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Original Research Article

Bacteriological Profile of Native Joint Septic Arthritis: A 9-Year Retrospective Study (2016–2024) Conducted in a Moroccan Hospital

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Abstract

Septic arthritis is a medical emergency requiring early microbiological diagnosis and immediate initiation of appropriate antibiotic therapy to prevent irreversible joint damage. This 9-year retrospective study aimed to describe the epidemiological and microbiological features of culture-confirmed native joint septic arthritis cases diagnosed at the bacteriology laboratory of the Mohammed V Military Instruction Hospital in Rabat (2016–2024), and to evaluate antimicrobial susceptibility profiles of isolated bacteria. Of 922 synovial fluid samples analyzed, 64 culture-confirmed septic arthritis cases were retained. Cytobacteriological evaluation included macroscopic examination, leukocyte count, microcrystal search, Gram staining, and culture on solid enriched media complemented by liquid enrichment broth (brain-heart infusion) and/or inoculation into blood culture bottles. Antimicrobial susceptibility was assessed using the disk-diffusion method following the guidelines of the European Committee on Antimicrobial Susceptibility Testing. The median patient age was 62 years [IQR 44–72], with a male predominance (male-to-female ratio of 2.2). The overall culture positivity rate was 6.9% (64/922). Gram staining was positive in 63% of cases (40/64), predominantly revealing Gram-positive cocci (59%, 38/64). Primary culture was positive in 86% of cases (55/64), while enrichment techniques enabled pathogen isolation in 9 initially sterile samples. Gram-positive cocci accounted for 85% of isolates (57/67), led by Staphylococcus aureus (43%, 29/67), followed by streptococci (27%, 18/67) and Gram-negative bacilli (12%, 8/67). Four multidrug-resistant strains were identified: Three methicillin-resistant Staphylococcus aureus (MRSA, 10% of S. aureus, 3/29) and one extended-spectrum beta-lactamase producing Klebsiella pneumoniae. Native joint septic arthritis in our setting is primarily caused by Staphylococcus aureus, with low multidrug-resistant organism prevalence. A rigorous cytobacteriological approach (including systematic enrichment techniques) is essential to optimize diagnostic yield. These findings support empirical antibiotic therapy primarily targeting Gram-positive cocci, guided by local ecology, with regular protocol reassessment in line with evolving resistance patterns.

Keywords: Septic arthritis, Infectious arthritis, Bacterial arthritis, Synovial fluid, Native joints, Antimicrobial resistance, Bacteriological profile, Diagnostic microbiology, Staphylococcus aureus, Morocco.

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INTRODUCTION

Septic arthritis is a medical and surgical emergency characterized by the invasion of the synovial cavity by a microorganism most commonly bacterial, triggering an inflammatory response that can lead to irreversible joint damage [Couderc *et al*, 2020]. Contamination occurs via hematogenous seeding, direct inoculation (e.g., trauma, surgery, arthrocentesis), or contiguous spread from adjacent infectious focus [Debard & Delobel, 2018; Falahi, 2018]. Delayed management heavily compromises both functional and vital prognoses [Wu *et al*, 2024; Zeller *et al*, 2022].

The global annual incidence is estimated at 2 to 10 cases per 100000 individuals in the general population, rising to 30–70 cases in high-risk patients, such as those with rheumatoid arthritis or prosthetic joints [Kanangat *et al*, 2006; Ravn *et al*, 2023; Zaizi, 2009]. Mortality ranges from 3 to 16%, and approximately 25% of patients experience permanent functional impairment [Stahl *et al*, 2023].

The bacteriological confirmation of septic arthritis relies on synovial fluid analysis obtained by arthrocentesis, complemented by blood cultures [Couderc *et al*, 2020]. *Staphylococcus aureus* is the

primary etiological agent of septic arthritis. It is responsible for approximately 50% of documented septic arthritis cases in both children and adults. In adults, it is followed by *Streptococcus* species, and in children aged 6 months to 4 years, by *Kingella kingae* [Stahl *et al,* 2023].

