Research Article

Bacterial Infections in Neutropenic Cancer Patients in Iraq: A Cross-Sectional Study of Clinical and Microbiological Patterns

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Abstract

Neutropenia is a serious and frequent complication in cancer care, particularly following chemotherapy. It markedly increases the risk of infections and is often complicated by fever, which may be the only early clinical sign of life-threatening bacterial infections. Understanding local epidemiological trends is critical to guiding effective infection control and antibiotic strategies, especially in resource-limited settings. In Iraq, where local epidemiological data remain scarce, this study provides urgently needed insights to inform infection control in oncology care. This study aimed to evaluate the incidence of fever and patterns of bacterial infections among neutropenic cancer patients in Iraq. A prospective cross-sectional study was conducted on 98 adult neutropenic cancer patients admitted to the Oncology Teaching Hospital, Almal National Hospital for Cancer Treatment, and Hematology and Transplant Center (HTC). Data on age, gender, cancer type, neutropenia severity, fever presence, and microbiological culture results were extracted and analyzed descriptively. The majority of the patients were female (68.4%) and over 50 years of age (75.5%). Hematological malignancies accounted for 81% of all cases. The most prevalent form was moderate neutropenia (68.4%). Fever developed in 58.2% of patients, and among these, 77.2% had positive bacterial cultures. Gram-negative organisms were predominant, with Escherichia coli (33.3%) and Klebsiella pneumoniae (29.8%) being the most frequently isolated pathogens. Neutropenia is highly prevalent among Iraqi cancer patients with hematological malignancies and is frequently accompanied by fever and Gram-negative bacterial infections. These findings highlight the need for routine microbiological surveillance, timely diagnosis, and context-specific empirical antibiotic protocols. Strengthening infection prevention strategies and updating treatment guidelines in oncology centers are essential to reducing infection-related morbidity in this vulnerable population.

Keywords: *Neutropenia; Febrile Neutropenia; Hematological Malignancies; Gram-Negative Bacteria; Cancer Patients.*

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Introduction

Neutropenia, defined as an abnormally low count of neutrophils, is a frequent and potentially life-threatening complication in cancer patients, particularly those undergoing cytotoxic chemotherapy (Neutropenia (Low Neutrophil Count) - Mayo Clinic, n.d.; Rout et al., 2025). It has been demonstrated to disrupt the innate immune defense mechanisms, thereby rendering patients susceptible to a wide range of infections, including those affecting the bloodstream and respiratory tract. In the event of fever occurring during neutropenia, it frequently constitutes the sole clinical manifestation of an underlying bacterial or fungal infection, necessitating prompt empirical antibiotic therapy (Lucas et al., 2018).

The management of febrile neutropenia has become increasingly intricate due to the emergence of multidrug-resistant organisms. Inadequate initial antimicrobial therapy has been associated with poor outcomes, particularly in immunocompromised individuals (Kedzior et al., 2021; Park et al., 2023). This problem is further exacerbated in low- and middle-income countries (LMICs), where diagnostic limitations, inconsistent access to appropriate antimicrobials, and weak antimicrobial stewardship infrastructures prevail (Abdulrahman Ahmed et al., 2024; WHO EMRO, 2023).

In Iraq, cancer patients encounter further systemic challenges. Years of conflict and underinvestment have resulted in a healthcare system characterized by fragmentation, with persistent barriers to access to timely diagnosis and treatment (see Mohsin et al., 2024; Mula-Hussain, 2012). While several regional hospitals now provide oncology services, infection prevention and control (IPC) measures remain inconsistent, as highlighted by national assessments (The Ministry of Health, in Cooperation with UNICEF and WHO, Releases the Assessment Results of WASH and Infection Prevention Control Services in Health Facilities in Iraq, 2022; WHO EMRO, 2023). These challenges have been shown to increase the risk of delayed infection recognition and inappropriate antimicrobial use.

Notwithstanding the elevated prevalence of cancer and immunosuppression within the Iraqi population, there persists a dearth of local data concerning neutropenia-related infections. A number of regional studies have documented microbial trends in neutropenic patients, highlighting the predominance of Gram-negative organisms such as Escherichia coli and Klebsiella pneumoniae, and a worrisome escalation in antimicrobial resistance (Al-Shawy & Jumaa, 2025; Ruaa et al., 2023). Nevertheless, comprehensive epidemiological evaluations remain constrained in terms of scope and coverage. In light of the persistent absence of national surveillance data concerning febrile neutropenia in Iraqi cancer patients, compounded by the escalating concern over resistant infections, an updated epidemiological assessment is both timely and imperative.

