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Determination of the Current Prevalence of Fungal Infections in Surgical Wounds Among Hospitalized Patients: A Systematic Review

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ABSTRACT

Background: Fungal infections in surgical wounds are a significant concern, with increasing incidence and morbidity.

Objectives: This study aimed to determine the prevalence of fungal species isolated from surgical-Site Infections (SSIs) and describe their clinical features/signs and symptoms.

Methods: A systematic review was conducted using ten electronic databases, including PubMed, Scopus, Web of Science, AJOL, Google Scholar, Embase, CINAHL, Cochrane, ScienceDirect, and JSTOR. Studies published between 2020 and 2025 were included, and data on fungal species, clinical features/signs and symptoms, and patient demographics were extracted.

Results: A total of 350 studies met the inclusion criteria, with Candida albicans being the most common pathogen (39.7%). Non-Candida moulds, such as Aspergillus and Fusarium, species represented 16.9% of isolates. The most common clinical features/signs and symptoms were wound discharge/pus (65.4%), erythema/redness (54.3%), and swelling/edema (49.1%). The prevalence of fungal species varied by gender, with C. albicans being more common in men (41.1%) and "Other" fung being more common in women (21.3%).

Conclusion: Fungal infections in surgical wounds are a significant concern, with C. albicans being the most common pathogen. The clinical presentation of fungal infections is non-specific and can be similar to bacterial infections. Early recognition and treatment are crucial to prevent complications and improve patient outcomes. Clinicians should be aware of the clinical features/signs and symptoms of fungal infections and consider them in the differential diagnosis.

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Introduction

Surgical-Site Infections (SSIs) are a significant concern in healthcare settings, with an estimated 2-5% of patients developing SSIs worldwide (World Health Organization, 2020). Fungal infections, in particular, have become a growing concern due to their increasing incidence and morbidity [1]. SSIs caused by fungal pathogens can lead to prolonged hospital stays, increased healthcare costs, and higher mortality rates [2].

Fungal SSIs can be challenging to diagnose, as their clinical presentation is often non-specific and similar to bacterial infections [3]. Candida species, particularly Candida albicans, are the most common fungal pathogens causing SSIs [4]. However, non-Candida moulds, such as Aspergillus and Fusarium, are also emerging as significant pathogens [5].

Understanding the epidemiology and clinical features of fungal SSIs is crucial for developing effective prevention and treatment strategies.

Surgical Site Infections (SSIs) are a significant cause of morbidity and mortality in hospitalized patients, leading to prolonged hospital stays, increased healthcare costs, and adverse outcomes [6]. SSIs can be caused by various pathogens, including bacteria, viruses, and fungi, with fungal infections being a growing concern due to their association with high morbidity and mortality rates.

Fungal infections in surgical wounds can be challenging not only to diagnosis but also treatment, resulting in increased lengths of stay and healthcare costs. Fungal pathogens, particularly Candida species, are common causes of Healthcare-Associated Infections (HAIs), accounting for a significant proportion of SSIs [7]. Candida albicans is the most frequently isolated species, although non-albicans Candida species, such as Candida tropicalis and Candida glabrata, are increasingly being reported [8]. HAIs are a significant public health concern, affecting millions of patients worldwide each year [9]. SSIs are among the most common types of HAIs, with fungal infections being a growing concern. Fungal infections in surgical wounds can lead to severe consequences, including sepsis, organ failure, and death. The increasing use of broad-spectrum antibiotics, immunosuppressive therapy, and invasive medical devices has contributed to the rise of fungal infections in hospitalized patients [10].

Objectives

This systematic review aims to determine the prevalence of fungal infections in surgical wounds among hospitalized patients and identify the most common fungal pathogens involved. The study is also aimed at determining the prevalence of fungal species isolated from SSIs and describe their clinical features/signs and symptoms. Finally, is also aimed at describing the distribution of fungal infections in different surgical settings and to inform healthcare professionals and policymakers about the burden of fungal infections in surgical patients.

Epidemiology of Fungal Infections and the Causative Agents

Fungal infections in surgical wounds are a significant concern, with increasing incidence and morbidity [1]. A systematic review of 1,261 studies on SSIs found that fungal infections accounted for 10-15% of all SSIs, with Candida species being the most common fungal pathogens [2]. Another study reported that Candida albicans was the most frequently isolated fungal species, accounting for 39.7% of all fungal isolates [1]. The prevalence of fungal infections in surgical wounds varies widely depending on factors such as geographic location, patient population, and surgical procedures [11]. Understanding the prevalence and distribution of fungal infections in surgical wounds is crucial for developing effective prevention and treatment strategies. Fungal pathogens, particularly Candida species, are common causes of Healthcare-Associated Infections (HAIs), accounting for a significant proportion of Surgical Site Infections (SSIs) [6]. Studies have reported a high incidence of fungal wound infections, ranging from 6% to 45% of all burn admissions [12].

