

Retrospective Study

Clinical pharmacists' involvement in carbapenem antibiotics management at Wenzhou Integrated Hospital

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Abstract

BACKGROUND

Carbapenem antibiotics are a pivotal solution for severe infections, particularly in hospital settings. The emergence of carbapenem-resistant bacteria owing to the irrational and extensive use of carbapenems underscores the need for meticulous management and rational use. Clinical pharmacists, with their specialized training and extensive knowledge, play a substantial role in ensuring the judicious use of carbapenem. This study aimed to elucidate the patterns of carbapenem use and shed light on the integral role played by clinical pharmacists in managing and promoting the rational use of carbapenem antibiotics at Wenzhou Integrated Traditional Chinese and Western Medicine Hospital.

AIM

To analyze carbapenem use patterns in our hospital and role of clinical pharmacists in managing and promoting their rational use.

METHODS

We performed a retrospective analysis of carbapenem use at our hospital between January 2019 and December 2021. Several key indicators, including the drug utilization index, defined daily doses (DDDs), proportion of antimicrobial drug costs to total hospitalization expenses, antibiotic utilization density, and utilization rates in different clinical departments were comprehensively analyzed.

RESULTS

Between 2019 and 2021, there was a consistent decline in the consumption and sales of imipenem-cilastatin sodium, meropenem (0.3 g), and meropenem (0.5 g). Conversely, the DDDs of imipenem-cilastatin sodium for injection increased in 2020 and 2021 *vs* 2019, with a B/A value of 0.67, indicating a relatively higher drug cost. The DDDs of meropenem for injection (0.3 g) exhibited an overall upward trend, indicating an increasing clinical preference. However, the B/A values for 2020 and 2021 were both > 1, suggesting a relatively lower drug cost.

The DDDs of meropenem for injection (0.5 g) demonstrated a progressive increase annually and consistently ranked first, indicating a high clinical preference with a B/A value of 1, signifying good alignment between economic and social benefits.

CONCLUSION

Carbapenem use in our hospital was generally reasonable with a downward trend in consumption and sales over time. Clinical pharmacists play a pivotal role in promoting appropriate use of carbapenems.

Key Words: Clinical pharmacists; Carbapenem antibiotics; Rational drug use; Drug utilization index; Defined daily doses; Antibiotic utilization density

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Core tip: This study explored the utilization patterns of carbapenem antibiotics and highlighted the significant role of clinical pharmacists in their management at Wenzhou Integrated Traditional Chinese and Western Medicine Hospital. These findings indicate a decline in the consumption and sales of specific carbapenems and an increase in the preference for certain types of carbapenems. The study concluded that the hospital's use of carbapenems is generally reasonable, emphasizing the crucial contribution of clinical pharmacists in promoting appropriate antibiotic use.

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INTRODUCTION

Carbapenem antibiotics are preferred in hospitals for the treatment of critically ill patients and immunodeficiency-related infections[1-3]. In recent years, the government issued multiple documents aimed at strengthening the rational use of antimicrobial drugs that clearly emphasize the need for hospitals to strengthen management and ensure standardized clinical usage of carbapenem antibiotics. The "Management Measures for the Clinical Application of Antimicrobial Drugs" document issued by the country also stipulates that hospital antimicrobial drug management teams include leaders from medical, pharmaceutical, clinical microbiology, and other relevant departments as well as highly qualified personnel with advanced professional titles[4,5]. Personnel from medical and pharmaceutical departments are primarily responsible for drug management. In response to this national call, our hospital has actively strengthened its professional level of carbapenem antibiotic management by involving various clinical pharmacists with specialized training[6]. This initiative has yielded positive results. This study primarily investigated the use of carbapenem antibiotics in our hospital and subsequently analyzed and evaluated the rationality of their use and involvement of clinical pharmacists in their management.

MATERIALS AND METHODS

General information

Data were collected from hospital information management and medical record systems. Patient records of carbapenem use from January 2019 to December 2021 were selected for retrospective analysis. The drug utilization index (DUI), defined daily doses (DDDs), proportion of antimicrobial drug costs to total hospitalization expenses, antibiotic utilization density (AUD), and utilization rates in various clinical departments were statistically analyzed.

Methods

The DDD was determined using the World Health Organization recommended average daily dose for adults. DDDs were calculated as the total amount of a drug divided by its DDD value, with higher DDDs indicating a higher frequency of drug use. The DUI was calculated as the DDDs divided by the total duration of drug use. AUD was calculated as DDDs divided by the total number of patients during the same period multiplied by 100.

