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AGE-STRATIFIED ANALYSIS OF ANTIBIOTIC PRESCRIBING PRACTICES: A COMPREHENSIVE STUDY ON EXTENDED-SPECTRUM ANTIBIOTICS IN ICU WITH APACHE IV SCORING

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ABSTRACT:
This prospective study investigates into the complex antibiotic prescribing practices, focusing on the distribution of extended-spectrum antibiotics in ICU within various age categories and their association with the severity of illness assessed by the APACHE IV scoring system. Analyzing data from ICU admitted patients, distinct age-related patterns was observed, age below 50 categories exhibiting the highest percentage of extended-spectrum antibiotic prescriptions. Correlation with APACHE IV scores revealed a strategic alignment of antibiotic choices with illness severity. Statistical analyses such as Chi-square test, fisher's exact test ($p > 0.005$) confirmed a significant association between age categories and extended-spectrum antibiotic use. While these findings provide valuable clinical insights, the study's limitations, including potential biases and short-term perspectives, necessitate careful consideration. In conclusion, this research contributes to a nuanced understanding of antibiotic prescribing, highlighting the need for age-specific and severity-basis approaches in clinical settings.

Keywords: ICU, APACHE score IV, Antibiotic, Prescription, Correlation

INTRODUCTION:

Antibiotic prescribing practices play a pivotal role in patient care, influencing treatment outcomes and the emergence of antimicrobial resistance(Borek *et al.*, 2021). Understanding the factors contributing to the selection of specific antibiotics is crucial for optimizing therapeutic strategies(Wojcik *et al.*, 2021). As the global healthcare landscape continually evolves, there is a growing recognition of the need for personalized and evidence-based approaches to medical treatment(Borek *et al.*, 2022). Age-related variations in immune response and the prevalence of

specific infections necessitate a nuanced examination of antibiotic utilization patterns across different age groups(Nikolich-Žugich *et al.*, 2021). Additionally, the severity of illness, assessed through the Acute Physiology and Chronic Health Evaluation (APACHE IV) scoring system, provides a comprehensive measure of the patient's health status, offering valuable insights into the complexity of clinical decision-making(Kramer, Zimmerman, Knaus, 2021).

This study seeks to contribute to the existing body of knowledge by conducting a thorough analysis of the distribution of extended-spectrum antibiotics within various age categories and across different severity levels, as indicated by the APACHE IV scores(Luo, Wang, Wang, 2021). The inclusion of APACHE IV scoring enhances the precision of understanding, linking antibiotic prescriptions to the severity of the patient's condition(Mirzakhani *et al.*, 2022). This study aims to delve into the intricate relationship between age, severity of illness (as measured by the APACHE IV score), and the prescription patterns of extended-spectrum antibiotics during the first day of hospital admission.

Methodology:

The methodology involves analyzing the distribution of extended-spectrum antibiotics in ICU within different age categories and APACHE score IV and assessing the association between age and APACHE IV with antibiotics. This analysis helps understand if there are any age-related and severity of disease related patterns in antibiotic prescription.

1. **Data Collection**: 640 ICU admitted patient’s data on antibiotic usage within various age groups was collected from Health care center in Karachi, Pakistan.
2. **Categorization by Age**: Patients were categorized into age groups (e.g., 18-20, 21-30, 31-40, etc.) to facilitate analysis.
3. **Calculation of Percentages**: The percentage of patients receiving extended-spectrum antibiotics within each age category was calculated to understand the proportion of antibiotic usage.
4. **Statistical Analysis**: Chi-square tests were conducted to assess the association between age categories and APACHE score IV with the use of extended-spectrum antibiotics. Additionally, Fisher's exact test was performed to confirm the statistical significance of this association.
5. **Interpretation**: Results were interpreted to determine whether there was a statistically significant association between age categories and the use of extended-spectrum antibiotics. This provides insights into potential age-related factors influencing antibiotic prescribing practices.
6. **Comparison across Age Groups**: The distribution of extended-spectrum antibiotics was compared across different age groups to identify any trends or disparities in antibiotic usage.

Inclusion Criteria:

1. **Hospital Admissions:** Patients admitted to the hospital.
2. **Age Range:** All age groups, including individuals aged 18 and above.
3. **Antibiotic Prescriptions:** Patients prescribed either extended-spectrum antibiotics or other antibiotics on the first day of admission.
4. **APACHE IV Score:** Patients with available APACHE IV scores, providing a measure of severity of illness.
5. **Complete Data:** Patients with complete and accurate demographic and medical information.

