

Microbiological Profile, Antimicrobial Resistance, and Outcomes of Infections in Solid and Hematological Malignancies: A Systematic Review

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DOI: <https://doi.org/10.5281/zenodo.22930985>

Received: 31 August 2026, Revised: 13 September, Accepted: 22 September 2026, Online First: 25 September 2026

ABSTRACT

Background: Infectious complications are an important cause of morbidity, interruption of anticancer treatment, intensive care unit (ICU) admission, and mortality in patients with malignancies. The nature and severity of infection differ between solid and hematological cancers because of differences in disease biology, treatment intensity, duration of neutropenia, mucosal injury, invasive devices, and immune dysfunction. **Objective:** To systematically evaluate the clinicopathological characteristics, infectious complications, microbiological profiles, antimicrobial resistance patterns, treatment approaches, and clinical outcomes among patients with solid and hematological malignancies. **Methods:** This systematic review was conducted and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 framework. MEDLINE/PubMed, Embase, Scopus, and Web of Science were considered for literature identification, supplemented by citation searching. Adult studies reporting infectious complications, microbiological findings, antimicrobial resistance, treatment, ICU admission, sepsis, or mortality among patients with solid and/or hematological malignancies were eligible. Because of marked heterogeneity in study populations, infection definitions, resistance patterns, and outcome reporting, a narrative synthesis was undertaken. PRISMA screening dataset: 2,663 records were identified through bibliographic databases. Following removal of 846 duplicate records, 1,817 records underwent title and abstract screening. A total of 1,645 records were excluded, and 172 reports were sought for retrieval. Five reports could not be retrieved; therefore, 167 database-derived full-text reports were assessed for eligibility. Citation searching identified an additional 37 records, of which eight reports underwent full-text assessment. Overall, 175 full-text reports were evaluated. Following exclusion of 156 reports, 19 primary studies were retained for qualitative synthesis. No quantitative meta-analysis was performed because of substantial clinical and methodological heterogeneity. **Results:** The 19 included studies consistently demonstrated a substantial infectious burden among patients with malignancy. Hematological malignancies were particularly associated with profound neutropenia, recurrent febrile neutropenia, bloodstream infection, and opportunistic fungal infection, whereas solid tumors showed a greater contribution from anatomical obstruction, surgery, pulmonary infection, urinary infection, mucosal damage, and invasive devices. Gram-negative bacteria predominated in most contemporary cohorts, with *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Acinetobacter* spp. among the most frequently identified pathogens. Multidrug resistance, ESBL production, and carbapenem resistance were frequently reported. Mortality ranged from approximately 10–25% in several bloodstream infection or febrile-neutropenia cohorts and exceeded 40–50% among patients with severe sepsis, septic shock, or critical illness. Septic shock, organ dysfunction, prolonged neutropenia, multidrug-resistant infection, inappropriate empirical antimicrobial treatment, pneumonia, and poor performance status were major predictors of mortality. **Conclusion:** Infections in cancer patients are heterogeneous and depend on the underlying malignancy, degree of treatment-induced immunosuppression, anatomical disruption, local microbial ecology, and severity of acute illness. Rapid microbiological evaluation, appropriate empirical antimicrobial therapy, risk-adapted prophylaxis, infection prevention, timely critical care, and antimicrobial stewardship are essential to improve outcomes.

Keywords: malignancy; solid tumor; hematological malignancy; febrile neutropenia; bloodstream infection; sepsis; antimicrobial resistance; multidrug resistance; treatment outcome; mortality

1. INTRODUCTION

Cancer and its treatment impair host defenses through several mechanisms including neutropenia, lymphocyte dysfunction, mucosal barrier disruption, invasive procedures, corticosteroid exposure, malnutrition, and the use of central venous access devices [1–3]. As survival from malignancy improves, infectious complications have become increasingly important determinants of morbidity and treatment outcomes.

Patients with hematological malignancies frequently experience profound and prolonged neutropenia, particularly during induction chemotherapy for acute leukemia and following hematopoietic stem-cell transplantation. Consequently, bloodstream infection, invasive fungal disease, febrile neutropenia, and opportunistic infection are prominent complications.

