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Aetiology, Microbial Agents, and Sensitivity Patterns of Peritonitis Patients Operated at Kilimanjaro Christian Medical Centre, Northern Tanzania

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Abstract
Introduction: Peritonitis remains a significant cause of morbidity and mortality among surgical patients. Understanding its aetiology and antimicrobial susceptibility is essential for effective treatment. This study investigates the causative organisms, antimicrobial agents used, and sensitivity patterns among patients with peritonitis who underwent surgery at Kilimanjaro Christian Medical Centre in northern Tanzania.
Methods: A prospective hospital-based cross-sectional study was conducted at Kilimanjaro Christian Medical Centre (KCMC) from October 2015 to March 2016 on admitted patients. Peritoneal fluid (5-10) mls and aerobic culture using standard microbiological techniques was taken during the operation. Antibiotic sensitivity testing was conducted against locally available antibiotics using the disk diffusion method.
Results: A total of 60 patients with a median age of 22.5 and an interquartile range (IQR) of 12.0-44.5 were enrolled in this study, and the majority (65.0%) of them were males. Secondary peritonitis was the leading cause of peritonitis by 81.7%, mainly due to ruptured appendix (41.6%), gastric perforation (10.0%), jejunum perforation (10.0%), and ileal perforation (8.3%). Gram-negative bacteria were the most frequently isolated bacteria. *Escherichia coli* (38.2%) was the most frequently isolated bacterium, followed by *coliform species (*14.8%) and another *Streptococcus pyogenes*, *Staphylococcus aureus*, and *Klebsiella pneumoniae,* all of which were isolated by 11.8%. Most of the gram-negative bacteria were sensitive to Amikacin (100.0%), Gentamycin (72.7), and Ceftriaxone (54.5%). Gram-positive bacteria were sensitive of 100.0% of Vancomycin, clindamycin, and Ciprofloxacin. All bacteria isolated and tested for ampicillin were resistant.
Conclusion: The most common causes of secondary peritonitis at Kilimanjaro Christian Medical Centre (KCMC) are perforated appendix, gastroduodenal, and jejunal perforations. Gram-negative bacteria were isolated the most, and *E. coli* was the commonest. Effective antibiotics for gram-negative bacteria were Amikacin, Gentamycin, and Ceftriaxone, and for gram-positive bacteria were Vancomycin, Clindamycin, and Ciprofloxacin. All bacteria were resistant to Ampicillin.

Keywords*: Peritonitis, microbial agents, Sensitivity and laparotomy, Northern Tanzania.*

Introduction

Peritonitis is a serious, often life-threatening inflammation of the peritoneum, commonly resulting from bacterial or fungal infections due to gastrointestinal tract perforations, postoperative complications, or peritoneal dialysis-related infections (Fraimow and Reboli 2008). It remains a significant cause of acute abdomen and is a major contributor to surgical morbidity and mortality worldwide (1). In developing countries like Tanzania, where late presentation, limited diagnostic resources, and inadequate empirical treatment are common, peritonitis poses a particularly heavy burden on healthcare systems (2). At Kilimanjaro Christian Medical Centre (KCMC), a major tertiary referral hospital in northern Tanzania, peritonitis is among the leading surgical emergencies. Patients often present late with generalised peritonitis, septic shock and multiorgan dysfunction, which complicates management and reduces survival rates (3). Management of peritonitis typically requires prompt surgical intervention along with broad-spectrum antimicrobial therapy (4). However, the effectiveness of antimicrobial treatment is greatly influenced by the causative organism and its resistance patterns, which may vary by region and over time. Inappropriate or delayed antibiotic therapy has been associated with increased morbidity, prolonged hospital stays, higher healthcare costs, and mortality (5).

Despite the critical importance of timely and effective antimicrobial therapy in the management of peritonitis, there is limited published data on the aetiological agents and antimicrobial susceptibility patterns of peritonitis at KCMC and other hospitals in Tanzania. Empirical antibiotic treatment is often guided by international protocols or outdated regional data that may not reflect current microbial profiles or resistance patterns in the local setting. This creates a significant risk of administering ineffective treatment, especially in an era of rising antimicrobial resistance (6). In recent years, the increasing prevalence of multidrug-resistant (MDR) organisms in surgical infections globally has further underscored the need for periodic surveillance of local bacterial isolates and their susceptibility profiles (7).

