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Original Article

Drug Utilization Evaluation of Antibiotics in an Indian Hospital Setting: A Prospective Observational Study

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ABSTRACT

Background: Rational drug use is essential to improving healthcare outcomes and minimizing risks such as antimicrobial resistance. This study evaluates prescription patterns in the General Medicine Department of an Indian hospital in alignment with WHO prescribing guidelines. **Objectives:** To assess drug utilization trends, particularly focusing on antibiotic use, polypharmacy, and injection practices, and to identify areas needing intervention. **Materials and Methods:** A prospective observational study was conducted involving 212 inpatients. Prescription data were analyzed for adherence to WHO indicators, including the number of drugs per prescription, generic prescribing, use of essential medicines, antibiotic utilization, and injection frequency. **Results:** The average number of drugs per prescription was 6.01, exceeding WHO recommendations and indicating significant polypharmacy. The overuse of antibiotics, accounted for 41.73% and injections were 29.10%. Suggesting potential overuse. Generic prescribing stood at 56.63%, while only 44.62% of drugs were from the Essential Drugs List. **Conclusion:** The findings highlight concerns in prescribing practices, especially polypharmacy and overuse of antibiotics and injections. Strategies such as antimicrobial stewardship, provider education, and clinical decision support tools are recommended to enhance rational drug use and align with WHO standards, especially in resource-limited settings.

Keywords: Drug Utilization Evaluation (DUE), Prescription Pattern Analysis, Polypharmacy, Antibiotic Overuse, Essential Drug List (EDL), Antimicrobial Resistance.

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INTRODUCTION

Drug Utilization Evaluation (DUE), as defined by WHO, is a systematic, ongoing, and authorised quality improvement process. It involves evaluating drug use against predetermined standards and providing feedback to clinicians and other relevant groups for enhancement. It is part of the broader category known as Drug Utilization Review (DUR), which aims to ensure medications are used safely, appropriately, and effectively (Promoting rational use of medicines, WHO).

Drug Utilization Evaluation (DUE) ensures the safe, effective, and appropriate use of medications by assessing prescribing, delivery, and consumption patterns against predefined standards. It helps identify treatment issues, particularly in high-risk patients, and suggests interventions to improve drug administration. Retrospective DUE studies are valuable for optimizing treatment, though their implementation faces challenges in developing countries. This method is especially important for managing broad-spectrum antibiotics, which are crucial for treating severe infections but contribute to Antimicrobial Resistance (AMR) when misused. AMR poses a global health warning, with approximate predicting 10 million deaths annually by 2050 if not addressed (Arain *et al.*, 2023; Rezvani *et al.*, 2022).

Antibiotics are extensively used in ambulatory and hospital settings, with misuse, especially for viral infections, contributing to rising antibiotic resistance and healthcare costs. Common pathogens include gram negative bacteria like *Klebsiella* and *E. coli*, and gram-positive bacteria like Staphylococcus aureus. In developing countries, irrational antibiotic use is widespread, often driven by subsidized health insurance, exacerbating resistance issues and complicating effective treatment strategies (Okoro *et al.*, 2019; A. S., R. M., and R. S, 2017).

The global rise in antibiotic resistance, driven by widespread broad-spectrum antibiotic use, presents significant challenges. Hospitals have implemented DUE and PPA to promote appropriate drug use and manage healthcare costs. Evaluating

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prescription patterns is essential for ensuring high-quality patient care and addressing irrational drug use, particularly in developing countries like India. The World Health Organization (WHO) stresses continuous monitoring through core drug use indicators. This study aims to optimize patient care and promote rational drug use through effective prescription analysis and intervention (Shanmugapriya *et al.*, 2018; Raveh *et al.*, 2006).

Broad spectrum antibiotics, commonly used for severe infections in children often lead to unnecessary antibiotic use, contributing to Antimicrobial Resistance (AMR). This misuse is prevalent in China and also can be observed in various parts of India, where many parents self-medicate their children without clinical advice, risking long-term health consequences (Lin *et al.*, 2021; Qingping *et al.*, 2013).