Understanding local microbiological patterns and resistance profiles is critical to optimizing empirical antibiotic therapy and minimizing selection pressure. In Morocco, robust national epidemiological data are scarce, with most literature limited to single-center retrospective studies.

The present study was conducted at the bacteriology laboratory of the Mohammed V Military Instruction Hospital (HMIMV) in Rabat over nine years, with the following objectives:

(1) to describe the epidemiological and cytobacteriological characteristics of culture-confirmed native joints septic arthritis;
(2) to analyze the antimicrobial susceptibility and resistance profiles of bacterial isolates.

MATERIALS AND METHODS

1. Study design and population

This was a retrospective, descriptive, single-center study conducted at the bacteriology laboratory of HMIMV Rabat, covering January 1, 2016 to December 31, 2024.

Inclusion criteria: all synovial fluid samples yielding at least one bacterial pathogen on primary culture or after enrichment.

Exclusion criteria: samples where only the Gram stain was positive, duplicate samples (same pathogen, same susceptibility profile, same patient), prosthetic joint infections, and pre-analytical non-conformities.

Data analysis was performed using Microsoft Excel and relied on conventional descriptive statistics.

2. Cytobacteriological analysis

Each sample underwent macroscopic examination (appearance, color, viscosity), microscopic examination on fresh preparation (leukocyte count, microcrystal search), Gram-stained smear and leukocyte differential count. The cultures were carried out on Columbia agar with 5% blood, Polyvitex chocolate agar, all these media were incubated at 37 °C for 24–48 h in atmospheres enriched with 5–10% CO2. In addition to conventional agar plates, joint aspiration fluids were directly inoculated into brain-heart infusion broth and/or blood culture bottles (BACTEC®). Pathogen identification was performed using conventional identification methods or MALDI-TOF mass spectrometry.

3. Antimicrobial susceptibility testing

Susceptibility was determined by disk-diffusion on Mueller-Hinton agar (or Mueller-Hinton with defibrinated horse blood supplemented with β-NAD for fastidious organisms), in accordance with the current recommendations of the European Committee on Antimicrobial Susceptibility Testing EUCAST [Amara *et al*, 2025]. Results were categorized as Susceptible (S), Susceptible at increased exposure (I), or Resistant (R).

RESULTS

1. Epidemiological data

Of 922 synovial fluid samples analyzed between 2016 and 2024, 64 septic arthritis cases were culture-confirmed, yielding an overall positivity rate of 6.9% (64/922).

Annual distribution is shown in **Figure 1**. A peak was observed in 2016 (12.2%) followed by a sharp decline in 2020 (1.9%), and a gradual increase in positive cases, suggesting an upward trend that requires ongoing surveillance.

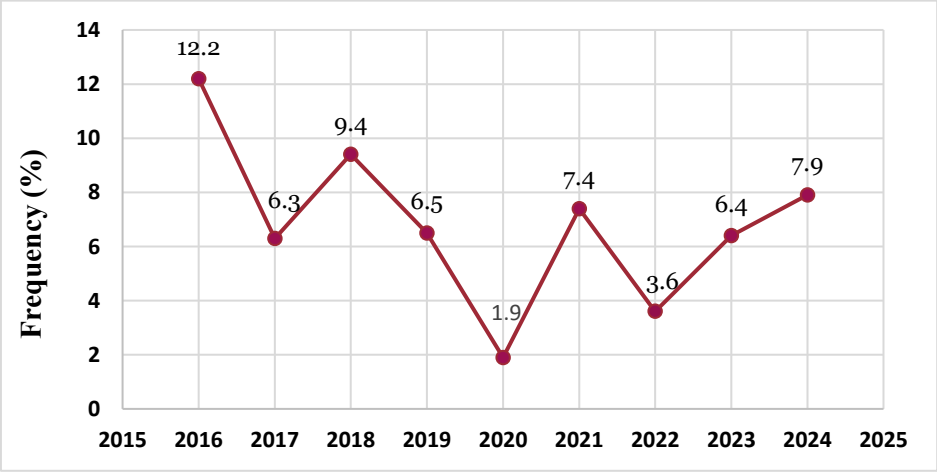


Figure 1: Evolution of the annual frequency (%) of culture-positive septic arthritis cases (2016–2024)