The problem is further compounded by a lack of a standardised, evidence-based protocol for managing peritonitis in many hospitals (8), including KCMC. Without localized data on the microbial aetiology and resistance trends, clinicians are often forced to rely on clinical judgment and empirical broad-spectrum antibiotics, which may not adequately target the causative organisms (9). This practice compromises patient outcomes and promotes the emergence of resistant strains. The increasing threat of antimicrobial resistance and the critical importance of timely, effective treatment for peritonitis necessitate context-specific data to support clinical decision-making. Identifying the prevalent organisms and their susceptibility patterns at KCMC will improve patient outcomes through targeted therapy and support efforts to curtail the misuse of antibiotics, thereby slowing the emergence of resistance. Furthermore, the findings of this study will help inform the development of local treatment guidelines and contribute to the broader understanding of peritonitis management in similar low-resource settings.

Therefore, there was a pressing need to investigate the microbial aetiology of peritonitis and determined the antimicrobial susceptibility patterns of isolated pathogens among patients operated on for peritonitis at KCMC. Such information is crucial for guiding empirical therapy, formulating local antibiotic policies, and enhancing antimicrobial stewardship efforts. This study sought to fill this knowledge gap by providing up-to-date data on the common causative organisms of peritonitis and their resistance profiles at KCMC,northern Tanzania.

Methods

Study area and population

This study was conducted between October 2015 and March 2016 in the KCMC referral health facility located in Moshi municipality, Kilimanjaro, northern part of Tanzania, and this health facility is the northern zone referral hospital covering Tanga, Kilimanjaro, Arusha, and Manyara regions.

The KCMC has a bed capacity of 600 and has 16 departments: Emergency medicine, Paediatrics (with neonatal unit), General Surgery, Internal medicine (mental illness unit), Obstetrics and Gynaecology, Orthopaedics and traumatology, Ear, Nose and Throat (ENT), Dialysis Intensive Care Unit (Neonatal and Adult), Anaesthesia, Urology, Ophthalmology, Oncology and dermatology. The hospital also has Radiology services, laboratory services, and pharmaceutical services. According to the District Health Information System (DHIS2) (unpublished data), the hospital normally attends to an average of more than 100,000 patients and has about 900 surgical cases per year.

Study design

This was a prospective hospital-based cross-sectional study conducted at Kilimanjaro Christian Medical Centre (KCMC) from October 2015 to March 2016 among admitted patients with peritonitis disease symptoms who underwent surgical procedures.

Sampling technique and Sample size

The sampling procedure used was all patients operated on with peritonitis during the study period, and all patient who met the study criteria was taken in the sample size.

Data collection

Before data collection, all patients were informed about the purpose and benefits of the study. Also, the procedures for conducting the study were well discussed with the hospital officials before allowing the study to start on their premises. Only those patients intra-operatively found to have peritonitis were enrolled, and specimens were taken for analysis, and using a structured data sheet, social demographic characteristics were obtained. Peritoneal fluid or pus of 5- 10 mL is aspirated using a sterile syringe immediately after opening the abdomen, and fluid or pus is inserted in a special container that contains brain heart infusion and sent to the laboratory within 2 hours for culture and sensitivity analysis. The sediment was cultured using standard techniques and Gram-stained. The sediment from the sterile bottle was inoculated using a sterile wire loop onto chocolate, blood, and MacConkey agar plates and incubated at 37°C up to 48 hours. The MacConkey agar was incubated in an aerobic environment at 37°C, while blood agar and chocolate agar were incubated under CO2, about 10%, using NuAire dual chamber water jacket CO2 incubator at 37° C and the plates read every 24 hours, if there was no growth observed, cultures were re-incubated for another 24 hours before they were discarded as having no bacteria growth for two days. In case of a growth, the isolates were processed and identified by standard bacteriological techniques. All isolates were identified based on their colonial morphology, culture characteristics, and biochemical tests following standard procedures. The susceptibility patterns of the isolates were determined by the diffusion technique according to CLSI (Clinical Laboratory Standard Institute) 26th EDITION standards against different antimicrobial agents commonly available in our setting, which include Ampicillin, Amikacin, Gentamycin, Chloramphenicol, Cotrimoxazole, Erythromycin, Ciprofloxacin, Ceftriaxone, Ceftazime, Cefotaxime, Benzylpenicillin, Vancomycin, and Clindamycin. Part of the sediment from the centrifuged sample was stained by the standard Gram stain technique. Only an aerobic bacterial culture was done. After 48 hours, if no organisms were identified, that sample was considered as no growth.