Upper Respiratory Tract Infections (URTIs) are common in developing countries, often leading to inappropriate antibiotic prescriptions despite their viral origins. This misuse contributes to adverse drug reactions, increased healthcare costs, and rising antibiotic resistance. With the declining efficacy of commonly used antibiotics like penicillin and amoxicillin, especially in secondary bacterial infections, reviewing prescription patterns is crucial (John, 2014).

Rational drug use and prescription quality evaluation are crucial for patient safety and reducing public health risks. Despite guidelines, irrational prescribing persists, increasing errors and costs. Prescription audits help identify areas of overuse, underuse, and misuse, enabling targeted interventions to improve outcomes. Antibiotics, while essential for bacterial infections, are expensive and strain healthcare budgets. In India, despite low drug prices, access is limited, with price variations and rising antibiotic resistance further complicating healthcare delivery and affordability (Marupaka *et al.*, 2020; Kumar *et al.*, 2023).

Prescribing patterns highlight the importance of rational drug use by healthcare providers. Auditing these practices is crucial for addressing issues such as polypharmacy and guideline non-compliance. As India increases healthcare spending, analyzing drug prescriptions becomes vital for patient welfare. The WHO's core prescribing indicators are effective tools for assessing drug use. Given India's role as a major generic drug producer and the use of the National List of Essential Medicines (NLEM) (Selvaraj *et al.*, 2022).

This research aims to analyze prescribing trends, including medication frequency, types, and variations across demographics and conditions. It seeks to identify patterns in drug use and areas for improvement. A key objective is to assess the rationality of prescribing by comparing current practices with evidence-based guidelines to ensure appropriate and high-quality drug therapy. Drug utilization research is crucial for understanding the effects of medication use and aligning treatments with best practices for optimal patient care (Satapathy *et al.*, 2020).

The study identifies issues in prescribing practices like polypharmacy, inappropriate drug combinations, and errors, which affect patient safety and outcomes. Through prescription pattern analysis, the research aims to propose targeted interventions to improve prescribing practices and promote rational drug use. Addressing these gaps enhances patient care and healthcare quality. Evaluating antimicrobial prescribing is critical in combating antimicrobial resistance, reducing morbidity, mortality, and the economic burden associated with inappropriate antibiotic use (Wadhwa *et al.*, 2023).

MATERIALS AND METHODS

Ethical Approval

The IEC of KLE College of Pharmacy, Hubballi granted acceptance via letter no. KLECOPH/2023-24/04. All participants provided informed and written consent.

Study Design

This study was a prospective observational study. The study was conducted at Vivekananda General Hospital in Hubballi, Karnataka, spanning a six-month period from September to February. Prior to three months of data gathering, a month of analyzing the data, and a month of thesis writing, the research involved a one-month planning process.

Study Subjects

Individuals over the age of 18 who were brought to the inpatient department were included in the study; outpatients, psychiatric, pregnant, lactating, and non-participating patients were not.

Source of Data

Current Index of Medical Specialists (CIMS), medical case files, treatment charts, and previous medical and drug histories were among the data sources. Data on health and medication histories, test results, progress charts, prescribed medications, and sociodemographic information (age, sex, occupation, and financial status) were gathered from hospitalized patients in the general medicine ward. The total number of prescription drugs was tracked.

Data Analysis and Plan

Microsoft Excel 2021 was used for data analysis, and a pilot study was used to estimate the sample size of 212.

RESULTS

Population Demographics

Prospective observational research involving 212 patients was conducted, of which 154 (73) were males and 58 (27) were females. The number of females in each age group is lower than

that of males. Overall, the population leans slightly towards males (Figure 1).

The chart (Figure 2) shows the gender distribution according to age group in the study population. The frequency of males is higher than the frequency of females in all the age groups.

The bar chart (Figure 3) illustrates the distribution of study participants according to the number of days they stayed in the hospital. The majority of the participants, 114 (53.77), had a hospital stay duration of 0-5 days. This distribution suggests that most patients required a relatively short hospital stay, with a significant drop in numbers as the duration increased. This could be indicative of the effectiveness of the treatment strategies employed, leading to shorter hospital stays for most patients.