Statistical analysis

Data were recorded in Microsoft Excel and analyzed using SPSS version 26.0. For normally distributed continuous data, results are expressed as mean \pm SD, and the statistical analysis was performed using *t*-tests. For non-normally distributed continuous data, the results are expressed as median (P25 and P75), and the statistical analysis was conducted using the Mann-Whitney U test. Categorical data are expressed as frequencies (*n*, %), and statistical analyses were performed using

the chi-squared test. Differences were considered statistically significant at $P < 0.05$.

RESULTS

Drug usage, sales amount, and growth rate

The results indicated that from 2019 to 2021, the usage and sales of imipenem-cilastatin sodium, meropenem (0.3 g), and meropenem (0.5 g) declined each year. The detailed data are presented in [Table 1](#).

Comparison of DDDs, DUI, sales amount, and drug proportions for main carbapenem antibiotics

The DDDs of imipenem-cilastatin sodium for injection showed a steady increase in ranking in 2020 and 2021 compared to 2019, with a B/A value of 0.67, indicating relatively higher drug prices. For meropenem injections (0.3 g), the DDDs exhibited a consistent upward trend from 2019 to 2021, suggesting growing clinical preference for this drug. However, the B/A values for 2020 and 2021 were both > 1 , indicating relatively lower drug prices. In contrast, the DDDs of meropenem for injection (0.5 g) increased progressively annually and consistently maintained its top-ranking position, indicating a high clinical preference for this drug. The B/A value was 1, demonstrating good synchronization between economic and social benefits. The detailed data are presented in [Table 2](#).

DISCUSSION

Current clinical application of carbapenem antibiotics

The clinical use of carbapenems has been increasing, and there has been a noticeable increase in cases of carbapenem-resistant bacteria among patients. Researchers have found that long-term irrational use of carbapenem antibiotics has led to the emergence of carbapenem-resistant *Acinetobacter baumannii* and *Pseudomonas aeruginosa* (*P. aeruginosa*) in patients' bodies[7-9]. Some studies analyzing drug correlations found a negative correlation between carbapenem-resistant *P. aeruginosa* and the use of carbapenem antibiotics in patients without a significant relationship with the amount of drug used[10,11]. Therefore, hospitals should strictly manage carbapenem use. Clinical pharmacists play an essential role in the management of these drugs by participating in ward rounds, consultations, and critical care analyses[12]. They can leverage their extensive theoretical knowledge and practical experience to analyze each patient's specific condition and organ function as well as the characteristics of antimicrobial drugs. By tailoring individualized medication plans, they can ensure the rational use of carbapenem antibiotics[13].

From 2019 to 2021, sales and DDDs of carbapenem antibiotics used at our hospital consistently declined, which may be attributed to the active involvement of clinical pharmacists in the management process[14,15]. Their contributions likely aided the optimization of carbapenem antibiotic use in our hospital.

Role of clinical pharmacists in managing carbapenem antibiotics use

Numerous studies have highlighted the crucial role of clinical pharmacists in effectively optimizing the clinical use of carbapenem antibiotics, underscoring their significance in healthcare[16,17]. In 2021, the National Health Commission and State Administration of Traditional Chinese Medicine jointly emphasized the need for hospitals to improve pharmaceutical service quality and promote their transformation. Clinical pharmacists are entrusted with formulating individualized medication plans for diverse patients to ensure medication safety and rationality, particularly in the complex context of anti-infective therapy[18,19]. Given the intricacy of patient infections, clinical pharmacists must diligently monitor various patient parameters to ensure the standardization and rationality of clinical drug administration[20]. At our hospital, clinical pharmacists actively participate in ward rounds and consultations by meticulously considering patient characteristics, infection profiles, pathogen types, and drug resistance. In collaboration with clinical physicians, they collectively determine the appropriate drug selection and dosage based on antibiogram results[21]. By considering bacterial resistance levels, they judiciously choose safe and effective antibiotics and devise and adapt infection treatment regimens[22,23]. Since the engagement of clinical pharmacists in carbapenem antibiotic management in our hospital, the sales and utilization of various carbapenem antibiotics have demonstrated a consistent downward trend. This highlights the positive impact of clinical pharmacists optimizing the use of these crucial antimicrobial agents.

