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Research Article

Assessment of Antibiotic Resistance Among Pediatric Cancer Patients

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ABSTRACT

Introduction: Antibiotics have greatly improved healthcare by treating previously lethal infections. However, overreliance and irrational use have led to Antimicrobial Resistance (AMR), where microbes neutralize antibiotic effects. While AMR is less common in cancer patients, it poses challenges during chemotherapy.

Objective: Assess AMR prevalence in pediatric cancer patients receiving antibiotics.

Materials and Methods: A cross-sectional study of 300 pediatric cancer patients receiving antibiotics was conducted at The Children's Hospital and Institute of Child Health, Lahore, Pakistan, over six months. Data was collected via convenient sampling.

Results: Predominantly, children aged 4 to 7 suffered from various cancers, with lymphoblastic leukemia (47%) most prevalent. Blood samples (29%) were most frequently used, revealing greater susceptibility to gram-negative bacteria. AMR incidence was higher in gram-negative bacteria. Sensitivity was noted for ciprofloxacin (23%), amikacin (21%), piperacillin (24%), and ceftazidime (23%). Penicillin antibiotics and ceftazidime showed higher AMR incidence.

Conclusion: AMR poses a significant challenge in treating infections in pediatric cancer patients. Appropriate antibiotic selection is crucial to prevent AMR and ensure chemotherapy efficacy.

Keywords: Antimicrobial Resistance; Cancer; Antibiotics; Gram-Negative Bacteria; Pediatric Patients.

INTRODUCTION

Cancer, characterized by uncontrolled cell division, disrupts normal cellular function and can spread malignancy to various organs. Annually, around 300,000 children and adolescents worldwide are diagnosed with cancer, with pediatric cases differing from those in adults. Pediatric cancers, including leukemias, lymphomas, and sarcomas, often respond better to chemotherapy than adult carcinomas, which typically originate from epithelial cells. Childhood cancers, such as acute lymphoblastic leukemia (ALL) and

acute myeloid leukemia (AML), constitute a significant portion of diagnoses, alongside CNS tumors like astrocytoma and various other carcinomas. Bacterial infections pose a serious threat to cancer patients following chemotherapy-induced neutropenia. Infections caused by Multi-Drug Resistant (MDR) gram-negative bacilli, including Enterococcus faecium, Staphylococcus aureus, Klebsiella pneumoniae, Acinetobacter baumannii, Pseudomonas aeruginosa, and Enterobacter spp., present challenges due to limited treatment options and potential toxicities from broad-spectrum antibiotics. Antibiotic resistance in pediatric oncology arises from factors such as irrational antibiotic use, limited reliance on microbiological data for antibiotic selection, and environmental antibiotic exposure in clinical settings. Poor infection control contributes to antibiotic resistance, particularly in immunosuppressed cancer patients vulnerable to nosocomial infections. Common antibiotics used in pediatric cancer treatment, such as penicillin, aminoglycosides, fluoroquinolones, glycopeptides, and tetracyclines, are susceptible to AMR, requiring careful administration. Statistics from the 8th European Conference on Infections in Leukemia (ECIL) highlight MDR prevalence, with β-lactamase-producing Enterobacteriaceae, aminoglycoside-resistant gram-negative bacteria, and carbapenem-resistant Pseudomonas aeruginosa being notable causes. This study hypothesizes that pediatric cancer patients are highly susceptible to MDR infectious diseases, necessitating appropriate antibiotic selection. The primary objective is to assess AMR prevalence among pediatric cancer patients receiving antibiotic treatment for infections encountered during cancer therapy [1-4].

MATERIALS AND METHODS

Study Design

This observational cross-sectional study aimed to investigate antibiotic resistance patterns in pediatric cancer patients.

Sample Size

Guardians of pediatric cancer patients were approached, and after obtaining consent, patients meeting inclusion criteria were included. Sample size was calculated using the Cochrane formula, targeting a representative sample of pediatric cancer patients with various infections.

Place and Duration of Study

Data collection took place at The Children's Hospital and The Institute of Child Health, Lahore, from June 15th to August 15th, spanning two months.

Inclusion Criteria

Patients aged 1 to 15, of both genders, diagnosed with cancer, willing to participate, and prescribed at least one antibiotic during the study period were included.