This study aims to address the existing evidence gap by providing an updated epidemiological assessment of neutropenia and bacterial infections among cancer patients in Iraq. This research aims to inform more effective infection control practices and support locally relevant empirical treatment protocols. To that end, the research analyzed demographic profiles, neutropenia severity, fever incidence, and microbiological culture results from two tertiary oncology centers in Baghdad.

Methods

Study Design and Setting

The present study employed a prospective cross-sectional study design to evaluate the demographic and clinical characteristics of neutropenic cancer patients and to identify the bacterial profile associated with febrile episodes. The data collection period spanned from March to October of 2023. The data were collected from two leading tertiary referral centers in Baghdad: the Oncology Teaching Hospital, the National Hospital for Cancer Treatment, and the Hematology and Transplant Center (HTC). These centers function as primary hubs for cancer diagnosis and treatment in Iraq, receiving referrals from across the country to ensure the representativeness of the sample.

Study Population and Inclusion Criteria

The study population comprised adult patients (aged ≥18 years) who were admitted to either facility during the study period and had been diagnosed with neutropenia, defined as an absolute neutrophil count (ANC) <1500 cells/μL. Patients were eligible for inclusion if they had a confirmed diagnosis of cancer (either hematological malignancy or solid tumor) and developed neutropenia at any stage during their hospital admission. The analysis of bacterial profiles was conducted exclusively on patients for whom microbiological testing (i.e., blood culture and sensitivity) had been performed in response to a documented febrile episode.

Exclusion Criteria

Patients were excluded from the study if their medical records were incomplete or lacked documentation of ANC values or culture results. Patients without fever or who did not undergo microbiological testing were excluded from the analysis of bacterial infection prevalence. These exclusions were implemented to ensure the accuracy of data for infection-specific analysis; however, they may have

excluded patients with undiagnosed or subclinical infections.

Data Collection

Patient data were extracted retrospectively from electronic and paper-based medical records by trained clinical researchers. The collected variables included demographic data (age, sex, and ethnicity), type of cancer (solid vs. hematological), severity of neutropenia (mild: ANC 1000–1500/µL; moderate: ANC 500–999/µL; severe: ANC <500/µL), presence of fever (defined as a single oral temperature ≥38.3°C or a sustained temperature ≥38.0°C for over one hour), and results of microbiological culture and antibiotic sensitivity testing.

Microbiological Analysis

For patients presenting with fever during neutropenia, blood samples were collected in a sterile manner for the purpose of culturing, prior to the administration of empirical antibiotic therapy. The culturing process was carried out in accordance with standard microbiological protocols that had been instituted at the hospital's laboratories. The identification of bacterial isolates was conducted through the implementation of biochemical tests and the utilization of automated systems, where available. Antibiotic susceptibility testing was performed using the Kirby-Bauer disk diffusion method, and results were interpreted in accordance with Clinical and Laboratory Standards Institute (CLSI) guidelines that were in effect at the time of the study. Despite the intention to perform antibiotic susceptibility testing, the generation of comprehensive profiles was impeded by reagent shortages and equipment downtime during the study period.

Data Analysis

The collected data were entered into a secure, password-protected database and subsequently analyzed using IBM SPSS Statistics for Windows, Version 25.0. Descriptive statistics were used to summarize demographic variables, neutropenia severity, fever incidence, and bacterial culture findings. Categorical variables were presented as frequencies and percentages. Due to the descriptive nature of the study, no inferential statistical tests were applied.

Ethical Considerations

The study protocol was reviewed and approved by the Iraqi Ministry of Health (Approval No. 10432 and 19000) and the Institutional Review Board of the Oncology Teaching Hospital, Baghdad. The research was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. In accordance with the principles of confidentiality, all patient data were anonymized, and no identifiable patient information was incorporated into the analysis or reporting.

Results

Patient Demographics

The study's sample population comprised 98 neutropenic cancer patients. The majority of the subjects were female (n = 67, 68.4%), while males comprised 31 cases (31.6%). The majority of participants were over 50 years old (n = 74, 75.5%), while only 24 patients (24.5%) were aged 50 or younger. With respect to ethnicity, the predominant group was identified as Arabs (n = 73, 74.4%), followed by Kurds (n = 17, 17.3%) and other ethnicities (n = 8, 8.2%).