The bar chart demonstrated in the Figure 4 shows the distribution of the most typical infectious ailments among the participants in the study. The most frequent occurring disease was pneumonia, affecting 21 (14.38) participants. Urinary Tract Infections (UTIs) alongside Acute diarrheal disease were the second and third most common diseases, each affecting 18 (12.33) and 12 (8.21) patients respectively. Tuberculosis and Dengue fever were the least frequent diseases, each affecting 9 (6.16) and 5 (3.42) patients respectively.

The antibiotics prescribed to the study participants are listed in Table 1, with Ceftriaxone was being the most frequently advised antibiotic, administered to 132 (62.26) participants mainly for prophylactic purposes. Metronidazole was the second most commonly prescribed antibiotic, with 65 (30.66) patients receiving it. Cefixime was the least prescribed drug, with only 6 (2.83) patients receiving it. The usage of anti-TB medicines was also low due to the smaller number of patients in the study, and the fact that these drugs were typically prescribed after discharge. This is the main reason for the low utilization of these drugs.

As presented in Table 2, the General Medicine Department exhibited relatively lower antibiotic expenditure compared to similar departments, even though it catered to a larger patient population over a prolonged study period. A significant portion of the total cost (97.12%) was attributed to parenteral antibiotic formulations, highlighting their predominant use. In contrast, oral antibiotics accounted for only 2.88% of the cost, suggesting a cautious and cost-conscious approach to antibiotic prescribing that favors outpatient or less invasive therapy where appropriate.

The data in the (Table 3) provides an overview of the usage of drugs in various diseases and the type of therapy. Dual Therapy was the most commonly administered type of therapy, with 70 patients, or nearly half of the total (47.94%), receiving this form of treatment. This could indicate that a combination of two therapeutic agents was found to be the most effective or suitable for the majority of the patients in this particular study. The second most common type of therapy was Triple Therapy, which was administered to 49 patients, making up 33.60% of the total. This suggests that a significant portion of the patients required a more complex treatment regimen involving three therapeutic agents. Polytherapy, which involves the use of multiple therapeutic agents, was administered to 20 patients, accounting for 13.7% of the total. This could suggest that these patients had more complex or resistant conditions that required a more aggressive treatment approach.

Finally, Monotherapy, which involves the use of a single therapeutic agent, was the least common type of therapy. It was administered to only 7 patients, accounting for 4.76% of the total. This could indicate that a single therapeutic agent was sufficient to manage the conditions of these patients, or it could suggest that these patients had contraindications or other reasons that prevented the use of multiple therapeutic agents.

The study analyzed prescription practices following WHO guidelines to identify areas for improvement in healthcare delivery and patient outcomes provided in Table 4. Despite finding that healthcare providers adhere to certain WHO recommendations, such as using generic names for 56.63% of prescribed medications, the study also highlights significant concerns requiring immediate attention. The study found that the average number of drugs per prescription exceeds WHO's guidelines, indicating a potential

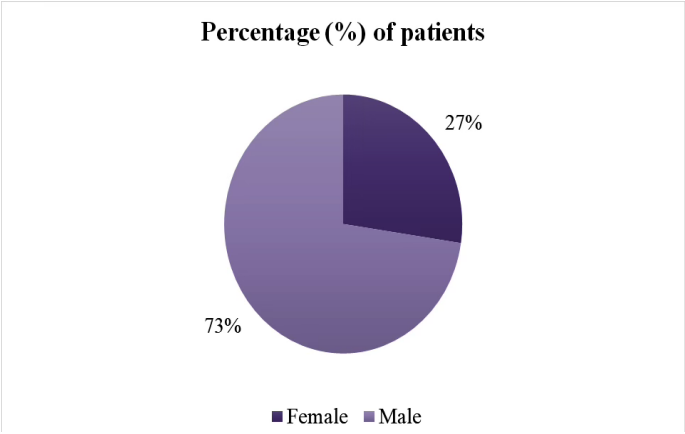

Figure 1: Gender Distribution Among Study Participants.