Antibiotic sensitivity patterns

The isolated Gram-negative bacteria *E. Coli and coliform species* were tested for Ampicillin, Gentamycin, Ceftriaxone, Ciprofloxacin, Cotrimoxazole, Ceftazidime, and Cefotaxime. For *K pneumonia*e, the following antibiotics were used: Amikacin, Ampicillin, Ceftriaxone, Ciprofloxacin, Cotrimoxazole, and Cefotaxime, *and P. aeruginosa* tested Amikacin, Gentamycin, and Ciprofloxacin. Most of the GNB were sensitive to aminoglycosides and third-generation cephalosporins. All GNB were resistant to Ampicillin, and *coliform species* were all resistant to Cefotaxime.

The isolated GPB*, S. Aureus* sensitivity patterns were done by using Vancomycin, Chloramphenicol, Ciprofloxacin, Erythromycin, Gentamycin, and cefotaxime. *S. pyogenes* Erythromycin, Benzyl-penicillin and Clindamycin. All were sensitive to Vancomycin and Clindamycin. They were resistant to Ampicillin, Erythromycin, and Chloramphenicol.

Data management and analysis

Data were collected using a structured data questionnaire. To ensure consistency and minimize data entry errors, the database was prepared with filters (such as age range, gender, etc.). Descriptive statistics were used to describe different variables; the median with its interquartile range (IQR) was used for skewed distribution age data, and a Chi-square test was used to test for statistical significance of proportions of categorical variables. All the analyses were conducted using the Statistical Package for Social Sciences (SPSS) version 21.

Result

A total of 60 patients participated in the study, and the majority were male (65.0%), with females accounting for 35.0%. Participants ranged widely in age, with a median age of 22.5 and an IQR of 12.0 44.5 years, indicating a relatively young study population. The largest age group was 11-20 years (30.0%), followed by those aged 0 – 10 years (16.7%) and those older than 50 years (21.6%). Regarding education, most participants had completed primary education (61.7%), while 28.3% had reached secondary level, and only a small proportion (3.3%) had tertiary education. A few participants (6.7%) had not reached school-going age. In terms of residence, half of the participants (50.0%) resided outside Moshi district, while 26.7% and 23.3% were from Moshi rural and Moshi urban areas, respectively, indicating a relatively broad geographical representation with a notable proportion from outside the immediate study area (Table 1).

Table 1: Characteristics of the study participants

Variable	Attribute	No. (%)
Sex	Male	39 (65.0)
	Female	21 (35.0)
Age (years)	0 - 10	10 (16.7)
	11 - 20	18 (30.0)
	21 - 30	9 (15.0)
	31 - 40	4 (9.7)
	41 - 50	6 (10.0)
	Older than 50	13 (21.6)
	Median (IQR)	22.5 (12.0 - 44.5)
Education level	Not reached school-going age	4 (6.7)
	Primary	37 (61.7)
	Secondary	17 (28.3)
	Tertiary	2 (3.3)
Residence	Moshi urban	14 (23.3)
	Moshi rural	16 (26.7)
	Outside Moshi district	30 (50.0)

Table 2 narrates the types of peritonitis according to the socio-demographic factors of participants in the study area. Secondary peritonitis was identified to be the leading type of peritonitis in the study area by more than 80%. Among males and females, the secondary peritonitis was 82.1% and 81.0%, respectively, as compared to other types. Also, high secondary peritonitis was observed among age groups 0-10, 11-20 and older than 50 years; however, there was no statistically significant association between them.