Exclusion Criteria

Patients diagnosed with cancer who were not prescribed antibiotics or did not encounter antibiotic resistance were excluded.

Research Procedure

A total of 300 cancer patients across different age groups, prescribed at least one antibiotic and experiencing antibiotic resistance, were contacted for inclusion. Guardians of eligible subjects were interviewed using a structured data collection form. The questionnaire covered demographic, socioeconomic, cancer history, chemotherapy duration, cancer protocol, and pre-antibiotic symptom information [5].

Data Analysis

Collected data were coded and analyzed using Microsoft Excel. Results were presented through graphs and tables.

RESULTS

Patients diagnosed with Hodgkin's lymphoma, acute lymphoblastic leukemia, adenocarcinoma, and osteosarcoma were assessed for bacterial infections, with particular attention to those exhibiting antibiotic resistance. The distribution of each cancer type among the pediatric patients included in the study. Table 1 presents the distribution of patients according to the duration of chemotherapy [6].

Clinical aspects observed during data collection are detailed in Table 2. Gram-positive bacteria identified in samples collected from pediatric patients are depicted in Figure 1, with Staphylococcus aureus being the most prevalent. Figure 2 illustrates the prevalence of various gram-negative bacteria, with Escherichia coli being the most frequently identified species in 36% of patient samples.

Illustrates the incidence of antibiotic resistance among pediatric patients. Penicillin (24%) and ceftazidime (23%) were among the antibiotics most susceptible to resistance, followed by meropenem (19%) and amoxicillin (16%).

The effectiveness of antibiotics in curing infections among the study population. Ciprofloxacin (23%) emerged as the most effective, along with Amikacin (21%), Piperacillin (16%), and Cefepime (16%) [7].

Furthermore, outlines antibiotic sensitivity and resistance

Duration of Chemotherapy	Percentage of Patients
1-3 months	79%
4-6 months	15%
7-9 months	4%
9-12 months	2%

Table 1: Duration of chemotherapy of the treated pediatric cancer patients.

Febrile Status of Patients		Causative Agents of Infections		Patients with Neutropenia	
Patients	Percentage	Gram +ve	Gram	Neutropenic	Non-Neutropenic
Febrile Patients	97%	51%	49%	95%	5%
Afebrile Patients	3%	--	--		

Table 2: Clinical observations pertaining to the included patients.

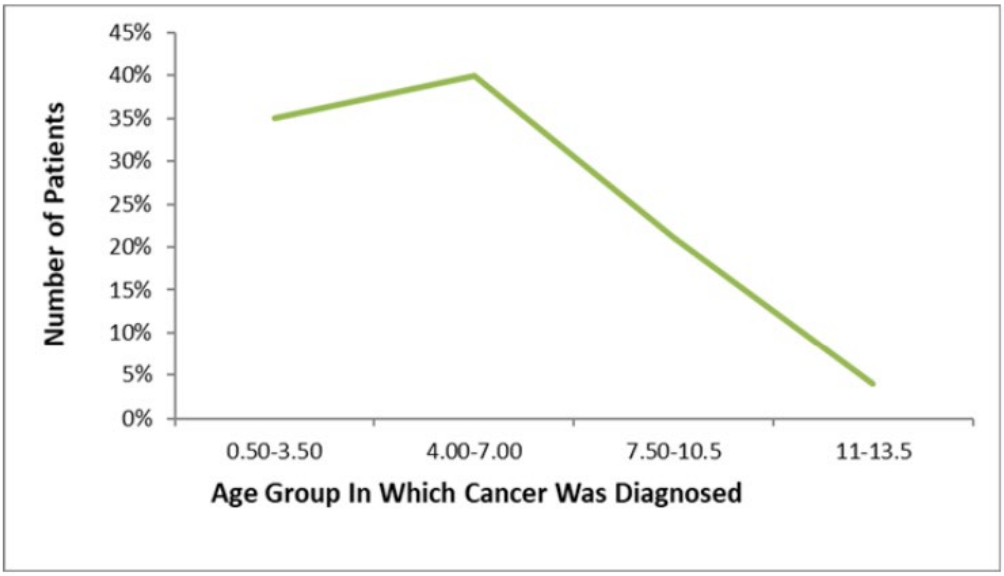

Figure 1: Images showing the age range (1 -15 years old) of the included pediatric patients being treated for various cancers.

patterns in included pediatric cancer patients. Ciprofloxacin was the most frequently prescribed antibiotic, with 122 out of 300 patients receiving it, followed by amikacin. Oxacillin was the least prescribed antibiotic.