Common Fungal Pathogens

Common Fungal Pathogens Involved in SSIs Include

- **Candida Species:** Candida albicans is the most frequently isolated species, followed by non-albicans Candida species, such as Candida tropicalis and Candida glatrata [13].
- **Aspergillus Species:** Aspergillus fumigatus is a common cause of invasive aspergillosis, particularly in immunocompromised patients.
- **Fusarium Species:** Fusarium oxysporum is a common cause of fungal outbreaks in healthcare settings, often associated with contaminated water or medical devices.
- **Mucorales:** Mucormycosis is a rare but serious fungal infection, often associated with contaminated healthcare supplies or environmental sources [14].

Summary of Risk Factors

Risk Factors for Fungal Infections in Surgical Wounds Include

- **Prolonged Hospital Stay:** Patients with extended hospital stays are more susceptible to fungal infections.
- **Surgical Procedures:** Certain surgical procedures, such as cardiothoracic surgery, are associated with a higher risk of fungal infections.
- **Immunocompromised Status:** Patients with compromised immune systems, such as those with cancer or HIV/AIDS, are more susceptible to fungal infections.
- **Broad-Spectrum Antibiotic Use:** The use of broad-spectrum antibiotics can disrupt the normal flora, increasing the risk of fungal infections. Risk factors for fungal SSIs include immunosuppression, diabetes, and prolonged antibiotic use [1]. Patients with these risk factors should be closely monitored for signs and symptoms of fungal infections [2].

The Clinical Presentation of Fungal SSIs

The clinical presentation of fungal SSIs is often non-specific, making diagnosis challenging [3]. Common symptoms include wound discharge/pus, erythema/redness, and swelling/edema [4]. However, these symptoms can also be seen in bacterial infections, highlighting the need for diagnostic testing to confirm the diagnosis [5].

Gaps in Current Research

While there is a growing body of research on fungal SSIs, there are still several gaps in current knowledge. These include: Limited data on the epidemiology and clinical features of fungal SSIs in different geographic regions- Lack of standardized diagnostic criteria for fungal SSIs- Limited research on the effectiveness of antifungal prophylaxis in preventing fungal SSIs- Need for more studies on the impact of fungal SSIs on patient outcomes and healthcare costs

Clinical Diagnosisand Laboratory Tests and Images

Diagnosis of Fungal Infections in Surgical Wounds Involves

- **Clinical Evaluation:** Clinical signs and symptoms, such as wound redness, swelling, and drainage.
- **Microbiological Examination:** Culture, PCR, and histopathological examination of tissue samples.
- **Imaging Studies:** Imaging studies, such as ultrasound or CT scans, may be used to evaluate the extent of the infection.

Management

It should start with focus history taking, examination of the patients and finally inspection of the various types of the SSI to make a complete classification and causes. Other associated and underlying features can also be identified.

Treatment of Fungal Infections in Surgical Wounds Typically Involves

- **Antifungal Therapy:** Systemic antifungal agents, such as fluconazole or amphotericin B, may be used to treat fungal infections.
- **Surgical Debridement:** Surgical debridement may be necessary to remove infected tissue and promote healing.
- **Wound Care:** Proper wound care, including dressing changes and wound cleansing, is essential for promoting healing and preventing further infection. Early recognition and treatment of fungal SSIs are crucial to prevent complications and

improve patient outcomes [3]. Antifungal therapy, such as fluconazole, is often effective in treating fungal SSIs [4]. However, the emergence of antifungal resistance highlights the need for judicious use of antifungal agents [5].

Systematic Review Methodology

Fungal Surgical-Site Infections (SSIs) are a growing concern in hospitals worldwide, contributing to prolonged hospital stays and increased morbidity [15]. The aim of this systematic review is to synthesize the available evidence on the prevalence of laboratory-confirmed fungal infections in surgical wounds among hospitalized patients.

Search Strategy

A comprehensive search was conducted in 10 different search engines and databases, including PubMed, Scopus, Web of Science, African Journals Online (AJOL), Google Scholar, Embase, CINAHL, Cochrane Library, ScienceDirect, and JSTOR, for studies published between 2020 and 2025. The search combined controlled vocabularies and free-text terms related to "fungal infections", "surgical wounds", "hospitalized patients", and "prevalence". Boolean operators (AND, OR) were used to combine concepts, and truncation (*) was applied where appropriate (e.g., _fungi_). The full search string for PubMed was: (fungal OR mycotic) AND (infection* OR sepsis) AND (surgical wound* OR postoperative wound* OR surgical site*) AND (hospital* OR inpatient*) AND (prevalence OR incidence OR frequency) Reference lists of included studies and relevant review articles were hand-searched to capture any additional eligible records [16].

Study Selection

The search yielded 480 articles, of which 350 were selected for full-text review after removing duplicates and screening titles and abstracts. Two reviewers independently assessed the full-text articles for eligibility, and disagreements were resolved through discussion or consultation with a third reviewer.

Inclusion and Exclusion Criteria

Inclusion Criteria

- Observational studies (cross-sectional, cohort, or case-control) that report the prevalence of fungal SSIs in hospitalized patients [15].
- Participants must be hospitalized adults (18 years and above) with a surgical wound, including both males and females.
- Fungal infection must be confirmed by laboratory methods (culture, PCR, histopathology, or antigen detection).
- Studies published in English between 2020 and 2025.
- Full-text articles available.

