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Research Paper

Epidemiological and bacteriological profile of acute peritonitis in visceral surgery

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Abstract:
A retrospective study conducted at Hassan II University Hospital in Fez on 77 cases of acute peritonitis highlights differences in the epidemiological and bacteriological profiles between community-acquired and nosocomial peritonitis. Community-acquired peritonitis was the most frequent, accounting for 71% of cases. The main etiology was appendicitis, and the most commonly isolated pathogens were Enterobacterales, mainly Escherichia coli*, of which 19% were extended-spectrum beta-lactamase (ESBL) producers.*
Nosocomial peritonitis, representing 29% of cases, occurred mainly following anastomotic leakage after digestive surgery. Their microbiological profile was dominated by Acinetobacter baumannii *and multidrug-resistant Enterobacterales, of which 22% were carbapenemase producers and 31% were ESBL producers.*
This study highlights the importance of early management, adapting antibiotic therapy according to local antimicrobial susceptibility data, and strengthening microbiological surveillance to limit the emergence of multidrug-resistant bacteria.

Keywords: *Peritonitis, Community-acquired, Nosocomial, Enterobacterales, Multidrug-resistant bacteria.*

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I. Introduction :

Peritonitis represents a composite group of conditions defined as inflammation of the serous membrane lining the abdominal cavity, known as the peritoneum, most often of infectious origin [1]. It is classified into primary, secondary, and tertiary peritonitis. Secondary peritonitis has a clearly identified intra-abdominal origin, usually due to digestive tract perforation.

Community-acquired peritonitis refers to peritonitis acquired outside the hospital setting [2]. However, postoperative peritonitis (PPO)—which corresponds to nosocomial secondary or tertiary peritonitis occurring after abdominal surgery—holds a particular place because it constitutes a severe complication feared by all, due to its nosocomial bacterial ecology, often involving multidrug-resistant organisms [3], and the high associated mortality, ranging from 23% to 60% [4]. While the role of surgery in the management of peritonitis is unequivocal and represents the cornerstone of treatment, antibiotic therapy and its appropriate prescribing rules are an essential complement, significantly improving patient prognosis by drastically reducing mortality.

Antibiotic choice is well standardized according to various expert consensus guidelines, but must take into account local epidemiology and bacterial antibiotic susceptibility patterns. Analysis of peritoneal fluid constitutes an important step in etiological diagnosis, aimed at adapting the empiric antibiotic therapy used in the first-line management of these infections [5].

The main objectives of this study are to establish the bacteriological profile of community-acquired and nosocomial peritonitis and to assess the emergence of antimicrobial resistance in these two populations.

II. Material and Methods

Study design:

This is a retrospective descriptive study conducted over a one-year period, from August 1st, 2024 to August 1st, 2025, including 77 patients hospitalized in the visceral surgery and surgical intensive care units of the Hassan II University Hospital of Fez for the management of community-acquired and nosocomial peritonitis.

Patients:
Inclusion criteria were community-acquired and nosocomial peritonitis confirmed intraoperatively with a positive bacteriological culture. Exclusion criteria included cases without sampling, samples not sent to the laboratory, culture-negative samples, as well as incomplete or non-exploitable medical records.

Data collection:
A standardized data collection form accompanying each specimen was used to gather demographic data, the type and mechanism of peritonitis, as well as outcome-related information. Data were extracted from the registers of the Microbiology Laboratory of the Hassan II University Hospital of Fez, in compliance with medical ethics principles.

Bacteriological analysis:
Specimens were inoculated onto fresh blood agar, cooked blood agar, EMB agar, and BHI broth, then incubated at 35 ± 2 °C in a CO_2-enriched atmosphere. Cultures were considered negative after 48 hours of incubation. Bacterial identification was performed using both manual methods (API) and automated systems (Phoenix). Antibiotic susceptibility testing was carried out on Mueller-Hinton agar for non-fastidious organisms and on blood agar for fastidious organisms, with interpretation according to EUCAST 2025 (S/R). Methicillin resistance was screened using a 30 µg cefoxitin disk. ESBL (Extended-Spectrum Beta-Lactamases) production was detected using the synergy test (amoxicillin–clavulanic acid combined with cephalosporins). Carbapenemases were identified using a rapid immunochromatographic assay (OXA-48, NDM, KPC, IMP, VIM).