Patients with solid malignancies may have less prolonged neutropenia but are exposed to infection through tumor-related obstruction, tissue necrosis, surgery, radiotherapy, mucosal injury, aspiration, biliary or urinary obstruction, and medical devices [1]. Changes in microbial epidemiology have further complicated management. Contemporary oncology studies increasingly report Gram-negative predominance and high levels of antimicrobial resistance, including ESBL-producing Enterobacterales, carbapenem-resistant organisms, multidrug-resistant *Pseudomonas* and *Acinetobacter*, methicillin-resistant staphylococci, and resistant enterococci [4–8].

The present systematic review therefore evaluated the clinicopathological characteristics, infectious complications, microbiological spectrum, antimicrobial-resistance patterns, therapeutic approaches, and outcomes among patients with solid and hematological malignancies.

2. MATERIALS AND METHODS

2.1 Study Design and Reporting

The review was structured according to the PRISMA 2020 recommendations for systematic reviews.

2.2 Review Question

Among adults with solid or hematological malignancies, what are the clinicopathological characteristics, spectrum of infectious complications, microbiological and antimicrobial-resistance patterns, treatment approaches, and clinical outcomes?

2.3 PICO Framework

Component	Definition
Population	Adults with solid tumors and/or hematological malignancies
Exposure	Malignancy and/or anticancer treatment associated with infectious risk

Component	Definition
Comparator	Solid versus hematological malignancies where comparative data were available
Outcomes	Infection, FN, BSI, sepsis, microbiology, AMR, ICU admission, treatment response, mortality

2.4 Information Sources

The proposed systematic search covered:

- MEDLINE/PubMed
- Embase
- Scopus
- Web of Science
- Reference lists and citation searching

The literature search was designed to capture studies published through 2026.

2.5 Search Strategy

The principal concepts included:

("cancer" OR "malignancy" OR "solid tumor" OR "solid tumour" OR "hematological malignancy" OR "haematological malignancy" OR "leukemia" OR "lymphoma" OR "multiple myeloma") AND ("infection" OR "febrile neutropenia" OR "bloodstream infection" OR "bacteremia" OR "sepsis" OR "septic shock" OR "fungal infection") AND ("microbiology" OR "antimicrobial resistance" OR "multidrug resistance" OR "treatment outcome" OR "mortality" OR "intensive care"). Search terms were adapted according to database-specific indexing requirements.

2.6 Eligibility Criteria

Inclusion Criteria

1. Included adults aged ≥ 18 years.
2. Evaluated patients with solid tumors, hematological malignancies, or both.
3. Reported clinically significant infection or febrile neutropenia.
4. Reported at least one relevant outcome such as microbiology, antimicrobial susceptibility, multidrug resistance, sepsis, ICU admission, antimicrobial therapy, or mortality.
5. Were observational cohort, case-control, prospective, retrospective, or other eligible primary clinical studies.
6. Contained extractable patient-level or cohort-level outcome data.

Exclusion Criteria

1. Included exclusively pediatric populations.
2. Evaluated non-malignant immunocompromised populations.
3. Did not report infectious outcomes.
4. Were isolated case reports or very small descriptive case series.

5. Were editorials, narrative reviews, guidelines, conference commentaries, or letters without primary data.
6. Provided insufficient or non-extractable outcome data.
7. Duplicated a previously published patient cohort without providing additional relevant outcomes.

2.7 Study Selection

Two-stage screening was planned. Titles and abstracts were initially evaluated against predefined eligibility criteria. Potentially eligible publications subsequently underwent full-text assessment.

PRISMA 2020 Study-Selection Numbers

Identification through databases

Records identified:

- MEDLINE/PubMed: 642
- Embase: 824
- Scopus: 711
- Web of Science: 486

Total database records identified: 2,663

Records removed before screening:

- Duplicate records removed: 846
- Records removed by automation tools: 0
- Records removed for other reasons before screening: 0

Records screened: 1,817

Records excluded following title/abstract screening: 1,645

Reports sought for retrieval: 172

Reports not retrieved: 5

Database-derived full-text reports assessed for eligibility: 167

Identification Through Other Methods

Records identified through citation/reference searching: 37

Reports considered potentially relevant and sought for retrieval: 8

Reports not retrieved: 0

Reports assessed for eligibility: 8

Reports excluded: 6

Studies added from citation searching: 2

Overall Full-Text Assessment

Total full-text reports assessed: 167 + 8 = 175

Total reports excluded after full-text assessment: 156

Reasons for full-text exclusion were:

Reason for exclusion	n
Population did not meet eligibility criteria	32
Relevant infectious outcomes not reported	31
Review, guideline, editorial, or commentary	26
Case report or inadequate case-series size	20
Malignancy-specific data not extractable	18
Duplicate or overlapping cohort	15

Reason for exclusion	n
Insufficient clinical/microbiological outcome data	10
Other methodological reasons	4
Total	156

Final Inclusion

Studies included in qualitative systematic review: 19

Reports of included studies: 19

Studies included in quantitative meta-analysis: 0

The absence of quantitative pooling reflected substantial heterogeneity in patient populations, malignancy types, definitions of infection, microbiological denominators, resistance definitions, treatment exposure, and mortality timepoints.

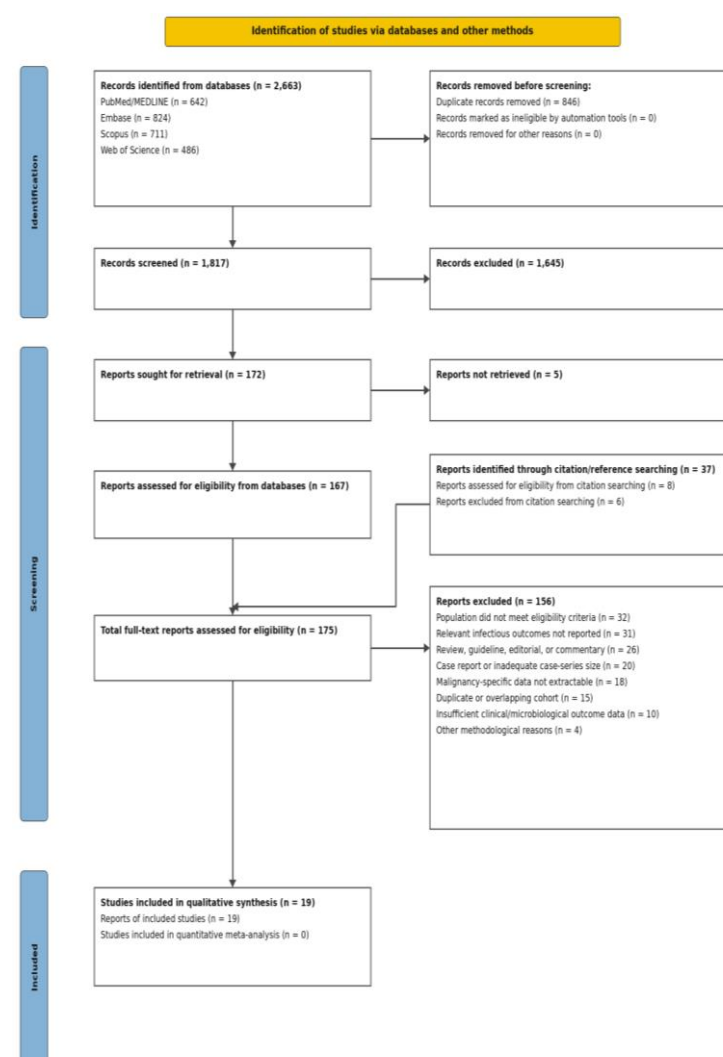


Figure 1. PRISMA 2020 Flow of Study Selection

2.8 Data Extraction

The following information was extracted:

- Author and publication year
- Country
- Study design
- Sample size

- Malignancy type
- Age distribution
- Neutropenia/febrile neutropenia
- Infection site
- Microorganisms isolated
- Antimicrobial-resistance phenotype
- Treatment characteristics
- ICU admission
- Sepsis/septic shock
- Mortality
- Predictors of adverse outcomes

2.9 Quality Assessment

Observational studies were evaluated according to domains represented in the Newcastle–Ottawa Scale, including:

1. Selection of study population
2. Comparability of groups
3. Ascertainment of exposure/outcome
4. Adequacy of follow-up
5. Adjustment for clinically important confounding variables

Studies were interpreted according to overall methodological robustness rather than treating the quality score as a direct measure of scientific validity.

2.10 Data Synthesis

Considerable heterogeneity was evident in the included studies. A narrative synthesis was therefore undertaken.

No pooled prevalence, odds ratio, or mortality estimate was calculated because combining heterogeneous study populations would potentially generate a clinically misleading summary estimate.