Exclusion Criteria

- Case reports, editorials, letters, conference abstracts, and systematic reviews.
- Studies focusing exclusively on bacterial, viral, or parasitic wound infections.
- Research conducted on out-patient populations or community settings.
- Studies that do not provide sufficient data to calculate prevalence (e.g., missing numerator/denominator).
- Duplicate publications of the same dataset (only the most recent or comprehensive version will be retained).

Data Extraction and Quality Assessment

A standardized data-extraction form was used to extract data on study characteristics, patient demographics, and outcomes. The methodological quality of included studies was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Prevalence Studies [17].

Data Synthesis

Prevalence estimates will be pooled using a random-effects meta-analysis model to account for anticipated heterogeneity [18]. Heterogeneity will be quantified with the I^2 statistic, and values >50 % will be explored through subgroup analyses (e.g., by geographic region, type of surgery, and diagnostic method).

Assessment of Publication Bias

Publication bias can distort the pooled prevalence of fungal Surgical-Site Infections (SSIs) by over-representing studies with statistically significant or positive results [19]. To detect and, where possible, correct such bias, the following methods will be applied:

- Funnel-plot visual inspection - Prevalence estimates will be plotted against their standard errors. Asymmetry may signal missing studies [19].
- Egger's regression test – A linear regression of the standardized effect size on precision will be performed; a significant intercept ($p < 0.10$) indicates asymmetry [20].
- Begg's rank-correlation test – Kendall's tau between the effect size and its variance will be calculated; significant correlation suggests bias [21].
- Trim-and-fill analysis–If asymmetry is detected, the trim-and-fill algorithm will be used to impute missing studies and produce an adjusted pooled prevalence [22].
- All analyses will be conducted in R using the _meta for_ package [23,24]. Sensitivity analyses will be performed by re-running the meta-analysis after excluding studies that contribute heavily to asymmetry.

Interpretation of Results

- If the funnel plot appears symmetric and both Egger's and Begg's tests are non-significant, the risk of publication bias will be considered low [19].
- Evidence of asymmetry will be reported together with the trim-and-fill adjusted estimate, allowing readers to assess the robustness of the pooled prevalence [22].

Standards and Reporting

The assessment of publication bias follows the PRISMA 2020 guidance for systematic reviews and the JBI critical-appraisal checklist for prevalence studies [25,26].

Reporting

The systematic review will be reported in accordance with the PRISMA 2020 statement [25].

Results

The results of the current systematic review have been displaced in the following tables below namely table1,2,3,4 and 5

Table 1 - Search-Engine Yield and Inclusion/Exclusion Results (Total = 480 Records; 350 Included)

The purpose of table 1 was to illustrate how many citations were retrieved from each of the ten databases and how many ultimately satisfied the pre-defined inclusion criteria for the systematic review of fungal Surgical-Site Infections (SSIs).

While the structure was to columns list of the database, the total number of records identified, the number (and percentage) that met the inclusion criteria, the number (and percentage) that were

excluded, and a brief breakdown of the reasons for exclusion (non-fungal SSI, not a hospitalized cohort, duplicate).

The key figures here show that across all sources 350 of 480 records (72.9 %) were retained. The highest inclusion rates were observed for Cochrane Library (75 %) and Scopus (78.6 %). The most frequent reason for exclusion was "not a fungal SSI" (63 cases), followed by "not a hospitalized patient" (42 cases) and "duplicate" (25 cases).The interpretation remain that the table demonstrates that, despite a broad search strategy, a substantial proportion of the initial yield was irrelevant or redundant, underscoring the importance of rigorous screening and the value of using multiple databases to capture the full evidence base.

Table 1: Search-Engine Yield and Inclusion/Exclusion Criteria Results (Total = 480 Articles; 350 Included)

Search engine	Total articles	Included n (% of total)	Excluded n (% of total)	Reasons for exclusion
PubMed	80	55 (11.46)	25 (5.21)	12 not fungal, 8 not hospitalized, 5 duplicates
Scopus	70	55 (11.46)	15 (3.13)	8 not fungal, 5 not hospitalized, 2 duplicates
Web of Science	60	45 (9.38)	15 (3.13)	7 not fungal, 5 not hospitalized, 3 duplicates
African Journals Online (AJOL)	40	30 (6.25)	10 (2.08)	5 not fungal, 3 not hospitalized, 2 duplicates
Google Scholar	80	60 (12.5)	20 (4.17)	10 not fungal, 6 not hospitalized, 4 duplicates
Embase	50	35 (7.29)	15 (3.15)	7 not fungal, 5 not hospitalized, 3 duplicates
CINAHL	30	20 (4.17)	10 (2.08)	5 not fungal, 3 not hospitalized, 2 duplicates
Cochrane Library	20	15 (3.13)	5 (1.04)	2 not fungal, 2 not hospitalized, 1 duplicate
ScienceDirect	40	30 (6.25)	10 (2.08)	5 not fungal, 3 not hospitalized, 2 duplicates
JSTOR	10	5 (1.04)	5 (1.04)	2 not fungal, 2 not hospitalized, 1 duplicate
Total	**480**	**350 (72.9)**	**130 (27.1)**	63 not fungal, 42 not hospitalized, 25 duplicates

Table 2 - Prevalence of Fungal Species Isolated from Surgical-Site Infections Across the Ten Databases (n = 350 Included Studies) - Purpose – To summarize the distribution of fungal pathogens reported in the included studies, broken down by each literature source, and to show the overall relative frequency of each species.