Statistical analysis:
Collected data were recorded and analyzed using Microsoft Excel software.

III. Results :

In our study, 77 cases of peritonitis were reported, including community-acquired peritonitis in 71.42% of cases (n=55) and nosocomial peritonitis in 28.57% of cases (n=22).

The etiologies of community-acquired peritonitis were mainly appendiceal in origin (54%, n=30), followed by intestinal perforation (22%, n=12), perforated peptic ulcer (20%, n=11), and biliary peritonitis (4%, n=2). Regarding nosocomial peritonitis, anastomotic leakage was the leading cause, accounting for 91% of cases (20/22), while 9% (2/22) were related to iatrogenic complications of ERCP, such as duodenal perforation or biliary tract injury.

Culture results in community-acquired peritonitis showed a predominance of monomicrobial infections (76%) compared with polymicrobial infections (24%). Similar findings were observed in nosocomial peritonitis, with a predominance of monomicrobial infections, accounting for 86% versus 14% for polymicrobial infections.

The organisms isolated in our series were mainly bacterial, with a predominance of Gram-negative bacilli (GNB). In the community setting, Enterobacterales were the most frequently isolated group, representing 70% of cases. In contrast, in nosocomial infections, Acinetobacter baumannii was the predominant Gram-negative bacillus, alongside Escherichia coli, accounting for 36.4% of isolates (Table 1).

Table 1: Frequency of bacteria isolated in peritonitis

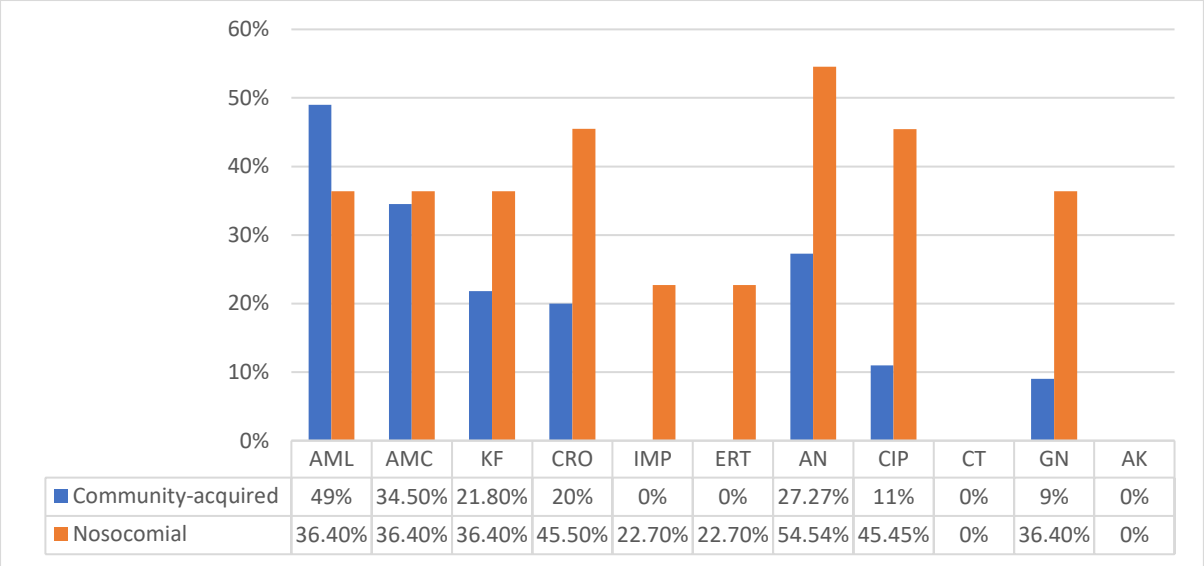
Microorganism	Community-acquired	Nosocomial
Escherichia coli	54.41% (n=37)	36.4% (n=8)
Klebsiella pneumoniae	10.3% (n=7)	13.6% (n=3)
Pseudomonas aeruginosa	7.3% (n=5)	4.5% (n=1)
Enterobacter cloacae	4.4% (n=3)	9.1% (n=2)
Acinetobacter baumannii	0	36.4% (n=8)
Enterococcus faecalis	13.23% (n=9)	9.1% (n=2)
Enterococcus faecium	3% (n=2)	4.5% (n=1)
Staphylococcus aureus	4.4% (n=3)	0
Candida tropicalis	1.5% (n=1)	0