Recommendations for clinical pharmacists' involvement in managing carbapenem antibiotics

(1) Standardize the process: Hospitals should establish standardized procedures for the application of carbapenem antibiotics. When the microbiology department provides clinical pharmacists multidrug-resistant bacteria results, immediate discussions should be conducted with physicians. Based on microbiological results and specific manifestations of the patient's condition, clinical pharmacists can identify the specific causative pathogen. Tailored treatment measures can be implemented with a comprehensive understanding of patients' medical and medication histories; (2) consider individual patient factors: The prolonged use of carbapenem antibiotics is often required. Symptoms such as edema, hypoalbuminemia, or renal impairment may affect a patient's responses to carbapenem antibiotics. Clinical pharmacists should leverage their pharmacokinetic knowledge and continuously refine medication plans based on a patient's specific condition. This approach maximizes bacterial resistance while minimizing the potential harm to a patient's physical and mental well-being. The active training of clinical pharmacists should enhance their capabilities, particularly in terms of increasing the pathogen testing rate. Pathogen testing is essential for determining the causative pathogen, which

Table 1 Drug usage, sales amount, and growth rate

Drug	Year	Drug usage and growth rate		Sales amount and growth rate	
		Drug usage (g)	Growth rate (%)	Sales amount (ten thousand yuan)	Growth rate (%)
Imipenem-cilastatin sodium for injection	2019	3856	-	102.7903	-
	2020	2741	-28.92	64.7471	-37.01
	2021	1912	-30.24	43.8109	-32.34
Meropenem for injection (0.3 g)	2019	4168.5		123.1964	
	2020	2136.3	-48.75	60.3083	-51.05
	2021	756.0	-64.61	19.3400	-67.93
Meropenem for injection (0.5 g)	2019	16142.5		210.1041	
	2020	12712	-21.25	161.9921	-22.90
	2021	10797.5	-15.06	125.4313	-22.57

Table 2 Comparison of defined daily doses, drug utilization index, sales amount, and drug proportion for main carbapenem antibiotics

Year	Parameter	Imipenem-cilastatin sodium for injection (1 g)	Meropenem for injection (0.3 g)	Meropenem for injection (0.5 g)
2019	DDD (g)	2	1.5	3
	DDC (yuan)	259.1	410.7	203.64
	AUD	41	74	115
	Ranking	3	2	1
	DDDs	1928	3473.75	5380.83
2020	Ranking	3	2	1
	B/A	1.00	1.00	1.00
	AUD	27	8	85
	Ranking	2	3	1
	DDDs	1370.75	1780.25	4237.33
2021	Ranking	3	1	2
	B/A	0.67	3.00	0.50
	AUD	20	13	74
	Ranking	2	3	1
	DDDs	956	625	3599.17
	Ranking	3	2	1
	B/A	0.67	1.50	1.00

AUD: Antibiotic utilization density; DDC: Drug distribution code; DDDs: Defined daily dose.

significantly influences medication decisions and provides valuable treatment guidance; (3) establish an antibiotic expert group: Hospitals should form antibiotic expert groups to develop guidelines for the clinical use and management of carbapenem antibiotics in accordance with the requirements outlined in national policies and related documents; (4) implement information technology in carbapenem antibiotic management: A standardized application process should be established for the application of carbapenem antibiotics in clinical settings. Clinicians must first log into the relevant system to complete an application. Subsequently, pharmacists with intermediate or high titles review the applications. If approved, the sample is submitted to an antibiotic expert group for further analysis. A prescription is issued only after group approval is received. The prescription review process could be improved by adopting a pre-approval approach. If a pharmacist identifies any unscientific aspects in a prescription, they should promptly request revision from the clinical physician. Temporary use should not exceed 24 h; (5) supervise and manage carbapenem antibiotic use in clinical departments: Clinical pharmacists should supervise and manage the application of carbapenem antibiotics in each department. At the end of each month, they summarize and analyze the department's drug usage frequency, testing rate,

and other relevant aspects. The results should be submitted to the departmental head to help achieve targets; (6) evaluate special cases monthly: On the 1st day of each month, clinical pharmacists evaluate special patient cases from the previous month based on the hospital's standardized evaluation criteria. Information such as patient age, sex, medical history, microbiology, and medication use should be collected. Using these data, medication rationality should be evaluated. If any irrationality is found, clinical pharmacists should immediately discuss it with the clinical physician and inform the department head about the evaluation results. If a clinical physician persists in unreasonable practice despite multiple discussions, the behavior should be reported to the hospital's medical management department, leading to public disclosure and penalties; and (7) regularly train clinical pharmacists: Clinical pharmacists should undergo regular training in carbapenem-related theories and practices. Monthly reviews of prescription practices within each department should be conducted that emphasize common issues with the drug's clinical use. Training and guidance should be provided to physicians and nursing staff to address these issues.

Although this study provides valuable insight into the utilization of carbapenem antibiotics and the role of clinical pharmacists in their management, several limitations require acknowledgment. First, the retrospective study design may have introduced bias related to data collection and recording, which may have affected the reliability of the findings. Second, the study's focus on a single hospital limits the generalizability of the results to other healthcare settings with different patient demographics, healthcare systems, and antibiotic-use policies. Finally, the study did not investigate the impact of varying degrees of bacterial resistance on the selection and modification of carbapenem therapy; thus, future research must explore these aspects in detail.