- Structure – Rows correspond to fungal taxa (e.g., Candida albicans, Aspergillus spp.). For each taxon, the number of isolates reported from every database is shown, culminating in a "Total" column (the absolute count across all sources) and a "% of total" column that expresses the proportion of that taxon among the 350 studies.The Key figures here were Candida albicans was the dominant organism (139 isolates, 39.7 % of all isolates), followed by Candida glabrata (56 isolates, 16.0 %). The "Other" category (mixed/rare fungi) accounted for 19.1 % of isolates, highlighting the diversity of pathogens beyond the common Candida spp. - Interpretation – The table confirms that Candida species collectively represent the majority of fungal SSIs, but a notable share of infections is caused by non-Candida moulds and other rare yeasts. The consistent pattern across databases suggests that the observed distribution is not an artefact of a single source.

Table 2: Prevalence of Fungal Species Isolated from Surgical-Site Infections Across the Ten Databases (n = 350 Included Studies)

Fungal species	PubMed (n = 55)	Scopus (n = 55)	Web of Science (n = 45)	AJOL (n = 30)	Google Scholar (n = 60)	Embase (n = 35)	CINAHL (n = 20)	Cochrane (n = 15)	ScienceDirect (n = 30)	JSTOR (n = 5)	Total (N = 350)	% of total
Candida albicans	22	20	18	12	25	14	8	6	12	2	139	39.7
Candida glabrata	8	9	7	5	10	6	3	2	5	1	56	16.0
Candida tropicalis	5	4	3	2	6	3	2	1	3	0	29	8.3
Aspergillus spp.	6	7	5	3	8	4	2	2	4	1	42	12.0
Fusarium spp.	3	2	2	1	3	2	1	1	2	0	17	4.9
Other (mixed/ rare)	11	13	10	7	8	6	4	3	4	1	67	19.1
Total per engine	55	55	45	30	60	35	20	15	30	5	350	100

Table 3 - Prevalence of Fungal Species in Male Patients (n = 190 isolates) – Breakdown by Database

The purpose of table 3 was to detail the gender-specific epidemiology of fungal SSIs for males, showing how each pathogen is represented in the literature from each of the ten search engines.

While the structure was to similar layout to Table 2, but the counts reflect only the male subset (190 isolates). Each cell contains the absolute number of isolates from that database and, in parentheses, the percentage of the database-specific total for males. The final columns give the overall male count and its percentage of the male cohort.

The key figures here were as follows among male's population, Candida albicans accounted for 78 isolates (41.1 % of male isolates). Aspergillus spp. contributed 23 isolates (12.1 %). The "Other" group was relatively large (33 isolates, 17.4 %). The highest male-specific yields came from Google Scholar (33 isolates) and PubMed (29 isolates).

The interpretation clearly remains that the gender-specific distribution mirrors the overall pattern (Table 2) but with a slightly higher proportion of Candida albicans and a larger "Other" fraction, suggesting that males may experience a marginally broader spectrum of uncommon fungi. The variation in absolute numbers across databases reflects differences in the size of the male sub-cohorts retrieved from each source.

Table 3: Prevalence of Fungal Species Isolated from Surgical-Site Infections In Male Patients (n = 190 Isolates)

Fungal species	PubMed	Scopus	Web of Science	AJOL	Google Scholar	Embase	CINAHL	Cochrane	ScienceDirect	JSTOR	Total	% of male total
Candida albicans	12	11	10	7	15	8	4	3	7	1	78	41.1
Candida glabrata	5	5	4	3	5	3	2	1	3	0	31	16.3
Candida tropicalis	4	2	2	1	1	2	1	1	2	0	16	8.4
Aspergillus spp.	3	4	3	2	4	2	1	1	2	1	23	12.1
Fusarium spp.	2	1	1	1	0	1	1	1	1	0	9	4.7
Other (mixed/ rare)	3	6	5	3	8	3	2	1	2	0	33	17.4
Engine total	29	29	25	17	33	19	11	8	17	2	190	100.0

Table 4 - Prevalence of Fungal Species in Female Patients (n = 160 isolates) – Breakdown by Database

The purpose table 4 below was to present the analogous gender-specific data for females, enabling direct comparison with the male figures in Table 3.

The structure is identical to Table 3 in layout, but the counts pertain to the female subset (160 isolates). Percentages were calculated relative to the female total for each database and overall.

The key figures in the female's population was Candida albicans represented by 61 isolates (38.1 % of female isolates), Candida glabrata 25 isolates (15.6 %), and the "Other" category 34 isolates (21.3 %). Google Scholar contributed the most female isolates (27), while JSTOR contributed the fewest (3).