In our study, resistance of Enterobacterales to ceftriaxone is higher in the nosocomial setting compared with the community setting, at 45.5% versus 20%, respectively. Among resistant strains, extended-spectrum beta-lactamase (ESBL)-producing isolates account for 31% of nosocomial isolates and 19% of community-acquired isolates. Furthermore, carbapenem resistance is observed mainly in nosocomial Enterobacterales, representing 22% of isolates in this group. Among these resistant strains, 80% produce NDM-type carbapenemases and 20% produce OXA-48 enzymes.

Regarding fluoroquinolones, nosocomial Enterobacterales show a resistance rate approximately three times higher than that observed in community-acquired isolates. For aminoglycosides, resistance mainly concerns gentamicin, particularly among nosocomial strains, whereas no resistance to amikacin is reported (Figure 1).

In the group of multidrug-resistant (MDR) bacteria, *Escherichia coli* is the most frequently isolated organism, followed by *Klebsiella pneumoniae* and *Enterobacter cloacae* (Figure 2). *Acinetobacter baumannii* is isolated exclusively in the nosocomial setting and remains susceptible only to colistin.

Finally, *Pseudomonas aeruginosa* shows no acquired resistance in our series.



	AML	AMC	KF	CRO	IMP	ERT	AN	CIP	CT	GN	AK
Community-acquired	49%	34.50%	21.80%	20%	0%	0%	27.27%	11%	0%	9%	0%
Nosocomial	36.40%	36.40%	36.40%	45.50%	22.70%	22.70%	54.54%	45.45%	0%	36.40%	0%

Figure 1: Antibiotic resistance profile of Enterobacteriaceae strains

AML: amoxicillin / AMC: amoxicillin–clavulanic acid / KF: Keflin / CRO: ceftriaxone / CN: gentamicin / AK: amikacin / CIP: ciprofloxacin / AN: nalidixic acid / CT: colistin / IMP: imipenem / ERT: ertapenem