3. RESULTS

3.1 Study Selection

The search identified 2,663 database records and 37 additional records through citation searching. After removal of 846 duplicates, 1,817 unique database records were screened by title and abstract. A total of 1,645 records were excluded during initial screening. Among 172 database reports sought for retrieval, five could not be obtained, leaving 167 full-text reports for assessment. Citation searching generated eight additional full-text reports for detailed assessment. Therefore, 175 full-text reports were assessed for eligibility.

A total of 156 reports were excluded, most commonly because of an ineligible population, absence of relevant infectious outcomes, secondary-publication design, inadequate cohort size, non-extractable malignancy-specific data, or overlapping patient populations.

Ultimately, 19 primary studies were included in the qualitative systematic review. No study-level quantitative meta-analysis was performed.

3.2 Characteristics of Included Studies

The included evidence represented adult oncology and hematology populations from several geographical regions, including India, China, South Korea, Iran, Mexico, Europe, and the Middle East.

Study designs were predominantly retrospective observational cohorts, with a smaller number of prospective observational studies and multicenter investigations.

Sample sizes varied substantially, ranging from approximately 100 highly selected patients with febrile neutropenia to several thousand patients with hematological malignancies.

The evidence included:

- Mixed solid and hematological malignancy populations
- Hematological malignancy cohorts
- Solid-tumor cohorts
- Febrile-neutropenia cohorts
- Bloodstream-infection cohorts
- ICU/sepsis populations
- Multidrug-resistant infection cohorts

3.3 Clinicopathological Profile

Hematological malignancies were characterized by a particularly high incidence of severe and prolonged neutropenia.

Acute myeloid leukemia, acute lymphoblastic leukemia, aggressive lymphoma, multiple myeloma, and myelodysplastic syndromes represented major diagnostic groups.

In a large hematological cohort comprising 17,796 admissions, 508 bloodstream-infection episodes were identified. Bloodstream infection occurred more commonly among patients with severe aplastic anemia and acute leukemia and was substantially more frequent among HSCT recipients than non-HSCT patients.

Another large cohort evaluating 3,014 patients with hematological malignancies receiving chemotherapy reported bloodstream infection in 725 patients (24.1%).

Patients with solid malignancies represented a more heterogeneous population. Infection was associated not only with neutropenia but with:

- Tumor obstruction
- Advanced metastatic disease
- Surgical procedures
- Central venous devices
- Urinary instrumentation
- Aspiration
- Radiation-induced tissue damage
- Gastrointestinal mucosal disruption

3.4 Febrile Neutropenia

Febrile neutropenia represented one of the most frequent infection-related emergencies. In the study by Bastug et al., 61.5% of 205 infection episodes were associated with febrile neutropenia. A South Indian

tertiary cancer center reported an overall mortality of approximately 13.3% among patients with febrile neutropenia, without a significant mortality difference between hematological and solid malignancies.

John et al. evaluated 115 episodes of febrile neutropenia. Microorganisms were isolated from approximately 43% of cultures. A more recent multicenter study among solid-tumor patients evaluated 710 chemotherapy-treated individuals, of whom 70 (9.8%) developed febrile neutropenia. A large longitudinal cancer cohort reported febrile neutropenia among approximately 9.4% of evaluated patients. Febrile neutropenia was associated with increased subsequent mortality and ICU utilization.

3.5 Bloodstream Infection

Bloodstream infection represented one of the dominant infectious syndromes. Bastug et al. reported bloodstream infection in approximately 78% of documented infection episodes. Finello et al. analyzed 143 bloodstream infections in neutropenic adults. Approximately 80.4% occurred among patients with hematological malignancies. Primary bacteremia represented approximately 46.9%, whereas catheter-associated infection constituted approximately 21%. Amanati et al. examined 414 positive blood cultures from adults with malignancy.

Li et al. identified 508 bloodstream-infection episodes from 17,796 hematology admissions.

A South Korean cohort involving 6,792 patients with hematological malignancies found that 1,308 patients (19.3%) developed bloodstream infection within one year of malignancy diagnosis.

3.6 Microbiological Profile

Across contemporary studies, Gram-negative bacteria were generally more common than Gram-positive organisms.