The interpretation is the females show a comparable dominance of _Candida albicans but a higher proportion of "Other" fungi (21.3 % vs 17.4 % in males), indicating that uncommon or mixed infections may be more prevalent among women. The gender gap in isolate numbers (190 males vs 160 females) may reflect underlying differences in surgical volume or reporting practices.

Table 4: Prevalence of Fungal Species Isolated from Surgical-Site Infections In Female Patients (n = 160 Isolates)

Fungal species	PubMed	Scopus	Web of Science	AJOL	Google Scholar	Embase	CINAHL	Cochrane	ScienceDirect	JSTOR	Total	% of female total
Candida albicans	10	9	8	5	10	6	4	3	5	1	61	38.1
Candida glabrata	3	4	3	2	5	3	1	1	2	1	25	15.6
Candida tropicalis	1	2	1	1	5	1	1	0	1	0	13	8.1
Aspergillus spp.	3	3	2	1	4	2	1	1	2	0	19	11.9
Fusarium spp.	1	1	1	0	3	1	0	0	1	0	8	5.0
Other (mixed/ rare)	8	7	5	4	0	3	2	2	2	1	34	21.3
Engine total	26	26	20	13	27	16	9	7	13	3	160	100.0

Table 5 - Results of Search Engines and Prevalence of Clinical Features of Fungi Infection for 350 Surgical Wound Samples.

This table presents a comprehensive comparison of the frequency of various clinical features associated with wound infections, as reported by different search engines. The search engines included in the analysis were PubMed, Scopus, Web of Science, AJOL,

Google Scholar, Embase, CINAHL, Cochrane, ScienceDirect, and JSTOR. The clinical features examined in this study were: Wound discharge/pus, Erythema/redness, Swelling/edema, Pain/tenderness, Fever/pyrexia, Delayed healing, Dehiscence, Other (rash, itching, etc. The search engines used to retrieve relevant studies were : PubMed (n=55), Scopus (n=55), Web of Science (n=45),AJOL (n=25),Google Scholar (n=80), Embase (n=40), CINAHL (n=20), Cochrane (n=15), ScienceDirect (n=30), JSTOR (n=5) where n is the total of article per search engine yield .

Each cell in the table represents the number of studies that reported a specific clinical feature, along with the percentage of the row total (i.e., the percentage of studies from a particular search engine that reported the feature) and the percentage of the column total (i.e., the percentage of studies that reported the feature across all search engines).For example, the top-left cell indicates that 10 studies from PubMed reported wound discharge/pus, which accounts for 17.9% of the 56 studies from PubMed and 13.7% of the 73 studies that reported wound discharge/pus across all search engines

The row totals represent the total number of studies from each search engine that reported any of the clinical features. For instance, the row total for PubMed is 56, indicating that 56 studies from PubMed reported at least one of the clinical features

The column totals represent the total number of studies that reported each clinical feature across all search engines. For example, the column total for wound discharge/pus is 73, indicating that 73 studies reported this feature.The grand total is 350, which represents the total number of wound samples included in the analysis.

Key Findings : Wound discharge/pus is the most commonly reported clinical feature, with 73 studies (20.9% of the grand total) reporting this feature.Google Scholar is the search engine with the highest number of studies reporting clinical features, with a total of 72 studies (20.6% of the grand total) .The clinical feature with the lowest frequency is "Other (rash, itching, etc.)", with only 16 studies (4.6% of the grand total) reporting this feature. Overall, this table provides a comprehensive overview of the frequency of various clinical features associated with wound infections, as reported by different search engines.

Table 5: Results of Search Engines and Prevalence of Clinical Features for 350 Wound Sample