Exclusion Criteria:

1. **Outpatient Cases:** Individuals receiving treatment on an outpatient basis without hospital admission.
2. **Pediatric Population:** Patients below the age of 18.
3. **Incomplete Data:** Cases with missing or incomplete information regarding antibiotic prescriptions, age, or APACHE IV scores.

4. **Non-Standard Antibiotic Regimens:** Patients receiving non-standard antibiotic regimens not falling under the categories of extended-spectrum or other antibiotics.
5. **Incomplete APACHE IV Scores:** Cases with missing or incomplete APACHE IV scores, preventing a comprehensive assessment of illness severity.
6. **Non-Relevant Medical Conditions:** Patients admitted for reasons unrelated to the scope of the study, such as surgical procedures or obstetric care.

These criteria are designed to ensure the study focuses on ICU admitted patients, includes a diverse age range, considers relevant antibiotic prescriptions, incorporates the severity of illness through APACHE IV scores, and maintains data completeness and accuracy. Exclusion criteria are established to maintain the study's internal validity by excluding cases that might introduce bias or confounding factors.

Result:

The results of this study present a comprehensive analysis of the distribution of extended-spectrum antibiotics within distinct age categories on the first day of ICU admission, with an exploration of the association between these prescribing patterns and severity of illness assessed by the APACHE IV scoring system. The following key findings elucidate the nuanced relationships observed in investigation.

Distribution of Extended-spectrum antibiotic prescription within age categories

The distribution of extended-spectrum antibiotics across various age categories provided significant insights between age and extended-spectrum antibiotic in the study of ICU patients. According to Table 1 and Figure 1, it is evident that among 640 patients, 538 (84.1%) received extended-spectrum antibiotic either alone or in combination with other antibiotics.

- In the youngest age category of 18-20 years, comprising 8 patients, 6 (75%) were prescribed extended-spectrum antibiotic, while 2 (25%) were prescribed other antibiotics.
- For 21-30 age category, 66 (84.6%) were prescribed extended-spectrum antibiotic, while 12 (15.4%) were prescribed other antibiotics.
- In the 31-40 age group, 84 (91.3%) were prescribed extended-spectrum antibiotic, while 8 (8.7%) were prescribed other antibiotics.
- Patients aged 41-50 age category, 96 (92.3%) were prescribed extended-spectrum antibiotic, while 8 (7.7%) were prescribed other antibiotics.
- Among 51-60 age category, 122 (84.7%) were prescribed extended-spectrum antibiotic, while 22 (15.3%) were prescribed other antibiotics.
- The above-60 age category, 164 (76.6%) were prescribed extended-spectrum antibiotic, while 50 (23.4%) were prescribed other antibiotics.
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Table 1: Distribution of the extended-spectrum antibiotic within age categories

Age category	First day of admission n (%)		Total
	Extended-spectrum Antibiotic	Other Antibiotics	
18-20	6	2	8
	75.0%	25.0%	100.0%
21-30	66	12	78
	84.6%	15.4%	100.0%
31-40	84	8	92
	91.3%	8.7%	100.0%
41-50	96	8	104
	92.3%	7.7%	100.0%
51-60	122	22	144
	84.7%	15.3%	100.0%
above 60	164	50	214
	76.6%	23.4%	100.0%

Total	538	102	640
	84.1%	15.9%	100.0%

Age was further divided into two categories, age below 50 and age above 50. The chi-square test results assess the association between the Age categories below 50 and above and the extended-spectrum antibiotic. These results indicate a statistically significant association between the age categories and the extended spectrum antibiotic. The Fisher's exact test also provides a p-value of 0.002, further confirming the statistical significance of the association as Table 2.

Table 2: Association of the extended-spectrum antibiotic within age categories (below 50 and above 50)

Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	9.104[a]	1	.003		
Continuity Correction[b]	8.461	1	.004		
Likelihood Ratio	9.350	1	.002		
Fisher's Exact Test				.003	.002
Linear-by-Linear Association	9.090	1	.003		
N of Valid Cases	640				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 45.90.
b. Computed only for a 2x2 table