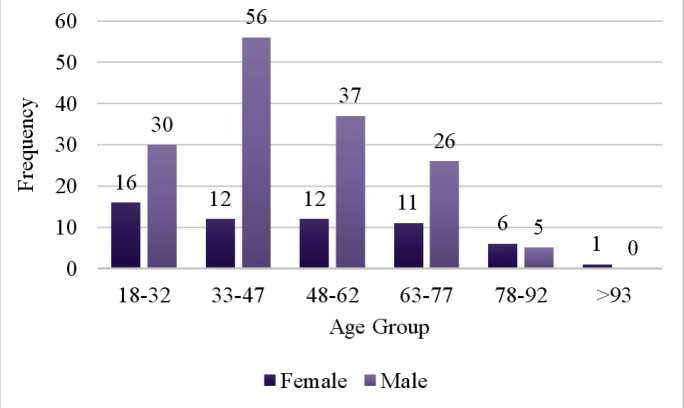

Figure 2: Gender Distribution Among Study Participants Across Different Age Groups.

Table 1: Frequency of Various Antibiotics Prescribed Among Study Participants.

Sl. No.	ATC Code	Antibiotics	No. of Patient= N (%)
1.	J01DD04	Ceftriaxone	132 (62.26)
2.	J01XD01	Metronidazole	65 (30.66)
3.	J01AA02	Doxycycline	54 (25.47)
4.	J01FA10	Azithromycin	52 (24.53)
5.	J01CR05	Piperacillin + Tazobactum	45 (21.23)
6.	A07AA11	Rifaximin	32 (15.09)
7.	J01DH02	Meropenem	29 (13.67)
8.	J01MA12	Levofloxacin	24 (11.32)
9.	J01MA02	Ciprofloxacin	13 (6.13)
10.	J01XA01	Vancomycin	13 (6.13)
11.	J01CR02	Amoxicillin + Clavulanic acid	19 (8.96)
12.	J01GB06	Amikacin	7 (3.30)
13.	J01DD08	Cefixime	6 (2.83)
14.	J04AB02	Rifampicin	4 (1.89)
15.	J01FF01	Clindamycin	3 (1.42)
16.	J04AK02	Ethambutol	2 (0.94)
17.	J04AK01	Pyrazinamide	2 (0.94)

Table 2: Distribution of Cost Between Parenterally and Orally Administered Drugs.

Sl. No.	Route of Administration	Total Cost of Antibiotics in General Medicine Department	Percentage % (GM)
1.	Parenteral (IV)	736243.3	97.12%
2.	Oral (PO)	21797.73	2.88%

concern for polypharmacy. The overuse of antibiotics, accounting for around 41.73% of encounters, raises alarms regarding the looming threat of antimicrobial resistance. Additionally, frequent injections in approximately 29.10% of encounters necessitate scrutiny to ensure appropriateness, considering associated risks and exploring alternative administration routes. It is crucial to address these concerns to enhance the quality of care and safeguard patient well-being in line with WHO guidelines. Strategies to address these concerns may include the implementation of antimicrobial stewardship programs, educational interventions for healthcare providers, and the development of clinical decision support tools. Future research must focus on evaluating the effectiveness of interventions aimed at improving prescribing practices and reducing rates of polypharmacy, antibiotic overuse, and inappropriate injection use.

Efforts to strengthen health systems and promote access to essential medicines, particularly in resource-limited settings, are critical to advancing the goals of rational drug use and improving population health outcomes. Taking a multifaceted approach involving collaboration between healthcare professionals, patients, and policymakers is imperative to achieve optimal patient outcomes.

DISCUSSION

Shiv Kumar *et al.*, conducted a study to estimate and compare the cost of antibiotics in the emergency department and wards of a private hospital. Penicillin was the most expensive class of antibiotics at 30% (₹9,165), while in other words, carbapenem was the most expensive at 40% (₹16,448). Piperacillin/tazobactam was the costliest antibiotic in the emergency department at 29.94% (₹9,075), while meropenem was the most expensive in other wards at 40% (₹16,448). The study concluded that the high cost of treatment aligns with the data of other studies, indicating a need for regular prescription audits and modifications of antibiotic policies to reduce inappropriate use and the economic burden on hospitals (Kumar *et al.*, 2023).

