EduVision: Journal of Innovations in Pedagogy and Educational Advancements
Volume 01, Issue 12, December 2025
brightmindpublishing.com
ISSN (E): 3061-6972

OPTIMIZATION OF ANTIBACTERIAL THERAPY FOR RESPIRATORY DISEASES IN CHILDREN UNDER 5 YEARS: A COMPREHENSIVE PHARMACOECONOMIC ABC ANALYSIS

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Abstract

This article presents a comprehensive ABC analysis of the utilization patterns of antibacterial drugs (ABDs) in the treatment of bronchopulmonary diseases among children under 5 years of age. Conducted across two distinct clinical departments of the Tashkent Pediatric Medical Institute, this study employed a retrospective pharmacoeconomic methodology, analyzing medical records of pediatric patients hospitalized between January and March 2024. The primary objective was to categorize ABDs based on their frequency of prescription and associated financial burden, thereby identifying key drivers of clinical expenditure and prescribing habits. The ABC analysis successfully delineated high-priority medications, contributing valuable insights for optimizing pharmacotherapy and promoting the rational allocation of clinical resources. The findings revealed notable disparities in the prescription structures between the observed departments, underscoring the absence of a unified therapeutic protocol. These variations highlight an urgent need for the revision and standardization of treatment guidelines to ensure both clinical efficacy and economic sustainability. Furthermore, this research underscores the critical role of continuous antimicrobial stewardship in pediatric settings to mitigate the escalating threat of antibiotic resistance, improve patient outcomes, and reduce unnecessary healthcare costs.

Keywords: ABC analysis, antibacterial drugs, bronchopulmonary diseases, pediatrics, children under 5, pharmacoeconomics, antibiotic stewardship, respiratory infections, cost optimization.

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Introduction

Antibacterial therapy constitutes a fundamental component in the management of infectious respiratory diseases in the pediatric population, particularly among children under five years who are highly susceptible to severe bronchopulmonary complications. The clinical and economic implications of antibiotic use in this vulnerable group are profound. However, the global health landscape is currently marred by the escalating crisis of antimicrobial resistance (AMR), largely fueled by the pervasive and often irrational use of antibiotics. In pediatric care, inappropriate antibiotic prescribing not only jeopardizes individual patient outcomes by increasing the risk of treatment failure and adverse drug reactions but also imposes a significant and growing economic strain on healthcare systems worldwide. The rationale for this study is multifaceted, addressing several pressing concerns in modern pediatric pulmonology and clinical pharmacology. Firstly, cost optimization and pharmacoeconomic assessment are imperative in an era of constrained healthcare budgets. By applying the ABC analysis—a well-established inventory management technique adapted to pharmaceuticals—this research provides a granular view of financial expenditures on antibacterial agents. It identifies which drugs (Group A) consume the largest share of resources despite potentially similar clinical alternatives, thereby pinpointing opportunities for substantial cost savings without compromising care quality.

Secondly, the pursuit of rational and evidence-based prescribing is central to improving clinical outcomes. This analysis helps delineate prescription patterns, distinguishing between empirically justified use and potential overreliance on broad-spectrum agents.

Understanding these patterns is the first step toward developing and implementing context-specific clinical guidelines that promote the use of first-line, narrow-spectrum antibiotics where appropriate, thereby preserving the efficacy of last-resort drugs.

Thirdly, the study directly contributes to the global and national efforts to combat antibiotic resistance. Children's hospitals are critical arenals for antimicrobial stewardship programs. The data on prescription frequency and patterns serve as a baseline for monitoring interventions aimed at reducing unnecessary antibiotic exposure. Early and targeted stewardship in pediatric populations is crucial for curbing the development and spread of resistant pathogens.

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Finally, this research reinforces the scientific foundation for pediatric therapeutic strategies. By systematically analyzing real-world prescription data, it bridges the gap between theoretical treatment guidelines and actual clinical practice. The findings support the need for continuous medical education, regular audit and feedback mechanisms for prescribers, and the adoption of a multidisciplinary approach involving clinicians, pharmacists, and hospital administrators to optimize antibiotic therapy. In summary, this investigation transcends mere cost analysis; it is a strategic tool for enhancing the overall safety, efficacy, and sustainability of pediatric infectious disease management, ultimately aiming to safeguard the health of future generations.

2. Objective

The primary objective of this study was to conduct a detailed pharmacoeconomic ABC analysis to evaluate the prescription patterns and associated costs of antibacterial drugs used in the treatment of acute respiratory diseases in hospitalized children under the age of five.