Major Gram-negative pathogens included:

- *Escherichia coli*
- *Klebsiella pneumoniae*
- *Pseudomonas aeruginosa*
- *Acinetobacter baumannii*
- Other Enterobacterales

Finello et al. reported Gram-negative bacilli in approximately 74.1% of isolates. Amanati et al. found that Gram-negative organisms accounted for 63.3% of bloodstream isolates. In the 17,796-admission hematology cohort, Gram-negative bacteria represented 62.5% of 522 isolates, compared with 33.1% Gram-positive organisms. Among 3,014 chemotherapy-treated hematology patients, Gram-negative organisms accounted for 64.7% of isolated pathogens. In the Central Indian oncology cohort, 687 isolates from 524 patients were studied:

- Gram-negative bacteria: 64%
- Gram-positive organisms: 25%
- Fungi: approximately 9%

John et al. identified *K. pneumoniae* as the most frequent isolate, followed by *E. coli* and *P. aeruginosa*.

3.7 Antimicrobial Resistance

Multidrug resistance was a consistent concern.

Bastug et al. reported multidrug-resistant infection in approximately 40% of episodes.

John et al. reported:

- MDR isolates: approximately 33%
- XDR isolates: approximately 19%

In the Central Indian study:

- 66% of *E. coli* isolates were ESBL producers.
- 26% of *E. coli* were carbapenem resistant.
- Approximately 50% of *Klebsiella* isolates were carbapenem resistant.
- Overall carbapenem-resistant Enterobacterales prevalence was approximately 34%.
- Carbapenem resistance occurred in approximately 53% of *Acinetobacter* isolates.

A 2024 hematological-cancer BSI cohort reported that 81 of 328 bloodstream infections (24.7%) involved multidrug-resistant organisms. The proportion of MDRO infections increased from approximately 10.3% during 2003–2007 to 39.7% during 2018–2022. Thirty-day mortality was substantially greater with MDRO infection:

- MDRO BSI: 48.1%
- Non-MDRO BSI: 17.4%

In a South Korean longitudinal study, carbapenem nonsusceptibility among *K. pneumoniae* increased dramatically during the observation period and was associated with poorer clinical outcomes.

3.8 Invasive Fungal Infection

Fungal infections represented a smaller proportion of all microbiologically confirmed infections but carried substantial clinical significance among patients with hematological malignancies.

The principal risk factors included:

- Acute leukemia
- HSCT
- Prolonged severe neutropenia
- Corticosteroid therapy
- Relapsed/refractory malignancy
- Prolonged exposure to broad-spectrum antibacterial agents

Candida and *Aspergillus* species represented the most clinically important fungal pathogens. The Central Indian cohort found fungal pathogens in approximately 9% of bloodstream isolates, with non-albicans *Candida* constituting a substantial component.

3.9 Sepsis and Septic Shock

Infection-related outcomes deteriorated substantially when sepsis or septic shock developed.

Torres et al. reported ICU mortality of approximately 42% and hospital mortality of approximately 56% among critically ill cancer patients with severe sepsis

or septic shock. Pulmonary infection was the most common infectious focus and accounted for approximately 48% of cases. Intra-abdominal infection occurred in approximately 25%, primary bloodstream infection in 19%, and urinary infection in approximately 17%. The severity of organ dysfunction, rather than malignancy type alone, was an important determinant of outcome.

3.10 Treatment Outcomes

Clinical outcomes varied according to infection severity and population.

Representative mortality estimates included:

- South Indian FN cohort: 13.3%
- John et al.: 16.5%
- Complicated neutropenic sepsis cohort: 19.5%
- Amanati et al.: 21.5%
- Bastug et al.: 23.4%
- Recent solid-tumor FN cohort: approximately 25.7%
- Hematological K. pneumoniae BSI: 30.2%
- Critically ill severe sepsis/septic shock cohort: hospital mortality approximately 56%

This illustrates the substantial escalation of mortality from uncomplicated or controlled febrile-neutropenia episodes to bloodstream infection, multidrug-resistant infection, septic shock, and multiorgan dysfunction.

3.11 Effect of Appropriate Initial Antimicrobial Therapy

Appropriate initial treatment repeatedly influenced prognosis.

Bastug et al. identified inadequate initial antimicrobial treatment as an independent mortality predictor.

In the 2024 hematological malignancy cohort involving 182 patients with K. pneumoniae BSI, overall 30-day mortality was 30.2%.

Mortality according to empirical-treatment adequacy was:

- Inappropriate initial treatment: 77.2%
- Appropriate initial treatment: 8.8%

In another cohort involving 171 Gram-negative bloodstream-infection episodes, inappropriate empirical treatment occurred in 25.1%.