Cancer Type and Neutropenia Severity

Hematological malignancies were predominant, affecting 81% of the cohort (n = 79), while 19% (n = 19) were diagnosed with solid tumors. With respect to the severity of neutropenia, moderate neutropenia was the most prevalent category, reported in 68.4% of patients (n = 67). The prevalence of mild neutropenia was observed to be 31.6% (n = 31), moderate neutropenia was observed in 68.4% (n = 67), and severe neutropenia was observed in 19.4% (n = 19).

Incidence of Fever

Fever was reported in 58.2% of patients (n = 57), while 41.8% (n = 41) remained afebrile during the neutropenic episode (**Table 1**).

Microbiological Culture Results

Among the 57 patients who developed fever, 44 (77.2%) yielded positive bacterial cultures, while 13 (22.8%) had no detectable growth (**Table 2**). Gram-negative organisms were predominant among the positive cultures. The most frequently isolated pathogen was Escherichia coli (n = 19, 33.3%), followed by Klebsiella pneumoniae (n = 17, 29.8%), Acinetobacter baumannii (n = 14, 24.6%), and Staphylococcus aureus (n = 7, 12.3%) (**Table 3**).

Table 1. Presence of Fever Among Neutropenic Cancer Patients (n = 98)

Fever Status	n	%
Yes	57	58.2
No	41	41.8

Table 2. Bacterial Culture Results Among Febrile Neutropenic Patients (n = 57)

Culture Result	n	%
Positive growth	44	77.2
Negative growth	13	22.8

Table 3. Distribution of Bacterial Isolates Among Culture-Positive Patients (n = 57)

Bacterial Species	n	%
Escherichia coli	19	33.3
Klebsiella pneumoniae	17	29.8
Acinetobacter baumannii	14	24.6
Staphylococcus aureus	7	12.3

Discussion

This study presents a contemporary epidemiological profile of neutropenic cancer patients in Iraq, a demographic with persistently elevated risks of infection-related complications. The predominance of hematological malignancies observed among neutropenic patients is consistent with global trends, as these cancers and their intensive treatment protocols often induce more profound and prolonged neutropenia (Rout et al., 2025; Ruaa et al., 2023). In the present cohort, the majority of patients were older adults and female, aligning with cancer incidence data from Iraq, where breast cancer and leukemia remain among the most commonly diagnosed malignancies (Home or Hope? The Impossible Choice for Iraqi Cancer Patients - Shafaq News, 2025; Obaid et al., 2020).

Fever was reported in over half of the neutropenic patients, underscoring its critical role as an early clinical indicator of infection. This finding aligns with international guidelines that categorize febrile neutropenia as a medical emergency necessitating immediate empirical antibiotic treatment (Lucas et al., 2018; Neutropenia (Low Neutrophil Count) - Mayo Clinic, n.d.). It is noteworthy that 77.2% of febrile patients had positive blood cultures, which is substantially higher than some reported rates. This may reflect a higher infection burden or improved sampling practices in these centers (Ruaa et al., 2023).

The predominance of Gram-negative organisms, particularly E. coli, K. pneumoniae, and A. baumannii, is consistent with prior local and regional studies (Al-Shawy & Jumaa, 2025; Mjali et al., 2021). These pathogens are of particular concern due to their rising resistance profiles. Recent Iraqi data from Mosul trauma centers and oncology wards corroborate the mounting challenge posed by extensively drug-resistant Gram-negative infections, frequently necessitating the utilization of last-resort antibiotics (Abdulrahman Ahmed et al., 2024; Kedzior et al., 2021). The challenges posed by antimicrobial resistance (AMR) in Iraq are compounded by several factors, including the inconsistent availability of susceptibility testing, the limited implementation of infection prevention and control (IPC) measures, and the suboptimal management of antibiotics. These issues have been repeatedly emphasized in national assessments and global health reports (The Ministry of Health, in Cooperation with UNICEF and WHO, Releases the Assessment Results of WASH and Infection Prevention Control Services in Health Facilities in Iraq, 2022; WHO EMRO, 2023).