In contrast, as shown in Table 2, our study conducted in the General Medicine Department demonstrates comparatively lower antibiotic costs. Despite serving a larger patient population over an extended duration, the total antibiotic expenditure is notably

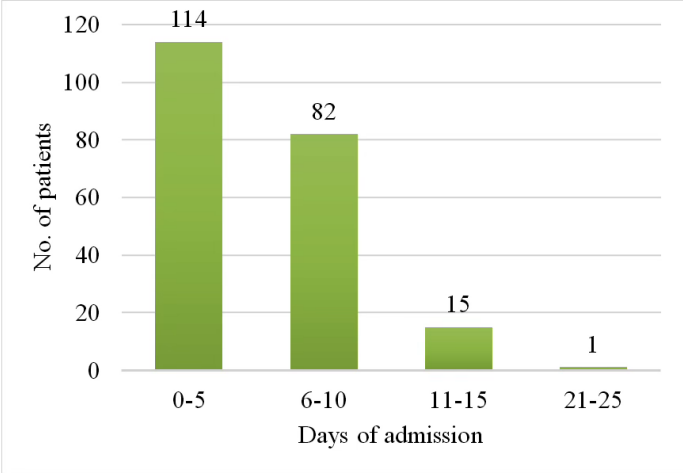

Figure 3: Distribution Among Study Participants in terms of Hospital Stay.

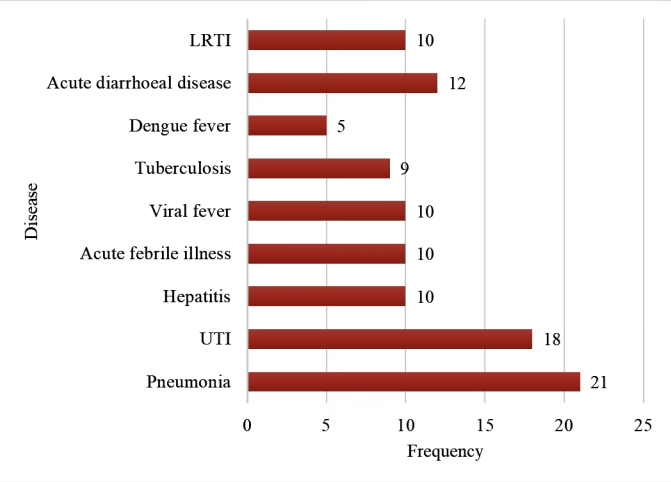

Figure 4: No of Patients Infected With Various Infectious Diseases Among Study Participants.

reduced. However, most of the antibiotic administration still occurs through parenteral routes (97.12% of total cost), albeit at a lower absolute cost compared to the Emergency Department. The utilization of oral antibiotics (2.88% of total cost) reflects a more conservative approach to antibiotic prescribing, emphasizing cost-effectiveness and outpatient management.

Our analysis sheds light on key aspects of treatment practices in general medicine, offering valuable insights for optimizing resource allocation and improving patient care. Firstly, we observed a significant predominance of parenteral administration, indicating its substantial financial impact. Understanding the distribution of treatment routes is crucial for making informed decisions in healthcare resource management.

Examining treatment types, we found that Dual Therapy was the most commonly administered, suggesting its efficacy for a considerable portion of patients. Triple Therapy followed closely, indicating the need for more complex treatment approaches in certain cases. While Polytherapy and Monotherapy were less common, they highlight the diversity of therapeutic strategies employed. Looking specifically at antibiotic treatment strategies for various diseases, such as pneumonia, Urinary Tract Infections (UTIs), and hepatitis, we identified nuanced patterns in antibiotic utilization. These variations underscore the importance of considering factors like microbial susceptibility and treatment guidelines when selecting antibiotics for individual patients.

Furthermore, our analysis of prescription practices revealed both adherence and areas for improvement in following WHO guidelines. While healthcare providers generally adhere to certain recommendations, concerns such as polypharmacy and antibiotic overuse require attention. Addressing these concerns calls for multifaceted approaches, including the implementation of antimicrobial stewardship programs and educational initiatives for healthcare providers. Strengthening health systems and promoting access to essential medicines are essential steps toward advancing rational drug use and improving patient outcomes.