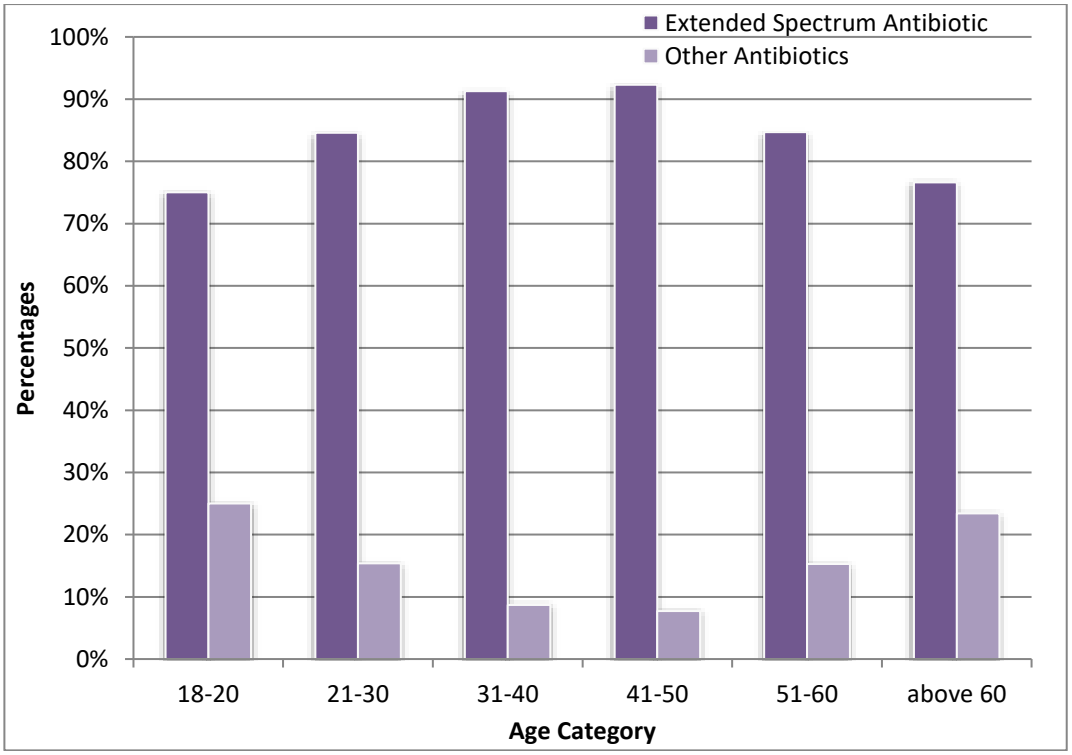

Figure 1: Distribution of the extended-spectrum antibiotic within age categories

Distribution of extended-spectrum antibiotic prescription within APACHE IV categories

The distribution of APACHE IV categories among extended-spectrum antibiotics provided significant insights between APACHE-IV and extended-spectrum antibiotic in the study of ICU patients. According to Table 3 and Figure 2, it is evident that among 640 patients, 538 (84.1%) received extended-spectrum antibiotic either alone or in combination with other antibiotics.

In all APACHE IV categories extended-Spectrum antibiotics were prescribed more than other types of antibiotics. However, after APACHE score 90, most of the patients were received 100 % extended-spectrum antibiotic.

Table3: Distribution of extended-spectrum antibiotic prescription within APACHE IV categories

APACHE-IV Category	Extended-Spectrum Antibiotic	Other antibiotics	Total
0-20	42	6	48
	87.5%	12.5%	100.0%
21-30	62	4	66
	93.9%	6.1%	100.0%
31-40	68	12	80
	85.0%	15.0%	100.0%
41-50	38	28	66
	57.6%	42.4%	100.0%
51-60	50	16	66
	75.8%	24.2%	100.0%
61-70	38	8	46
	82.6%	17.4%	100.0%
71-80	56	4	60
	93.3%	6.7%	100.0%
81-90	50	16	66
	75.8%	24.2%	100.0%
91-100	38	0	38
	100.0%	0.0%	100.0%
101-110	38	0	38
	100.0%	0.0%	100.0%
111-120	34	4	38
	89.5%	10.5%	100.0%
121-130	16	4	20
	80.0%	20.0%	100.0%
131-140	6	0	6
	100.0%	0.0%	100.0%
>141	2	0	2
	100.0%	0.0%	100.0%
Total	538	102	640
	84.1%	15.9%	100.0%