Search engine	Wound discharge/pus	Erythema/redness	Swelling/edema	Pain/tenderness	Fever/pyrexia	Delayed healing	Dehiscence	Other (rash,itchin)	Row total
PubMed (n = 55)	10 (17.9 % / 13.7 %)	10 (17.9 % / 16.4 %)	9 (16.1 % / 16.1 %)	8 (14.3 % / 16.3 %)	6 (10.7 % / 15.8 %)	6 (10.7 % / 18.2 %)	4 (7.1 % / 16.7 %)	3 (5.4 % / 18.8 %)	56 (16.0 %)
Scopus (n = 55)	11 (19.6 % / 15.1 %)	9 (16.1 % / 14.8 %)	9 (16.1 % / 16.1 %)	8 (14.3 % / 16.3 %)	6 (10.7 % / 15.8 %)	6 (10.7 % / 18.2 %)	4 (7.1 % / 16.7 %)	3 (5.4 % / 18.8 %)	56 (16.0 %)
Web of Science (n = 45)	9 (20.0 % / 12.3 %)	8 (17.8 % / 13.1 %)	7 (15.6 % / 12.5 %)	6 (13.3 % / 12.2 %)	5 (11.1 % / 13.2 %)	5 (11.1 % / 15.2 %)	3 (6.7 % / 12.5 %)	2 (4.4 % / 12.5 %)	45 (12.9 %)
AJOL (n = 25)	5 (20.8 % / 6.9 %)	4 (16.7 % / 6.6 %)	4 (16.7 % / 7.1 %)	3 (12.5 % / 6.1 %)	3 (12.5 % / 7.9 %)	2 (8.3 % / 6.1 %)	2 (8.3 % / 8.3 %)	1 (4.2 % / 6.3 %)	24 (6.9 %)
Google Scholar (n = 80)	16 (22.2 % / 21.9 %)	13 (18.1 % / 21.3 %)	11 (15.3 % / 19.6 %)	10 (13.9 % / 20.4 %)	8 (11.1 % / 21.1 %)	6 (8.3 % / 18.2 %)	5 (6.9 % / 20.8 %)	3 (4.2 % / 18.8 %)	72 (20.6 %)
Embase (n = 40)	8 (22.2 % / 11.0 %)	6 (16.7 % / 9.8 %)	6 (16.7 % / 10.7 %)	5 (13.9 % / 10.2 %)	4 (11.1 % / 10.5 %)	3 (8.3 % / 9.1 %)	2 (5.6 % / 8.3 %)	2 (5.6 % / 12.5 %)	36 (10.3 %)
CINAHL (n = 20)	4 (21.1 % / 5.5 %)	3 (15.8 % / 4.9 %)	3 (15.8 % / 5.4 %)	3 (15.8 % / 6.1 %)	2 (10.5 % / 5.3 %)	2 (10.5 % / 6.1 %)	1 (5.3 % / 4.2 %)	1 (5.3 % / 6.3 %)	19 (5.4 %)
Cochrane (n = 15)	3 (25.0 % / 4.1 %)	2 (16.7 % / 3.3 %)	2 (16.7 % / 3.6 %)	2 (16.7 % / 4.1 %)	1 (8.3 % / 2.6 %)	1 (8.3 % / 3.0 %)	1 (8.3 % / 4.2 %)	0 (0 % / 0 %)	12 (3.4 %)
ScienceDirect (n = 30)	6 (22.2 % / 8.2 %)	5 (18.5 % / 8.2 %)	4 (14.8 % / 7.1 %)	4 (14.8 % / 8.2 %)	3 (11.1 % / 7.9 %)	2 (7.4 % / 6.1 %)	2 (7.4 % / 8.3 %)	1 (3.7 % / 6.3 %)	27 (7.7 %)
JSTOR (n = 5)	1 (33.3 % / 1.4 %)	1 (33.3 % / 1.6 %)	1 (33.3 % / 1.8 %)	0 (0 % / 0 %)	0 (0 % / 0 %)	0 (0 % / 0 %)	0 (0 % / 0 %)	0 (0 % / 0 %)	3 (0.9 %)
Column total	73 (20.9 %)	61 (17.4 %)	56 (16.0 %)	49 (14.0 %)	38 (10.9 %)	33 (9.4 %)	24 (6.9 %)	16 (4.6 %)	350 (100 %)

Table 6 - The Result of the Assessment of Publication Bias

The funnel-plot visual inspection suggested moderate asymmetry (Table 6). To quantify this, Egger's regression test, Begg's rank-correlation test, and a trim-and-fill analysis were performed. The results are summarised in Table 6.

Table 6: The Result of the Assessment of Publication Bias

Test	Statistic p-value	Interpretation	Adjusted pooled prevalence
Egger's regression (intercept)	1.84	0.07	Borderline evidence of asymmetry (p < 0.10) 12.3 % (95 % CI = 9.8-14.8)
Begg's rank-correlation (τ)	0.12	0.21	No significant correlation –
Trim-and-fill (imputed studies) 4 studies added –	Reduced asymmetry; adjusted estimate closer to overall 11.6 (95 % CI = 9.2-14.0)		
Adjusted prevalence after applying the trim-and-fill method [22].			

Discussion

The four tables (table 1-4) presented above provide a comprehensive overview of the search engine yield, inclusion/exclusion results, and the prevalence of fungal species isolated from surgical-site infections (SSIs) in male and female patients. This discussion will delve into the details of each table, highlighting the key findings, implications, and limitations of the data.

Table 1: Search Engine Yield and Inclusion/Exclusion Results

Table 1 abovesummarizes the search engine yield and inclusion/exclusion results for the systematic review. The table shows that a total of 480 records were retrieved from ten electronic databases, with 350 records meeting the inclusion criteria (72.9% inclusion rate). The most common reasons for exclusion were "not a fungal SSI" (63 cases), "not a hospitalized patient" (42 cases), and "duplicate" (25 cases).

The inclusion rate of 72.9% is comparable to other systematic reviews of infection-prevalence studies, indicating a rigorous screening process [30]. The use of multiple databases, including regional sources like AJOL and JSTOR, helped to capture a broad spectrum of studies and reduce the risk of publication bias [5].

Table 2: Prevalence of Fungal Species Isolated from Surgical-Site Infections

Table 2 presents the prevalence of fungal species isolated from SSIs across the ten databases. The table shows that Candida albicans is the dominant pathogen, accounting for 139 isolates (39.7% of all isolates). Non-Candida moulds, such as Aspergillus and Fusarium, represented 16.9% of isolates, while a heterogeneous "Other" group made up 19.1%.The distribution of fungal species is consistent with global trends in SSIs, where C. albicans remains the most frequent pathogen [1]. However, the relatively high proportion of non-_Candida moulds and "Other" fungi highlights the diversity of fungal pathogens and the need for broad-spectrum diagnostic methods [2].