Our study identifies concerns regarding polypharmacy, with an average of 6.01% of drugs per prescription, exceeding WHO guidelines. This highlights the need for interventions to optimize prescribing practices, as polypharmacy can lead to adverse drug reactions and compromised patient adherence. Additionally, the prevalent prescription of antibiotics in 41.73% of encounters raises concerns about potential overuse and antimicrobial resistance. The frequent use of injections in 29.10% of encounters also requires scrutiny to ensure appropriateness and explore alternative administration routes. Despite these challenges, approximately 44.63% of drugs prescribed are from the Essential Drug List, reflecting efforts to prioritize essential medications in line with WHO guidelines. While our study slightly deviates from WHO's average drug per prescription, the higher percentage of drugs from the Essential Drug List suggests adherence to global health guidelines. However, gaps in data collection on generic prescribing and antibiotic/injection usage indicate areas for improvement in aligning prescribing practices with WHO recommendations. Moving forward, addressing these gaps can enhance healthcare quality and patient safety.

In summary, our findings offer valuable insights into treatment practices in general medicine, emphasizing the need for informed decision-making and continuous improvement efforts. Future research should focus on evaluating the effectiveness of interventions aimed at addressing identified concerns and enhancing prescribing practices to achieve optimal patient care. Adherence to WHO Core Prescribing Guidelines, our study demonstrates commendable adherence to certain WHO recommendations, particularly in the consistent usage of generic names for approximately 56.63% of prescribed medications. This adherence promotes cost-effectiveness and enhances patient understanding and access to essential treatments, reflecting a positive aspect of prescribing practices.

Table 3: No. of patients undergoing different types of therapies.

Sl. No.	Therapy	No. of Patients
1.	Monotherapy	7 (4.76)
2.	Dual therapy	70 (47.94)
3.	Triple therapy	49 (33.60)
4.	Polytherapy	20 (13.7)

Table 4: WHO Core Prescribing Guidelines and Percentages of Drugs Prescribed.

Sl. No.	WHO Core prescribing guidelines	Percentage of Prescriptions (%) *n*= 212
1.	Average no. of drugs per prescription	6.01
2.	% of drugs prescribed by the generic name	56.62
3.	% encounter with an antibiotic	41.72
4.	% encounter with an injection	29.09
5.	% of drugs from EDL	44.62

CONCLUSION

The study of prescription practices in the General Medicine Department, based on WHO guidelines, identifies key areas for improvement. Polypharmacy is a concern, with an average of 6.01 drugs per prescription, contributing to adverse drug reactions. Antibiotic overuse, present in 41.73% of encounters, raises concerns about antimicrobial resistance, while injections were used in 29.10% of cases, suggesting a need for safer alternatives. Only 44.62% of drugs were from the Essential Drugs List, indicating gaps in adherence to WHO recommendations. To address these issues, the study recommends implementing antimicrobial stewardship programs, educating healthcare providers, and developing clinical decision support tools to promote rational drug use and improve patient outcomes.

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ABBREVIATIONS

ADR: Adverse Drug Reaction; **AMR:** Antimicrobial Resistance; **CIMS:** Current Index of Medical Specialists; **DUE:** Drug Utilization Evaluation; **EDL:** Essential Drugs List; **NCCN:** National Comprehensive Cancer Network; **NLEM:** National List of Essential Medicines; **PPA:** Prescription Pattern Analysis; **URTI:** Upper Respiratory Tract Infection; **UTI:** Urinary Tract Infection; **WHO:** World Health Organization.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

SUMMARY

This study examines antibiotic prescribing patterns in the General Medicine Department of an Indian hospital, following WHO guidelines. It highlights a high prevalence of polypharmacy, with prescriptions often exceeding recommended limits. Antibiotics were frequently prescribed, raising concerns about antimicrobial resistance. A considerable number of prescriptions also included injectable medications, emphasizing the need to evaluate their necessity.

While a moderate proportion of prescriptions followed generic prescribing practices, the use of essential medicines remained suboptimal, indicating a need for more cost-effective and rational drug use. Ceftriaxone was the most commonly prescribed antibiotic, primarily for prophylactic purposes, and dual therapy was frequently employed.

The study underscores the importance of antimicrobial stewardship, regular prescription audits, and educational initiatives to promote rational prescribing. Addressing polypharmacy, optimizing antibiotic use, and reducing unnecessary injections can improve patient outcomes and help combat antibiotic resistance. Future research should focus on developing targeted interventions to enhance prescribing practices, especially in resource-limited settings.

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