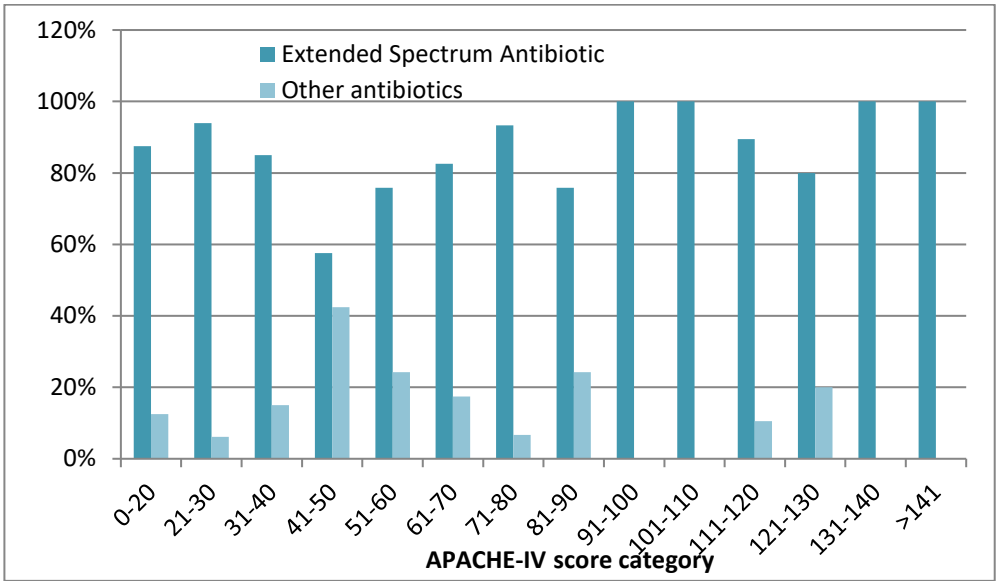

Figure2: Distribution of extended-spectrum antibiotic prescription within APACHE-IV score categories

The chi-square test results assess the association between the APACHE IV categories below 80 & above 80 and the extended-spectrum antibiotic. These results indicate a statistically significant association between the APACHE-IV categories and the extended spectrum antibiotic. The Fisher's Exact Test also provides a p-value of 0.002, further confirming the statistical significance of the association as Table 4.

Table 4: Association of extended-spectrum antibiotic prescription within APACHE IV categories (below 80 or above 80 score)

Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.451[a]	1	.035		
Continuity Correction[b]	3.978	1	.046		
Likelihood Ratio	4.665	1	.031		
Fisher's Exact Test				.038	.021
Linear-by-Linear Association	4.444	1	.035		
N of Valid Cases	640				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 33.15.
b. Computed only for a 2x2 table

Discussion:

The findings of this study reveal compelling insights into the interplay between age, severity of illness, and antibiotic prescribing practices, specifically focusing on extended-spectrum antibiotics on the first day of ICU admission, increased by the APACHE IV scoring system.

The age-stratified analysis demonstrated varying proportions of extended-spectrum antibiotic prescriptions across different age categories. Notably, there was a consistent decrease in the percentage of patients receiving extended-spectrum antibiotics with age above 50(Gutiérrez-Gutiérrez *et al.*, 2021). This pattern may reflect age-related differences in susceptibility to certain infections, emphasizing the importance of modified narrow spectrum antibiotic choices based on patient age and condition(Rhee *et al.*, 2020; Song *et al.*, 2020).

The integration of APACHE IV scores provided a nuanced perspective on the relationship between illness severity and antibiotic prescribing practices(Zubair *et al.*, 2023; Biswas *et al.*, 2023). Higher severity scores were associated with a higher likelihood of extended-spectrum antibiotic

prescription(Larcher *et al.*, 2022). The observed correlation suggests that clinicians are aptly adjusting their antibiotic choices based on the perceived severity of the patient's condition. This aligns with the principle of precision medicine, emphasizing modified treatments based on individual patient characteristics(Li Bergan, 2020).

The study's outcomes have direct implications for clinical decision-making. Understanding the age-related trends in antibiotic prescribing assists healthcare providers in crafting targeted treatment plans(Lenze *et al.*, 2021). Moreover, the association between severity of illness and extended-spectrum antibiotic use underscores the importance of judicious prescribing to optimize therapeutic efficacy while minimizing the risk of antibiotic resistance.

Limitations and Future Research: Despite the valuable insights provided by this study, the study's reliance on current data may restrict its ability to capture long-term trends or changes in prescribing practices over an extended period. Furthermore, the effectiveness of the study may be influenced by unforeseen external factors impacting the healthcare landscape. These limitations underscore the importance of interpreting the results within the context of the study's design and the inherent constraints associated with prospective research.

Conclusion: In conclusion, this study illuminates the intricate relationship between age, severity of illness, and antibiotic prescribing practices, with a specific focus on extended-spectrum antibiotics. The integration of APACHE IV scores enhances the depth of understanding, emphasizing the importance of personalized medicine in antibiotic decision-making. These findings contribute to the ongoing discourse on optimizing antibiotic use, paving the way for improved patient care and the mitigation of antimicrobial resistance in healthcare settings.

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