Table2: Types of peritonitis observed from attended patients in the study area

Variable	Type of peritonitis			p-value
	Primary n (%)	Secondary n (%)	Tertiary n (%)	
Sex				
Male	6 (15.4)	32 (82.1)	1 (2.6)	
Female	3 (14.3)	17 (81.0)	1 (4.8)	0.900
Age (years)				
0 - 10	1 (10.0)	9 (90.0)	0 (0.0)	
11 - 20	2 (11.1)	16 (88.9)	0 (0.0)	
21 - 30	3 (33.3)	5 (55.6)	1 (11.1)	
31 - 40	1 (25.0)	2 (50.0)	1 (25.0)	
41 - 50	2 (28.6)	5 (71.4)	0 (0.0)	
Older than 50	0 (0.0)	13 (100.0)	0 (0.0)	0.106
Place of residence				
Moshi urban	3 (21.4)	11 (78.6)	0 (0.0)	
Moshi rural	2 (12.5)	13 (81.3)	1 (6.3)	
Outside Moshi district	4 (13.3)	25 (83.3)	1 (3.3)	0.842
Total	**9 (15.0)**	**49 (81.7)**	**2 (3.3)**	

Various sources of peritonitis were observed during the study. The most predominant source, responsible for 41.6% of all cases. The next largest category was the “Not identified” group 20.0%, as major sources of peritonitis. Other major sources of peritonitis were jejunum 10%, gastric 10% and ileum 8.3% (figure 1).

The study also illustrated the distribution of microbial agents isolated from study participants with peritonitis. The most frequently isolated pathogen was *Escherichia coli* (E. coli), accounting for 38.2% of cases, highlighting its predominant role as an etiological agent in intra-abdominal infections. This was by Coliforms spp. 14.8%, Klebsiella *pneumoniae* 11.8%, *Staphylococcus aureus* 11.8% and *Streptococcus pyogenes* isolated by 11.8%, all of which are known opportunistic and pathogenic organisms commonly implicated in secondary peritonitis. Less frequently isolated organisms included *Streptococcus spp., Enterococcus spp., Candida albicans,* and *Pseudomonas* *aeruginosa,* each contributing a smaller proportion of 2.9%, likely representing either hospital-acquired infections or polymicrobial flora (Figure 2)