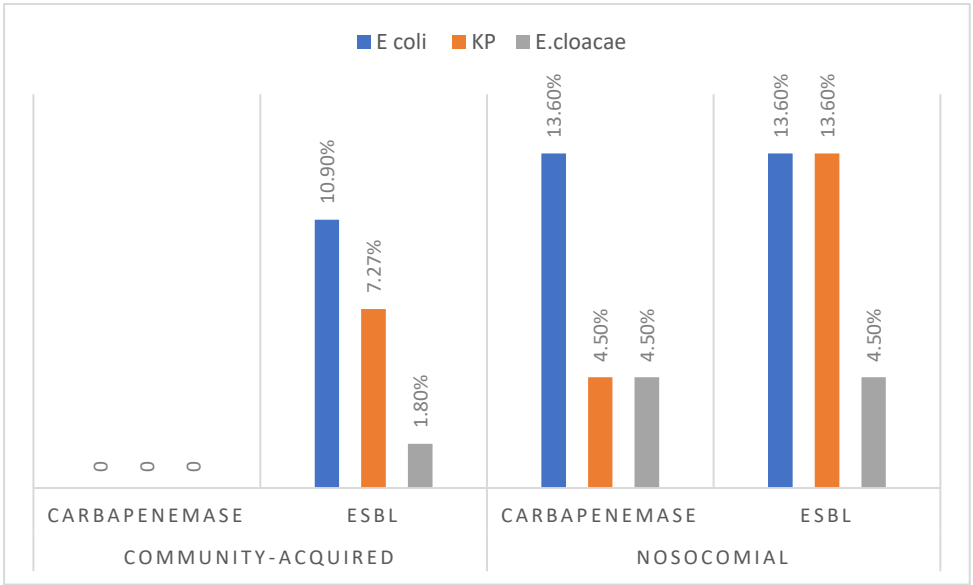
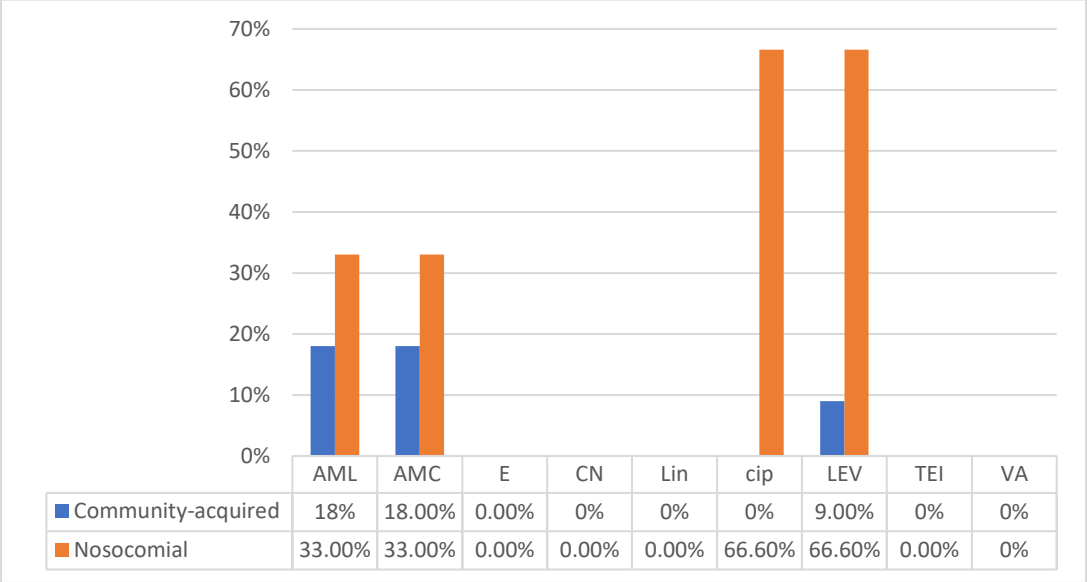


Figure 2: Distribution of Enterobacteriaceae according to the resistance mechanism

Among Gram-positive cocci, staphylococci—isolated only in community-acquired peritonitis—produce only penicillinase and are all methicillin-susceptible.

Regarding enterococci, nosocomial strains show a higher rate of resistance to quinolones compared with community strains. In contrast, no resistance to glycopeptides is observed (Figure 3).



	AML	AMC	E	CN	Lin	cip	LEV	TEI	VA
Community-acquired	18%	18.00%	0.00%	0%	0%	0%	9.00%	0%	0%
Nosocomial	33.00%	33.00%	0.00%	0.00%	0.00%	66.60%	66.60%	0.00%	0%

Figure 3: Antibiotic resistance profile of Enterococcus spp. strains isolated.
AML: amoxicillin / AMC: amoxicillin–clavulanic acid / E: erythromycin / CN: gentamicin / Lin: linezolid / CIP: ciprofloxacin / Lev: levofloxacin / Tei: teicoplanin / VA: vancomycin

IV. Discussion

Acute peritonitis is recognized as the second leading cause of sepsis worldwide; it is a life-threatening emergency requiring rapid hospitalization and immediate therapeutic management [6]. In our series, community-acquired peritonitis accounted for 71% of cases, which is consistent with a large observational study conducted across 68 European hospitals reporting 79% community-acquired infections and 21% nosocomial infections [7]. These findings are also in agreement with those reported by Zhang S. in China [8].