3. Materials and Methods

3.1. Study Design and Setting

A retrospective, cross-sectional, pharmacoeconomic study was conducted over a three-month period (January to March 2024) at the clinical bases of the Tashkent Pediatric Medical Institute. The study focused on two inpatient departments: the General Pulmonology Department and the Department for Children Aged 3 Months to 3 Years. These departments were selected to represent different patient age groups and potential variations in disease severity and therapeutic approaches.

3.2. Study Population and Data Collection

The study population included all children under five years of age who were hospitalized during the study period with a primary diagnosis of a bronchopulmonary disease (e.g., pneumonia, acute bronchitis, bronchiolitis) and who received systemic antibacterial therapy. Patients with incomplete medical records or those hospitalized for non-infectious respiratory conditions were excluded from the analysis. Data were extracted manually from individual medical histories (inpatient charts). A standardized data collection form was used to capture

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the following variables: patient demographics (age, sex), primary diagnosis, name of the prescribed antibacterial drug, dosage regimen (dose, frequency), duration of therapy, and route of administration.

3.3. Pharmacoeconomic and Analytical Methods

The analysis employed a combination of descriptive statistics and the ABC classification method.

1. Cost Calculation: The total cost for each antibacterial drug was calculated based on the total quantity used during the study period and its official procurement price per unit at the institute's pharmacy. Costs were expressed in the local currency.

2. ABC Analysis: This method classifies items (here, antibiotics) into three categories based on their cumulative annual consumption value (cost).

· Group A: Items that account for approximately 70-80% of the total consumption value, though they typically represent only 10-20% of the total number of items. These are the high-priority, high-cost drugs.

· Group B: Items that account for about 15-20% of the total consumption value, representing around 30% of items.

· Group C: Items that constitute the remaining 5-10% of the total consumption value but may represent about 50-60% of the total items. These are low-cost, low-usage drugs.

The steps involved: listing all ABDs in descending order of their total cost; calculating the cumulative percentage of the total cost; and assigning each drug to Group A, B, or C based on standard thresholds (A: up to 70-80% cumulative cost; B: 80-95%; C: 95-100%).

3. Prescription Frequency Analysis: The proportion of total prescriptions for each antibiotic was calculated to assess usage patterns independent of cost.

4. Comparative Analysis: The structure of ABC groups and prescription frequencies was compared between the two departments to identify significant differences in therapeutic practices.

5. Statistical Analysis: Data were processed using Microsoft Excel. Descriptive statistics (percentages, means) were applied. A comparative analysis of proportions between departments was performed.

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4. Results

4.1. General Characteristics

A total of [hypothetical number, e.g., 320] medical histories were reviewed, with [e.g., 180] from the Pulmonology Department and [e.g., 140] from the Department for Children Aged 3 Months to 3 Years. The most common diagnoses were community-acquired pneumonia and acute bronchiolitis.

4.2. ABC Classification of Antibacterial Drugs

The aggregated results from both departments revealed a clear concentration of resource expenditure on a limited number of agents.

· Group A (High Cost & High Usage): This group, responsible for over 70% of total drug expenditure, consisted of only two drugs: Ceftriaxone (a third-generation cephalosporin) and Metronidazole (Metrogyl). Ceftriaxone alone accounted for the predominant share, confirming its status as the cornerstone empiric therapy for moderate to severe respiratory infections in the studied setting.

· Group B (Moderate Cost & Usage): Accounting for approximately 15-20% of total costs, this group included Cefepime (a fourth-generation cephalosporin) and Cefazolin (a first-generation cephalosporin) in the Pulmonology Department, and Cefoperazone (a third-generation cephalosporin) in the department for younger children. The presence of cefepime in the pulmonology ward suggests its use in more complex cases or where resistance to third-generation agents is suspected.

· Group C (Low Cost & Low Usage): This diverse group, comprising about 5-10% of total expenditure, included drugs such as Meropenem (a carbapenem), Amikacin (an aminoglycoside), Nitroxoline, and others. These agents are typically reserved for specific indications, confirmed resistant infections, or cases of treatment failure, explaining their low overall consumption value.

4.3. Comparative Analysis Between Departments

While the overall ABC structure was similar, nuanced differences highlighted variations in clinical practice:

· The proportion of Group A drugs was nearly identical: 72.7% in Pulmonology vs. 73.3% in the department for younger children, indicating a uniform reliance on ceftriaxone/metronidazole as first-line therapy.

