the control group, the proportion of high-rate cost cases in the intervention group decreased from 60% to 23.3%, as shown in Table 3.

Table 3. Proportion of high magnification cost cases in two groups

Group	n	High-magnification cases	High-magnification cases /%
Control	30	18	60.00
Intervention	30	7	23.33

3.4 Two sets of cost-effect analysis

The average direct total cost required for every 1% clinical effective rate obtained in the intervention group was 195.06 yuan, and the total direct cost required for the control group was 235.84 yuan, which was smaller than that of the control group. (See Table 4).

Table 4. Cost effectiveness Analysis of Two Groups

Project	Control	Intervention
Clinically effective (%)	80.00	83.33
Total cost(RMB)	13927.38	17145.81
Cost-effect ratio (RMB/1%)	174.09	205.76

In order to exclude the interference of other uncertain factors on the analysis results, this study used univariate sensitivity analysis to increase and decrease the total cost and clinical effective rate by 10% respectively, and then compared the cost-effect ratio of the two groups, and the results showed that the cost-effect ratio of the two groups was consistent with that before adjustment, and the cost-effect ratio of the intervention group was smaller than that of the control group (see Table 5).

Table 5. Sensitivity analysis of cost-effectiveness for two groups

Project	Cost-effectiveness ratio of the intervention group	Cost-effectiveness ratio of the control group
10% increase in effective rate	158.27	187.05
10% reduction in effective rate	193.44	228.62
10% increase in total cost	191.50	226.33
10% reduction in total cost	156.68	185.18

4. Discussion

Under the Diagnosis-Intervention Packet (DIP) framework, rational drug use plays a critical role in reducing medical costs for healthcare institutions. Currently, public hospitals face significant challenges in performance evaluation under DIP, particularly in balancing medical quality assurance with operational efficiency. The standardization and efficiency of medical processes under DIP not only assess physicians but also evaluate the pharmaceutical service capabilities of hospitals during their transition toward value-based care. As key contributors to hospital pharmaceutical services, clinical pharmacists must actively explore their unique roles in this transformation and develop actionable strategies to address these challenges [7].

In optimizing hospital operations and implementing refined pharmaceutical management under DIP, clinical pharmacists can contribute in two key ways. First, during clinical treatment, they assist physicians in optimizing medication selection by prioritizing drugs with better efficacy, fewer side effects, or lower risks of readmission to enhance clinical outcomes. Second, for disease groups where total hospitalization costs exceed DIP payment standards, clinical pharmacists conduct rational medication analyses to address inappropriate drug use, thereby demonstrating their value in ensuring clinically appropriate, effective, and cost-efficient therapies. By leveraging DIP data to evaluate and regulate medication use, clinical pharmacists can establish standardized management pathways for optimizing hospitalization cost structures, enabling both vertical and horizontal comparisons. This approach supports refined pharmaceutical management and facilitates hospital operations under DIP reform.

The results of this study demonstrate that after implementing multi-faceted interventions by clinical pharmacists, the proportion of high-cost cases in the studied disease group significantly decreased, while clinical efficacy remained unaffected. Furthermore, the interventions exhibited clear cost-effectiveness advantages. This confirms that clinical pharmacists' interventions can substantially reduce treatment costs for "unspecified bacterial pneumonia" without compromising clinical outcomes. These findings represent a valuable exploration of clinical pharmacists' evolving roles under DIP policies and provide practical experience for expanding pharmacist-led services to adapt to comprehensive DIP payment reforms.

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