The microbiology of peritonitis reflects the intestinal flora, which is often polymicrobial, with an aerobic component responsible for local or systemic inflammation and an anaerobic component promoting abscess formation [9]. The localization of lesions also influences the spectrum of causative pathogens: gastroduodenal, small bowel, appendicular, and colorectal segments each have a specific flora in terms of species and bacterial load [10]. Gram-negative bacteria and anaerobes predominate in colorectal or appendicular peritonitis, whereas Gram-positive bacteria and yeasts are more common in gastroduodenal infections. In small bowel infections, a relative balance between these groups is observed [11]. In our study, *E. coli* is the dominant microorganism, consistent with the predominance of appendicular infections, in agreement with data from Rabat [12], Indonesia [13], and Italy [14]. In the United States, *Bacteroides* spp. are more frequent (27%), while *E. coli* accounts for 17%. In some studies, *K. pneumoniae*, *Enterobacter* spp., *Aerobacter* spp., and anaerobes are isolated in peritonitis related to perforated peptic ulcers [15].

In the nosocomial setting, *Acinetobacter baumannii* is the predominant bacterium, reported worldwide and representing a major public health concern [16]. Patients in intensive care units are particularly at risk due to the severity of underlying conditions, prolonged hospital stays, the use of broad-spectrum antibiotics, and the increased use of invasive procedures such as intubation, urinary catheters, and central venous catheters. Since 2018, carbapenem-resistant *Acinetobacter* species have been classified by the WHO as a critical priority group requiring the development of new antibiotics [17].

Patients hospitalized in intensive care units are also at increased risk of ESBL-producing infections [18]. At the national level, the prevalence of multidrug-resistant bacteria has increased over the years, rising from 11.8% in Fez in 2012 [19], to 24% in Oujda in 2018 [20], and reaching 32% in Marrakech in 2019 [21], a figure close to ours (31%). A Tunisian study from 2020 reported a rate of 26.4% [22]. International studies conducted in China in 2012 [23] and in Italy in 2020 [24] also show high prevalences, of 33.4% and 35%, respectively.

In our study, the overall prevalence of ESBL-producing Enterobacteriaceae in community-acquired peritonitis was 19%, higher than that reported in Turkey (11.1%) [25] and the United States (10.2%) [26], but lower than in Iran (27.5%) [27]. The isolates were predominantly *E. coli* and *K. pneumoniae* (56% and 31%, respectively), followed by *E. cloacae* (13%). These findings are consistent with the literature, where *E. coli* and *K. pneumoniae* are the most frequently reported species [28].

The multidrug resistance of ESBL-producing strains is explained by the fact that ESBL genes, carried on plasmids, are often associated with other resistance genes, particularly those conferring resistance to aminoglycosides and fluoroquinolones [29].

In our series, carbapenemase-producing Enterobacteriaceae were isolated only in the intensive care unit, accounting for 22% of isolates, in agreement with national [30,31] and international data [22,24]. In the literature, *Klebsiella* spp. is described as the most frequently involved species in carbapenemase production, due to its strong genetic adaptability and frequent exchange of resistance genes, making it the most affected by this resistance mechanism [32]. However, in our series, *Escherichia coli* was the most frequently isolated species, which may be explained by the limited size of our sample.

V. Conclusion :

Acute peritonitis remains a major health issue, both because of its frequency and the severity of its prognosis. The concerning emergence of multidrug-resistant bacteria, particularly ESBL- and carbapenemase-producing organisms in the nosocomial setting, highlights the importance of rigorous microbiological surveillance and early adaptation of antibiotic therapy. Ultimately, the combination of appropriate surgical management, rational empirical antibiotic therapy subsequently adjusted according to the antibiogram, along with a strict policy for the prevention of nosocomial infections, remains essential to improve the prognosis of patients with peritonitis, whether community-acquired or hospital-acquired.

Ethics statement

Administrative authorization to conduct this retrospective study and access the data was obtained from the Head of the Central Laboratory, Hassan II University Hospital, Fez, Morocco. All data were anonymized prior to analysis, and patient confidentiality was maintained throughout the study.

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Competing interests

The authors declare no competing interests.

Authors' contributions

- Fatima Zahra koubali, Hamza Rahmouni and Fatima Zahra Benatiya Andaloussi contributed to the conceptualization, methodology, data curation, formal analysis, validation, and writing of the manuscript, including both the original draft and review and editing.
- Sara Kouara , Ghita Yehyaoui and Mustapha Mahmoud contributed to the critical revision of the manuscript.
- All authors read and approved the final manuscript.

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