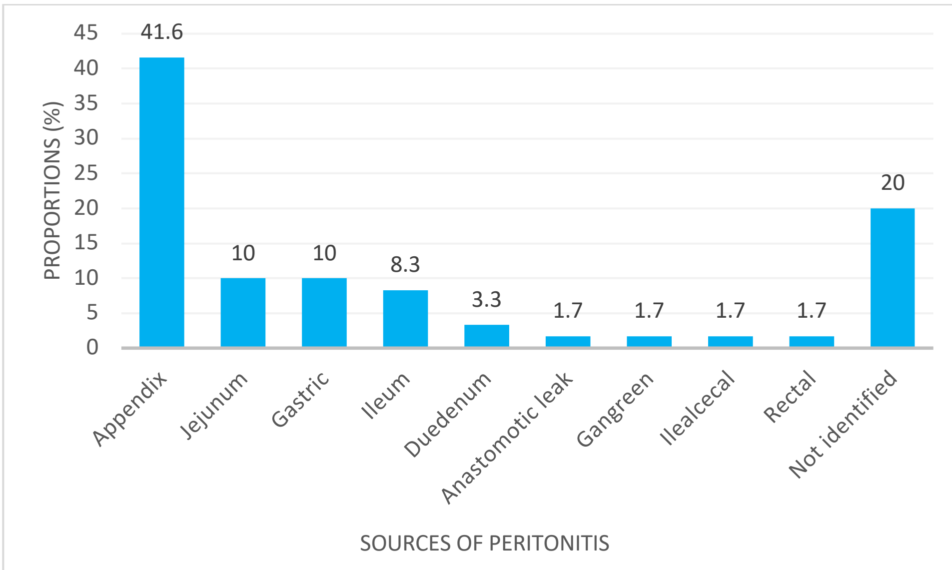

Figure 1. Shows sources of peritonitis among study participants

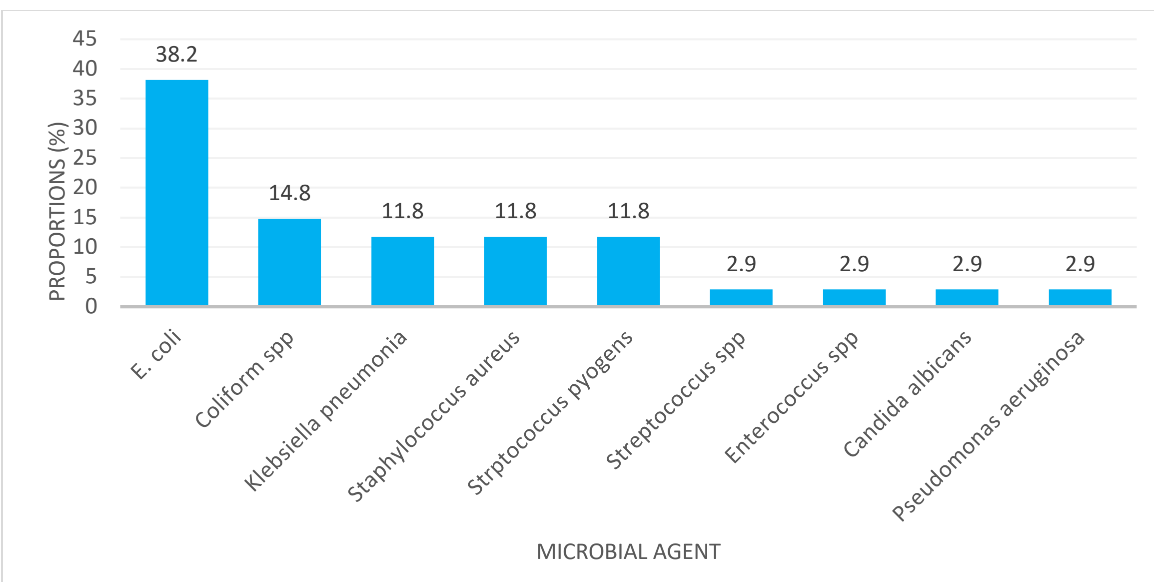

Figure 2. Microbial agents isolated from the study participants

Antibiotic sensitivity patterns

Table 3a presents the antibiotic sensitivity patterns of bacterial isolates from peritonitis cases, highlighting varying levels of resistance and susceptibility among both gram-negative and gram-positive organisms. Among the gram-negative isolates, *E. coli, Coliform spp.,* and *Klebsiella pneumoniae* exhibited complete resistance (100%) to ampicillin. However, *K. pneumoniae* and *Pseudomonas aeruginosa* showed full sensitivity (100%) to amikacin and ciprofloxacin. *E. coli* displayed moderate sensitivity to ceftriaxone (54.5%) and ciprofloxacin (58.3%). Gram-positive isolates demonstrated more favourable sensitivity patterns. *Staphylococcus aureus* showed partial sensitivity to erythromycin (33.3%) and complete sensitivity to benzylpenicillin (100%), while *Streptococcus pyogenes* was 100% sensitive to both benzylpenicillin and erythromycin. *Enterococcus spp.* and *Streptococcus spp*. were fully sensitive to ciprofloxacin and erythromycin.

Table 3a: Antibiotic sensitivity pattern of bacterial isolates

	Gram-negative				Gram-positive			
	E. *coli*	**Coliform spp**	**K.*pneumonia***	**P.*aurginosa***	**S. *aureus***	**Strepto-pyogens**	**E. spp**	**Strepto. Spp**
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Amikacin								
Sensitive			4/4 (100.0)	1/1 (100.0)				
Resistant								
Ampicillin								
Sensitive								1/1 (100.0)
Resistant	6/6 (100.0)	4/4 (100.0)	3/3 (100.0)					
Ceftriaxone								
Sensitive	6/11 (54.5)	1/4 (25.0)						
Resistant	5/11 (45.5)	3/4 (75.0)						
Ciprofloxacin								
Sensitive	7/12 (58.3)	2/4 (50.0)	3/3 (100.0)	1/1 (100.0)				1/1 (100.0)
Resistant	5/12 (41.7)	2/4 (50.0)						
Erythromycin								
Sensitive					1/3 (33.3)	1/2 (50.0)	1/1 (100.0)	1/1 (100.0)
Resistant					2/3 (66.7)			
Benzylpenicillin								
Sensitive						3/3 (100.0)	1/1 (100.0)	
Resistant								