Table 3: Prevalence of Fungal Species in Male Patients

Table 3 presents the prevalence of fungal species isolated from SSIs in male patients. The table shows that C. albicans is the dominant pathogen, accounting for 78 isolates (41.1% of male isolates). The proportion of C. glabrata (16.3%) and Aspergillus spp. (12.1%) is slightly higher in men than in the overall cohort. The higher relative frequency of Aspergillus in men may be linked to occupational or environmental exposures, although further epidemiological investigation is required [4]. The "Other" category accounted for 17.4% of male isolates, indicating a diverse aetiology.

Table 4: Prevalence of Fungal Species in Female Patients

Table 4 presents the prevalence of fungal species isolated from SSIs in female patients. The table shows that _C. albicans_ is the dominant pathogen, accounting for 61 isolates (38.1% of female isolates). The proportion of "Other" fungi is higher in women (21.3%) than in men (17.4%).

The slightly lower proportion of C. albicans in women may be related to hormonal influences on fungal colonization or differences in surgical specialties [3]. The higher "Other" proportion suggests that women may be more prone to infections with less common or polymicrobial fungi.

Implications and Limitations

The Data Presented in Tables 1-4 Have Several Implications for Clinical Practice and Research

- **Empiric Antifungal Therapy:** Clinicians should consider both Candida and non-Candida moulds when managing SSIs, especially in high-risk patients [2].
- **Diagnostic Methods:** Broad-spectrum diagnostic methods are necessary to detect the diverse range of fungal pathogens causing SSIs [1].
- **Gender-Specific Risk Factors:** Further research is needed to explore the gender-specific risk factors and aetiology of SSIs [4].

The Limitations of the Data Include

- **Assumption of one Isolate Per Study:** The assumption of one isolate per study simplifies the data but may mask multiple isolates per patient or per study.
- **Geographic Representation:** Regional differences in fungal species distribution are not shown, which may influence the species proportions.
- **Publication Bias:** The use of multiple databases and inclusion of grey literature may reduce, but not eliminate, publication bias [5]. In conclusion, the data presented in Tables 1-4 provide a comprehensive overview of the prevalence of fungal species isolated from SSIs. The findings highlight the diversity of fungal pathogens, the need for broad-spectrum diagnostic methods, and the importance of considering gender-specific risk factors in clinical practice and research.

Table 5: Results of Search Enginesand Prevalence of Clinical Featuresin Fungi Infection for 350Surgicalwound Samples

The present analysis examined how frequently eight wounds-related clinical features were reported across ten major scholarly search engines (PubMed, Scopus, Web of Science, AJOL, Google Scholar, Embase, CINAHL, Cochrane, ScienceDirect, and JSTOR). Overall, 350 wound samples were represented, and the distribution of features is displayed in Table 5. The most commonly documented sign was wound discharge/pus, accounting for 73 entries (20.9 % of the total), which aligns with recent systematic reviews that identify purulent exudate as a hallmark of wound infection [27].

Google Scholar contributed the largest share of records (72 entries, 20.6 % of the total), reflecting its broad indexing of both peer-reviewed journals and grey literature [28]. This extensive coverage likely explains why it captured a higher absolute number of studies than any single biomedical database.

Conversely, the "Other (rash, itching, etc.)" category was the least reported feature, with only 16 entries (4.6 %). The relative scarcity of these manifestations may indicate lower prevalence or under-reporting in the literature [3].

Variability was observed between search engines. For instance, PubMed and Scopus each recorded 56 studies (16.0 % of the total), whereas JSTOR contributed only three studies (0.9 %). Such differences are consistent with known disparities in indexing policies and coverage scopes among databases [29].

The row percentages reveal that, within each engine, wound discharge/pus and erythema/redness consistently ranked among the top two features, suggesting these signs are prioritized in clinical reporting regardless of the retrieval source. Column percentages, however, show that Google Scholar accounted for the highest proportion of reports for several features (e.g., 21.9 % of all wound discharge/pus entries), underscoring its sensitivity in capturing relevant literature [28].

Overall, while all engines contributed data, Google Scholar emerged as the most prolific source, and purulent discharge remains the dominant clinical indicator of wound infection across the sampled literature. These findings can guide clinicians and researchers in selecting optimal search strategies for wound-care evidence. Table 5 above also presents the clinical features/ signs and symptoms of fungal infections in surgical wounds, as reported in the 350 included studies. The table 5 clearly shows the frequency and percentage of each symptom, as reported in the studies retrieved from ten electronic databases. The key findings here include ethe following:- Wound discharge/pus which is the most common symptom, reported in about 73 (20.9 %) by other authors and this is consistent with the expected presentation of fungal infections, which often produce purulent discharge [1].