CONCLUSION

The use of carbapenem antibiotics in our hospital was generally rational and declined over time. Clinical pharmacists play a vital role in ensuring the appropriate use of antibiotics and assisting physicians with adhering to appropriate prescription practices. Therefore, the active involvement of clinical pharmacists in the standard and rational application of carbapenems is important. Their widespread participation significantly promotes the optimal use of carbapenems in clinical settings.

ARTICLE HIGHLIGHTS

Research background

This study analyzed the utilization patterns of carbapenem antibiotics at Wenzhou Integrated Traditional Chinese and Western Medicine Hospital and highlighted the integral role of clinical pharmacists in their management and rational use. Carbapenem antibiotics are crucial for treating severe infections in hospitals; however, their irrational and extensive use has led to the emergence of carbapenem-resistant bacteria.

Research motivation

The main objectives of this study were to analyze the utilization patterns of carbapenem antibiotics at Wenzhou Integrated Traditional Chinese and Western Medicine Hospital over a specified period and investigate the role of clinical pharmacists in managing and promoting their rational use. This study aimed to provide insight into the trends of carbapenem consumption and sales, assess key indicators such as drug utilization index (DUI), defined daily doses (DDDs), and antibiotic utilization density (AUD), and evaluate the economic and social benefits associated with different carbapenems. Ultimately, this study aimed to emphasize the importance of clinical pharmacists in ensuring appropriate antibiotic use and optimizing patient care.

Research objectives

The main objectives of this study were to analyze the utilization patterns of carbapenem antibiotics at Wenzhou Integrated Traditional Chinese and Western Medicine Hospital over a specified period and investigate the role of clinical pharmacists in managing and promoting their rational use. This study aimed to provide insight into carbapenem consumption and sales trends, assess key indicators such as DUI, DDDs, and AUD, and evaluate the economic and social benefits associated with different carbapenems. Ultimately, this study aimed to emphasize the importance of clinical pharmacists in ensuring appropriate antibiotic use and optimizing patient care.

Research methods

This study retrospectively analyzed carbapenem use at Wenzhou Integrated Traditional Chinese and Western Medicine Hospital from January 2019 to December 2021. Several key indicators, including DUI, DDDs, proportion of antimicrobial drug costs to total hospitalization expenses, AUD, and utilization rates in different clinical departments, were comprehensively analyzed. These indicators provide insight into the patterns of carbapenem use and allow for the assessment of the economic and social benefits associated with different carbapenems. The data analysis aimed to elucidate the trends and preferences for carbapenem use, shedding light on the important role played by clinical pharmacists in their management and rational use.

Research results

This study found a decline in the consumption and sales of specific carbapenems at Wenzhou Integrated Traditional Chinese and Western Medicine Hospital from 2019 to 2021. The preference for certain types of carbapenems increased, and clinical pharmacists played a vital role in promoting appropriate antibiotic use. Overall, hospital utilization of carbapenem antibiotics was reasonable with a downward usage trend.

Research conclusions

This study revealed reasonable utilization of carbapenem antibiotics at Wenzhou Integrated Traditional Chinese and Western Medicine Hospital with a decreasing trend in consumption and sales over the analyzed period. Clinical pharmacists play a crucial role in promoting appropriate use of carbapenems. These findings indicate a decline in the consumption and sale of specific carbapenems as well as an increasing preference for certain types of carbapenems. This study emphasizes the importance of clinical pharmacists in ensuring rational antibiotic use and highlights their significant contribution to patient care.

Research perspectives

Future studies should consider several key aspects: investigating the factors influencing carbapenem use trends, evaluating the impact of clinical pharmacist interventions, assessing the economic and social implications of carbapenem use, monitoring long-term carbapenem resistance, and conducting comparative analyses with other healthcare facilities. By addressing these issues, researchers can gain a comprehensive understanding of carbapenem utilization patterns and the role of clinical pharmacists, both of which will contribute to effective antimicrobial stewardship and patient care.

FOOTNOTES

Author contributions: Xu XM and Pan CY proposed the study concept; Zeng DL contributed to the data collection; Pan CY contributed to the formal analysis; Xu XM and Zeng DL participated in the survey; Xu XM contributed to these methods; Zeng DL guided the research; Pan CY and Zeng DL validated this study; Xu XM, Pan CY, and Zeng DL contributed to study visualization; and Xu XM, Pan CY, and Zeng DL reviewed and co-wrote the manuscript.

Institutional review board statement: This study was reviewed and approved by the Medical Ethics Committee of Wenzhou Integrated Traditional Chinese and Western Medicine Hospital (No. 2019-L059).

Informed consent statement: All study participants or their legal guardians provided written informed consent before study enrollment.

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