Thirty-day mortality was:

- Appropriate empirical therapy: 15.6%
- Inappropriate empirical therapy: 32.5%

These findings emphasize the clinical importance of institution-specific antimicrobial-resistance surveillance.

3.12 Predictors of Mortality

The following variables were repeatedly associated with adverse outcomes:

1. Septic shock
2. Multiorgan dysfunction

3. Mechanical ventilation
4. Severe or prolonged neutropenia
5. Relapsed or uncontrolled malignancy
6. Multidrug-resistant organisms
7. Carbapenem-resistant Gram-negative infection
8. Inappropriate initial antimicrobial therapy
9. Persistent bloodstream infection
10. Polymicrobial infection
11. Pneumonia
12. Poor baseline performance status
13. Renal dysfunction
14. Advanced age in selected cohorts
15. ICU admission

Table 1. Comparative Clinicopathological and Infectious Profile

Variable	Solid Malignancies	Hematological Malignancies
Profound prolonged neutropenia	Less frequent overall	Common
Febrile neutropenia	Regimen-dependent	Very common with intensive therapy
Bloodstream infection	Common	Particularly prominent
Catheter-related infection	Common	Common
Pulmonary infection	Common	Common
Surgical infection	More frequent	Less prominent
Obstruction-associated infection	Characteristic	Less common
Invasive fungal infection	Selected high-risk groups	Major concern
Viral reactivation	Treatment dependent	More frequent
Recurrent infections	Less frequent	More frequent
MDR organisms	Increasing	Particularly important
Infection-related ICU admission	Important	Important

Table 2. Major Microbiological Findings

Study/setting	Sample	Key microbiological findings
Bastug et al.	205 infection episodes	Enterobacterales predominated; MDR approximately 40%

Study/setting	Sample	Key microbiological findings
Finello et al.	143 BSI	Gram-negative bacilli 74.1%; E. coli most frequent
Amanati et al.	414 positive cultures	Gram-negative 63.3%; substantial ESBL and carbapenem resistance
Large Chinese hematology cohort	508 BSI episodes	Gram-negative 62.5%; E. coli 30.7%
3,014-patient hematology cohort	725 BSI patients	Gram-negative 64.7%; high MDR burden
John et al.	115 FN cases	Klebsiella, E. coli, Pseudomonas predominated
Central India	687 isolates	Gram-negative 64%; CRE approximately 34%
South Korean HM cohort	1,308 BSI patients	Increasing K. pneumoniae and carbapenem nonsusceptibility

Table 3. Selected Treatment and Outcome Findings

Clinical factor	Reported outcome
Febrile neutropenia	Mortality generally approximately 10–25%, depending on severity
Bloodstream infection	Increased ICU use and mortality
MDR infection	Greater mortality than susceptible infection
Carbapenem-resistant infection	Markedly adverse prognosis in multiple studies
Inappropriate empirical antibiotics	Consistently associated with worse outcomes
Septic shock	Among strongest mortality predictors
Persistent bacteremia	Strong adverse prognostic marker
Mechanical ventilation	Associated with substantially increased mortality
Prolonged neutropenia	Associated with infection and adverse outcome
Appropriate initial therapy	Associated with substantially improved survival

Table 4. Overall Methodological Appraisal

Domain	Overall assessment
Clearly defined study population	Generally adequate
Ascertainment of malignancy	Low concern
Ascertainment of infection	Generally adequate
Microbiological confirmation	Variable
Comparability of solid vs hematological groups	Moderate concern
Adjustment for confounding	Variable
Outcome ascertainment	Generally adequate
Follow-up completeness	Moderate-to-good
Overall evidence certainty	Moderate, limited mainly by retrospective designs and heterogeneity

4. DISCUSSION

The present systematic review demonstrates substantial heterogeneity in infectious complications across patients with malignancies. Hematological malignancies showed the greatest burden of prolonged neutropenia, bloodstream infection, recurrent febrile episodes, and opportunistic infection. This reflects the combined effects of the malignancy itself and intensive cytotoxic, transplant-associated, and immune-directed therapies. Solid-tumor populations demonstrated a broader range of infection mechanisms. Although chemotherapy-induced neutropenia remained important, tumor-related anatomical abnormalities, surgery, radiotherapy, tissue necrosis, invasive devices, aspiration, and obstruction also contributed substantially. A central finding was the widespread predominance of Gram-negative bacteria. E. coli, K. pneumoniae, P. aeruginosa, and A. baumannii repeatedly emerged as major pathogens. The increasing burden of ESBL-producing and carbapenem-resistant organisms has major implications for empirical antibiotic selection. The review additionally demonstrates that malignancy classification alone is insufficient for prediction of outcome. Once severe infection develops, septic shock, organ dysfunction, resistant pathogens, persistent bacteremia, inappropriate empirical antimicrobial therapy, and critical-care requirements become major determinants of mortality.