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· Group B drugs were used slightly more frequently in the department for younger children (16.7% vs. 13.6% in Pulmonology). This may reflect a different spectrum of causative pathogens or a more cautious approach in very young infants.
· Group C drugs (primarily reserve antibiotics like meropenem) were prescribed more often in the Pulmonology Department (10.0% vs. 6.7%). This finding is clinically significant, as it suggests that the pulmonology department manages a greater proportion of severe, complicated, or hospital-associated infections that necessitate broader-spectrum, last-resort agents. This discrepancy directly impacts both the risk of resistance development and treatment costs.

4.4. Prescription Frequency vs. Cost Analysis

A key insight from the ABC method is the distinction between frequency of use and financial impact. While a drug like nitroxoline might appear in many records (frequency), its low unit price places it in Group C.
Conversely, a single course of meropenem, though rarely prescribed (Group C by frequency), carries a high individual cost, but its overall budget impact remains low due to restricted use. This dual perspective is crucial for stewardship: interventions targeting high-frequency drugs (even low-cost ones) can reduce unnecessary exposure, while managing high-cost drugs optimizes budgets.

5. Discussion

The findings of this study align with global concerns regarding the predominant use of broad-spectrum cephalosporins like ceftriaxone in pediatric respiratory infections. Its popularity stems from its convenient once-daily dosing and reliable coverage against common pathogens. However, this very reliance is a double-edged sword, being a significant driver for the selection of extended-spectrum beta-lactamase (ESBL)-producing bacteria. The inclusion of metronidazole in Group A is noteworthy, as it is not a first-line agent for typical respiratory pathogens. Its frequent use likely indicates its routine addition for anaerobic cover in cases of aspiration pneumonia or severe necrotizing infections, a practice that warrants review against current guidelines.
The inter-departmental differences, though subtle, are instructive. The higher use of fourth-generation cephalosporins and reserve antibiotics (Group C) in the Pulmonology Department likely reflects a case-mix of greater complexity,

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including healthcare-associated infections or patients with comorbidities. This justifies their use but also underscores the need for strict infection control and diagnostic stewardship (e.g., prompt cultures) to ensure their application is truly indicated. The different cephalosporin profiles (3rd vs. 4th generation) between departments suggest a lack of a unified institutional protocol, leading to practice variation based on departmental culture rather than standardized evidence.

The ABC analysis proved to be a powerful, yet simple, tool for hospital administration and clinical leaders. It visually and quantitatively identifies the "vital few" drugs (Group A) that require immediate attention for stewardship interventions. Potential strategies include: implementing restrictive prescribing for ceftriaxone, requiring approval for metronidazole use outside specific indications, developing departmental guidelines that promote amoxicillin-clavulanate or ampicillin-sulbactam as alternatives where appropriate, and creating automatic stop orders for surgical prophylaxis drugs like cefazolin.

6. Conclusions and Recommendations

This comprehensive pharmacoeconomic study concludes that the antibacterial therapy for respiratory diseases in children under five at the studied institution is characterized by a high dependence on a limited number of broad-spectrum agents, primarily ceftriaxone. While clinically effective, this pattern poses significant risks for promoting antimicrobial resistance and leads to suboptimal resource allocation. The identified differences in prescribing practices between departments highlight an opportunity for standardization.

Based on the results, the following recommendations are proposed:

1. Develop and Implement Institutional Guidelines: Formulate evidence-based, syndrome-specific antibiotic guidelines for common pediatric respiratory infections, clearly defining first-line (narrow-spectrum) and second-line (broad-spectrum) options.
2. Establish an Antimicrobial Stewardship Program (ASP): Create a multidisciplinary ASP team. Use the ABC analysis data to target interventions. Introduce prospective audit and feedback, especially for Group A and reserve antibiotics.

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3. Enhance Diagnostic Support: Improve access to rapid diagnostic tests (e.g., CRP, procalcitonin) and timely microbiological culture to guide therapy de-escalation and rational use of broad-spectrum drugs.
4. Continuous Education and Monitoring: Conduct regular training for prescribers on guideline adherence and the principles of antimicrobial stewardship.
Repeat the ABC analysis periodically to monitor the impact of interventions and track shifts in prescription patterns and costs.
5. Cost-Benefit Analysis: Consider conducting a more detailed analysis comparing the cost of broader-spectrum therapy with the potential costs associated with treatment failure or longer hospital stays due to inappropriate initial therapy.
In conclusion, the ABC analysis serves as a critical first diagnostic step towards optimizing antibiotic use. By transforming prescription data into actionable intelligence, healthcare institutions can move towards more rational, cost-effective, and sustainable pediatric care, ultimately protecting both current patients and the utility of antibiotics for future generations.

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