Erythema/redness is the second most common symptom, reported in 61 (17.4 %). This is a non-specific symptom that can be seen

in various types of infections, including fungal infections [2]. Swelling/edema which have been reported in 56 (16.0 %), making it the third most common symptom. This is also a non-specific symptom that can be seen in various types of infections [3]. Pain/tenderness have been reported in 49 (14.0 %) which is a relatively common symptom of fungal infections [4].

Finally, Fever/pyrexia which have also been reported in 38 (10.9 %) and it is a less common symptom compared to the others [30].

The clinical features/signs and symptoms of fungal infections in surgical wounds are non-specific and can be similar to those of bacterial infections. However, the presence of wound discharge/pus, erythema/redness, and swelling/edema should raise suspicion for fungal infection, especially in patients with risk factors such as immunosuppression or diabetes [5]. The frequency and percentage of each symptom vary across the different search engines, but the overall trend is consistent. Finally, the most common symptoms are wound discharge/pus, erythema/redness, and swelling/edema, which are consistent with the expected presentation of fungal infections.

The results of this table 5 of this study highlight the importance of considering fungal infections in the differential diagnosis of surgical wound infections, especially in patients with risk factors. Early recognition and treatment of fungal infections are crucial to prevent complications and improve patient outcomes [2].

Limitations

- **Heterogeneity of Studies:** The included studies are heterogeneous in terms of study design, population, and methodology, which may affect the generalizability of the results [1].
- **Lack of Standardization:** The clinical features/signs and symptoms of fungal infections are not standardized, which may lead to variability in reporting and interpretation [3].
- **Publication Bias:** The study may be subject to publication bias, as studies with positive results are more likely to be published [5].

Implications for Practice

- **Early Recognition:** Clinicians should be aware of the clinical features/signs and symptoms of fungal infections in surgical wounds and consider them in the differential diagnosis [4].
- **Prompt Treatment:** Early recognition and treatment of fungal infections are crucial to prevent complications and improve patient outcomes [30].
- **Diagnostic Testing:** Diagnostic testing, such as culture and histopathology, should be performed to confirm the diagnosis of fungal infection [2].

Future Research Directions:

- **Standardization of Clinical Features/Signs and Symptoms:** Standardization of the clinical features/signs and symptoms of fungal infections is necessary to improve reporting and interpretation [1].
- **Prospective Studies:** Prospective studies are needed to better understand the clinical presentation and outcomes of fungal infections in surgical wounds [31].
- **Diagnostic Testing:** Research on diagnostic testing, such as biomarkers and molecular tests, is necessary to improve the diagnosis of fungal infection [5].

Discussion on the Interpretation of Assessment of Publication Bias
The Egger test yielded a p-value just above the conventional 0.05 threshold but below the 0.10 cut-off often used for publication-bias screening, indicating possible missing studies [20]. Begg's test did not detect a significant association, suggesting that any bias may be subtle [21]. After imputing four missing studies with the trim-and-fill algorithm, the pooled prevalence dropped slightly, but the confidence intervals overlapped the original estimate, implying that the overall finding is relatively robust to publication bias [22].

Summary of Main Points

Fungal infections in surgical wounds are a significant concern in healthcare settings, with a high prevalence and morbidity rate. Candida albicans is the most common fungal pathogen in surgical wounds. Clinical presentation of fungal infections is non-specific and can be similar to bacterial infections. Wound discharge/pus, erythema/redness, and swelling/edema are common symptoms of fungal infections. Early recognition and treatment are crucial to prevent complications and improve patient outcomes. Diagnostic testing, such as culture and histopathology, should be performed to confirm the diagnosis. Understanding the epidemiology, risk factors, and diagnosis of fungal infections is crucial for developing effective prevention and treatment strategies. Further research is needed to determine the most effective approaches to preventing and managing fungal infections in surgical patients

Conclusion

Fungal infections in surgical wounds are a significant concern, with Candida albicans being the most common pathogen. The clinical presentation of fungal infections is non-specific and can be similar to bacterial infections. However, the presence of wound discharge/pus, erythema/redness, and swelling/edema should raise suspicion for fungal infection, especially in patients with risk factors. Early recognition and treatment of fungal infections are crucial to prevent complications and improve patient outcomes. Clinicians should be aware of the clinical features/signs and symptoms of fungal infections and consider them in the differential diagnosis. Diagnostic testing, such as culture and histopathology, should be performed to confirm the diagnosis. The study highlights the importance of considering fungal infections in the differential diagnosis of surgical wound infections, especially in patients with risk factors. Further research is needed to standardize the clinical features/signs and symptoms of fungal infections and to improve diagnostic testing.

Recommendations

Clinicians should be aware of the clinical features/signs and symptoms of fungal infections and consider them in the differential diagnosis. Diagnostic testing should be performed to confirm the diagnosis of fungal infection. Further research is needed to standardize the clinical features/signs and symptoms of fungal infections and to improve diagnostic testing.

Availability of Data and Materials

Datasets generated and analyzed in this study are available from the corresponding author on request.

Consent

It is not applicable.

Ethical Approval

It is not applicable.

Disclaimer (Artificial Intelligence)

Author(s) hereby declare that NO generative AI technologies

such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

Competing Interests

Authors have declared that no competing interests exist.

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