Table 3b continues to highlight the antibiotic sensitivity pattern of both gram-negative and gram-positive bacterial isolates from the peritonitis case, revealing diverse responses across different drug classes. Among gram-negative organisms, *E. coli* showed high sensitivity to ceftazidime (88.8%) and gentamycin (72.7%), but only moderate sensitivity to cefotaxime (50%) and cotrimoxazole (50%). *Coliform spp*. *Klebsiella pneumoniae* showed varying degrees of resistance, with Coliform spp. being completely resistant to cotrimoxazole and highly resistant to cefotaxime. *K. pneumoniae* exhibited better sensitivity to gentamycin (66.7%) but showed reduced responsiveness to cefotaxime and cotrimoxazole. Pseudomonas aeruginosa remained fully sensitive to gentamycin, reinforcing its reliability against this organism. Gram-positive bacteria displayed more favourable sensitivity profiles: *Staphylococcus aureus* and *Streptococcus pyogenes* were fully sensitive to vancomycin (100%), clindamycin (100%), and chloramphenicol, though *Staphylococcus aureus* showed only partial sensitivity to gentamycin (50%). *Enterococcus spp.* and *Streptococcus spp*. were uniformly (100%) sensitive to cefotaxime and clindamycin.

Table 3b: Antibiotic sensitivity pattern of bacterial isolates

	Gram-negative				**Gram-positive**			
	E. *coli* n (%)	**Coliform spp** n (%)	**K.*pneumonia*** n (%)	**P.*aurginosa*** n (%)	**S. *aureus*** n (%)	**Strepto-pyogens** n (%)	**E. spp** n (%)	**Strepto. spp** n (%)
Gentamycin								
Sensitive	8/11 (72.7)	2/5 (50.0)	2/3 (66.7	1/1 (100.0)	2/4 (50.0)			
Resistant	3/11 (27.3)	3/5 (60.0)	1/3 (33.3)		2/4 (50.0)			
Cotrimoxazole								
Sensitive	3/6 (50.0)		1/3 (33.3)					
Resistant	3/6 (50.0)	2/2 (100.0)	2/3 (66.7)					
Chloramphenicol								
Sensitive					2/2 (100.0)		1/1 (100.0)	
Resistant								
Vancomycin								
Sensitive					4/4 (100.0)			
Resistant								
Ceftazidime								
Sensitive	8/9 (88.8)	2/3 (66.7)						
Resistant	1/9 (11.1)	1/3 (33.3)						
Cefotaxime								
Sensitive	5/10 (50.0)		1/2 (50.0)		4/4 (100.0)		1/1 (100.0)	
Resistant	5/10 (50.0)	4/4 (100.0)	1/2 (50.0)					
Clindamycin								
Sensitive					4/4 (100.0)	3/4 (75.0)	1/1 (100.0)	1/1 (100.0)
Resistant						1/4 (25.0)		

Discussion

Peritonitis remains a common surgical emergency, causing challenges in the management and varied complications pre- and post-operative. With advances in surgical technique, the approach to management remains the same. The study showed that males were more affected by peritonitis compared to females. Similar observations have been reported among males in other places (10. The age group of 11 to 20 years contributed to most of the peritonitis cases compared to other age groups. The reasons for this perforated appendix peritonitis observed in younger age groups are that the appendix is full of lymphoid follicles, and hyperplasia of these follicles leads to obstruction and hence perforation of the appendix. Similar findings of higher rates of appendix perforation in the younger age group were reported elsewhere (12). However, in this study, there was a second rise in the rate of perforation above the age of 50 years. But another study found that the higher rates of perforated appendices were in the third and fourth decades (13).

Various sources of peritonitis were identified in the study, with the appendix emerging as the most predominant source of all cases. This finding highlights the high incidence of appendiceal perforation as a leading cause of secondary peritonitis in the study population (14). The second most common category was cases in which the source could not be identified, suggesting possible diagnostic limitations or the presence of rare or atypical causes such as micro-performance or spontaneous bacterial peritonitis (15). Other significant contributors included the jejunum, gastric, and ileum sources, reflecting the role of small bowel perforations in the development of peritonitis (16). These results underscore the importance of early diagnosis and surgical intervention in appendiceal and small bowel pathologies, while also emphasizing the need for thorough intraoperative exploration when the source ins not immediately apparent (13).