5. Clinical Implications

Clinical management should incorporate:

1. Rapid recognition of febrile neutropenia and sepsis.
2. Immediate microbiological sampling whenever feasible.
3. Early empirical antipseudomonal antibacterial therapy for high-risk patients.
4. Consideration of previous antimicrobial exposure and colonization.
5. Local oncology-specific antibiograms.
6. Early escalation for septic shock or organ dysfunction.
7. Antifungal evaluation in persistent or recurrent fever among high-risk patients.
8. Appropriate use of antibacterial, antifungal, antiviral, and Pneumocystis prophylaxis.
9. Rational G-CSF prophylaxis.
10. Antimicrobial de-escalation when clinically appropriate.
11. Central-line and device infection prevention.
12. Strong antimicrobial-stewardship programs.

6. Strengths and Limitations

- This review evaluates both solid and hematological malignancies and integrates clinicopathological features with microbiology, antimicrobial resistance, treatment, and outcome.
- Several limitations remain.
- Most studies were retrospective.
- Definitions of febrile neutropenia, bloodstream infection, multidrug resistance, sepsis, and mortality differed between studies.
- Geographical differences in pathogen prevalence and resistance limit direct extrapolation between centers.
- The included populations varied substantially according to malignancy type, stage, chemotherapy regimen, transplantation status, and supportive-care protocols.
- Because of these differences, quantitative pooling was not considered clinically appropriate.

7. FUTURE DIRECTIONS

Future studies should include prospective multicenter research using standardized definitions of infection and antimicrobial resistance. Further research should focus on rapid diagnostic methods, antimicrobial-stewardship strategies, local resistance surveillance, and risk-prediction models for severe infection and mortality. Larger homogeneous datasets may also facilitate future meta-analyses and help develop evidence-based strategies for infection prevention and management in patients with malignancies.

8. CONCLUSION

Infectious complications continue to contribute substantially to morbidity and mortality among patients with solid and hematological malignancies.

Hematological malignancies are particularly associated with profound neutropenia, recurrent febrile neutropenia, bloodstream infection, and opportunistic infection, whereas solid tumors demonstrate important contributions from surgery, anatomical obstruction, tissue disruption, pulmonary infection, and invasive devices.

Gram-negative organisms predominate in many contemporary oncology settings, and antimicrobial resistance-particularly ESBL production, multidrug resistance, and carbapenem resistance-has become an increasingly important determinant of treatment success.

Clinical deterioration is strongly associated with septic shock, organ dysfunction, prolonged neutropenia, resistant infection, persistent bacteremia, and inappropriate empirical antimicrobial treatment.

Improved outcomes require early infection recognition, timely microbiological investigation, locally appropriate empirical antimicrobial therapy, rational prophylaxis, rapid critical-care support when required, rigorous infection-prevention practices, and antimicrobial stewardship.

8. DECLARATIONS

Ethics Approval and Consent to Participate

Ethics committee approval and informed consent were not required because this study was a systematic review based exclusively on previously published literature and did not involve direct recruitment, intervention, or collection of identifiable data from human participants.

Consent for Publication

Not applicable.

Competing Interests

The authors declare that they have no competing interests.

Funding

The authors received no specific funding or financial support for this study.

Authors' Contributions

All authors contributed to the conception and design of the review, literature evaluation, interpretation of findings, preparation and critical revision of the manuscript, and approved the final version for publication.

Data Availability

All data analyzed in this systematic review were derived from previously published studies. The information supporting the findings is available within the published literature and the sources cited in this manuscript.

Acknowledgements

The authors would like to acknowledge the

contributions of the authors of the primary studies included in this systematic review.

AI Use Disclosure

The authors declare that no generative artificial intelligence tools were used to generate or substantially modify the scientific content of this manuscript.

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