These findings carry significant clinical implications. The high rate of culture-positive febrile neutropenia, as well as the predominance of resistant Gram-negative pathogens, underscores the pressing need to reinforce microbiological surveillance in Iraqi oncology centers. The employment of context-specific empirical treatment protocols, guided by local resistance patterns, is imperative to curtailing treatment delays and enhancing patient outcomes (Park et al., 2023). Furthermore, systematic investment in IPC measures, including hand hygiene training, environmental sanitation, and staff education, must be prioritized as part of a broader strategy to reduce infection risk (The Ministry of Health, in Cooperation with UNICEF and WHO, Releases the Assessment Results of WASH and Infection Prevention Control Services in Health Facilities in Iraq, 2022; WHO EMRO, 2023). However, the absence of comprehensive antimicrobial susceptibility data constitutes a significant limitation of this study, as it hinders our capacity to evaluate resistance patterns and guide specific empirical therapy. It is imperative that future studies prioritize the incorporation of resistance profiling into infection surveillance efforts.

The study also emphasizes the broader structural challenges confronting cancer care in Iraq. Decades of conflict, inadequate oncology infrastructure, and socioeconomic instability have persisted, resulting in ongoing challenges to accessing timely and safe cancer treatment (see Mohsin et al., 2024; Mula-Hussain, 2012). Notwithstanding the noteworthy advancements—including initiatives to fortify cancer diagnostics and broaden the availability of

chemotherapy services—significant disparities in infection control and supportive care endure (*Iraq Makes Progress in Improving Cancer Services, Implements ImPACT Review Recommendation*, 2023).

Limitations

It is imperative to acknowledge the limitations of the present study. The cross-sectional design of the study limits the assessment of longitudinal outcomes, including infection-related mortality. Furthermore, the absence of systematic inclusion of antimicrobial susceptibility profiles constrained our capacity to offer commentary on resistance dynamics. Notwithstanding, this study offers one of the scarce recent assessments of neutropenic infections in Iraqi cancer patients, providing pivotal insights to guide clinical practice and policy in this under-resourced context. Furthermore, the exclusion of patients without fever or microbiological testing may have introduced selection bias, potentially leading to an underestimation of the true prevalence of infections among neutropenic patients. Furthermore, given that the study was conducted at two major tertiary centers in Baghdad, the findings may not fully represent infection trends or care practices in rural or less-resourced regions of Iraq, where microbiological capacity and treatment access may differ.

Conclusion

This study underscores the significant prevalence of neutropenia and its concomitant bacterial infections among Iraqi cancer patients, particularly those afflicted with hematological malignancies. The most prevalent severity level was moderate neutropenia, and fever—a critical early marker of infection—was observed in over half of the cases. The microbiological analysis revealed a clear predominance of Gram-negative organisms, with Escherichia coli and Klebsiella pneumoniae being the most frequently isolated pathogens. The presence of Acinetobacter baumannii, a known multidrug-resistant organism, further underscores the complexity of managing infections in this vulnerable population.

These findings underscore the pressing need for enhanced microbiological surveillance and the formulation of context-specific empirical antibiotic guidelines. In order to improve patient safety and outcomes in oncology care in Iraq, there is a necessity for the implementation of enhanced infection control practices, routine culture testing, and antimicrobial stewardship programs. Future research endeavors should incorporate longitudinal data, resistance profiling, and clinical outcomes to develop more robust infection prevention and treatment strategies.

Declarations

Ethics Approval and Consent to Participate

The study protocol was reviewed and approved by the Iraqi Ministry of Health (Approval No. 10432 and 19000) and the Institutional Review Board of the Oncology Teaching Hospital, Baghdad. The research was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. In accordance with the principles of confidentiality, all patient data were anonymized, and no identifiable patient information was incorporated into the analysis or reporting.

Consent for Publication

Not applicable.

Availability of Data and Material

The data that supports the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest / Competing Interests

The authors declare that there are no conflicts of interest.

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Author Contributions

S.A.M: Conceptualization, Methodology, Writing of the original draft.

A.M: Conceptualization, Methodology, Writing of the original draft.

S.A: Conceptualization, Methodology, Writing of the original draft.

M.K.AQ: Investigation, Resources.

M.K.AA: Investigation, Resources.

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Use of Generative AI and AI-Assisted Technologies

The authors declare that no generative AI or AI-assisted technologies were used in the preparation of this work.

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