DISCUSSION

The findings of this research underscore the dual role of antibiotics in cancer treatment, wherein they exhibit both therapeutic potential and contribute to antibiotic resistance (AR) development. Antibiotics have demonstrated capabilities in promoting cancer apoptosis, inhibiting cancer growth, and preventing metastasis, thereby becoming increasingly integrated into cancer treatment protocols. However, their use also escalates the risk of resistance emergence among patients. AR, a complex process, is perpetuated by various factors including inadequate infection prevention/control

measures, which facilitate the selection and proliferation of resistant bacteria [8,9].

Despite advancements in supportive care, infections remain a significant concern in pediatric cancer treatment, especially those caused by Multi-Drug Resistant (MDR) gram-negative bacteria. Studies have highlighted the prevalence of gram-negative bacteria, particularly Enterobacteriaceae, in bloodstream infections among pediatric cancer patients. Notably, resistance rates vary regionally, with higher rates observed in certain European regions. Neutropenia, a common side effect of cancer treatment, increases susceptibility to infections, necessitating prompt initiation of broad-spectrum antibiotics. Febrile neutropenic episodes, though common, require careful evaluation and management to minimize risks [10].

In our study, gram-positive bacteria, including Staphylococcus aureus and Streptococcus species, were prevalent among pediatric cancer patients, while gram-negative bacteria like Escherichia coli and Pseudomonas predominated, consistent with trends reported in recent epidemiological studies. Resistance patterns revealed varying degrees of resistance to commonly used antibiotics, with ciprofloxacin demonstrating the highest sensitivity. Studies comparing antibiotic regimens have highlighted the efficacy of ciprofloxacin in febrile neutropenic episodes, supporting its role as a viable treatment option.

Efforts to combat AR include the exploration of narrow-spectrum antibiotics to minimize disruption of the normal microbiome and mitigate antimicrobial impact. Narrow-spectrum agents, such as bacteriophages and monoclonal antibodies, show promise in targeted therapy [11,12]. Rapid diagnostic techniques, including matrix-assisted laser desorption ionization-time-of-flight mass spectrometry and rapid antigen testing, enable timely initiation of definitive antimicrobial therapy, crucial in immune-compromised cancer patients.

Guidelines from the Infectious Diseases Society of America (IDSA) advocate for judicious antibiotic use, particularly in pediatric cancer patients, emphasizing the importance of selecting preferred and alternative antibiotics for treating infections caused by Extended Spectrum Beta-Lactamase (ESBL) producing bacteria. These guidelines aim to curb irrational antibiotic use and mitigate the emergence of antibiotic resistance in vulnerable patient populations [13-17].

Antibiotics play a vital role in pediatric cancer treatment, their overuse contributes to antibiotic resistance, posing challenges in infection management. Future strategies should focus on optimizing antibiotic use, exploring alternative therapies, and implementing rapid diagnostic techniques to combat AR effectively, ultimately improving patient outcomes in pediatric oncology.

CONCLUSION

Antibiotic resistance poses a significant threat to patients undergoing chemotherapy, endangering their lives. Urgent attention from healthcare scientists and governing bodies is imperative to address this issue. Our study revealed susceptibility to gram-negative bacteria, particularly E. coli and S. aureus, among the pediatric cancer patient population. Despite the discovery of various antibiotics, some microorganisms persistently resist treatment. Ciprofloxacin emerged as a reliable option, with high sensitivity observed, while resistance was noted against penicillin and ceftazidime.

High resistance rates in pediatric cancer patients compromise the efficacy of antibiotics, leading to increased mortality rates. Establishing government-level policies or guidelines for appropriate antibiotic selection is crucial to combat antibiotic resistance in this vulnerable population and improve survival outcomes. Cancer advocates should leverage their political and social influence to address this healthcare challenge effectively.

Collaborative efforts between oncologists and infectious disease experts are essential to formulate central policies aimed at combating infectious diseases in cancer patients, particularly pediatric cases. These efforts are crucial for safeguarding the effectiveness of advancements in oncological therapy.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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