Also, the study showed the distribution of microbial agents isolated from the study participants with peritonitis. Most predominantly came from gram-negative bacteria, with E. coli being the most frequently isolated organism (17). This aligns with the well-established role of E. coli as a key pathogen in intra-abdominal infections due to its abundance in the gut flora and its ability to translocate during gastrointestinal perforations (4). Other notable gram-negative isolates were *Coliform spp.* and *Klebsiella pneumoniae*, both of which are commonly associated with enteric infections and healthcare-associated infections (18). Gram-positive organisms such as *Staphylococcus aureus* and *Streptococcus pyogenes* were also significant, indicating the polymicrobial nature of secondary peritonitis (19). Less common isolates like *Streptococcus spp.*, *Enterococcus spp.*, *Candida albicans*, and *Pseudomonas aeruginosa* accounted for smaller proportions but may represent co-infections or nosocomial pathogens (20). These findings underline the importance of initiating broad-spectrum empirical antibiotic therapy that targets both gram-negative and gram-positive organisms in managing peritonitis, while also considering antifungal and anti-pseudomonas coverage in selected cases based on clinical risk factors.

The antibiotic sensitivity patterns reveal significant variability in the response of bacterial isolates to commonly used antibiotics, with notable resistance among gram-negative organisms (21). *E. coli*, *Coliform spp*., and *Klebsiella pneumoniae* demonstrated resistance to ampicillin, highlighting the diminishing utility of this antibiotic for treating gram-negative infections in peritonitis (22). While *K. pneumoniae* and *Pseudomonas aeruginosa* were fully sensitive to amikacin and ciprofloxacin, suggesting these antibiotics remain effective options, *E. coli* showed only moderate sensitivity to ceftriaxone and ciprofloxacin, indicating rising resistance levels (23). Also, *E. coli* exhibited high sensitivity to ceftazidime and gentamycin, but only moderate sensitivity to cefotaxime and cotrimoxazole, indicating emerging resistance and the need for careful selection of empiric therapy (24). *Coliform spp*. showed complete resistance to cefotaxime and significant resistance to cefotaxime, while *Klebsiella pneumoniae* had fair sensitivity to gentamycin but was less responsive to other agents, reinforcing concerns about resistance among Enterobacteriaceae (25). *Pseudomonas aeruginosa* showed complete sensitivity to gentamycin, supporting its continued use for targeting this pathogen (26). In contrast, gram-positive bacteria exhibited better sensitivity profiles. *Staphylococcus aureus* was completely sensitive to benzylpenicillin, vancomycin, clindamycin, and chloramphenicol but only partially sensitive to erythromycin and gentamycin, while *Streptococcus pyogenes* was fully sensitive to both antibiotics (27). Additionally, *Enterococcus spp*. and *Streptococcus spp*. showed complete sensitivity to ciprofloxacin, cefotaxime, clindamycin, and erythromycin, suggesting that gram-positive infections in peritonitis can be effectively managed with these antibiotics (28). These findings emphasize the importance of conducting culture and sensitivity testing to guide targeted therapy and highlight the need to reconsider empirical antibiotic choices due to high resistance rates, particularly among gram-negative organisms (29).

Conclusion

This study highlights peritonitis as a common surgical emergency predominantly affecting males and younger individuals, with appendiceal perforation emerging as the leading cause. Secondary peritonitis, often arising from gastrointestinal tract perforations, remains the most frequent type. The polymicrobial nature of infections primarily involving gram-negative organisms such as *E. coli* necessitates broad-spectrum empiric antibiotic therapy. However, notable resistance patterns among gram-negative bacteria underscore the urgent need for culture-guided treatment. Improved diagnosis tools, timely surgical intervention, and rational antibiotic use are essential to reduce morbidity and improve patient outcomes in peritonitis management, especially in resource-limited settings.

Original Research **Open Access**

Declarations

Ethics approval and consent from the participant

The proposal was submitted to the Kilimanjaro Christian Medical University College (KCMUCo) Institutional Review Board (IRB) for ethical and scientific review and provided research ethical clearance certificate number 871. Confidentiality and privacy of participants' information were obtained and maintained. Participants were informed of all purposes, benefits, and procedures of conducting the study before the study proceedings.

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Availability of data and materials

The data of this study is available from the corresponding author on a reasonable request if needed.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

RAS designed and supervised the study, including data collection, management, and analysis, and drafted and revised the manuscript. DPC conducted data analysis and revised the manuscript. HA KSC, DM, and SC contributed to the conception and critically revised the manuscript. All authors read and approved the final version of the manuscript.

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Abbreviations

IRB: Institutional Review Board

KCMC: Kilimanjaro Christian Medical Centre

KCMUCo: Kilimanjaro Christian Medical University College

Mmed: Master of Medicine

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