The curve illustrates the annual positivity rate calculated as follows: Number of culture-positive septic arthritis cases divided by the total number of joint fluid specimens received per year. For each year from 2016 to 2024, the corresponding data points are: 2016 (5/41, 12.2%), 2017 (7/112, 6.3%), 2018 (12/127, 9.4%), 2019 (9/139, 6.5%), 2020 (1/52, 1.9%), 2021 (7/94, 7.4%), 2022 (3/83, 3.6%), 2023 (7/110, 6.4%), and 2024 (13/164, 7.9%), for an overall total of 64/922 (6.9%).

A male predominance was observed: 44 patients were males (69%) and 20 patients were females (31%). The sex ratio(M/F) was 2,2.

Median patient age was 62 years [IQR, 44-72] (Range, 3-90). The 60–79 year age group was most represented (39%, 25/64), followed by 40–59 years (23%, 15/64) as it is shown in **Figure 2**.

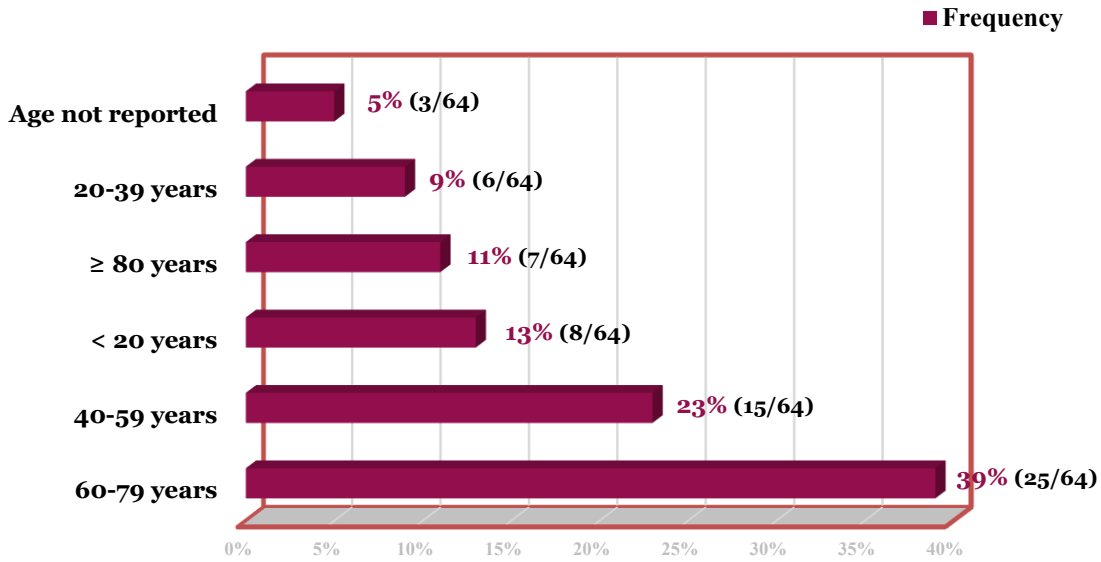


Figure 2: The distribution of the study population by age group

The joint fluid samples were obtained predominantly from patients in the emergency department (32%, 21/64) and the rheumatology service (17%, 11/64).

2. Cytobacteriological findings

Macroscopic examination revealed a manifestly inflammatory pattern in 56% (36/64) of positive samples, predominantly purulent (30%, 19/64), turbid (23%, 15/64) and hemopurulent (3%, 2/64). A hemorrhagic appearance was observed in 30% (19/64) of the samples.

Synovial fluid leukocyte counts ranged between 1000–25000/mm³ in 45% (29/64) of samples, with leukocytosis (>50000/mm³) in 19% (12/64). Neutrophil predominance was observed in 95% (61/64) of cases, with a neutrophil proportion exceeding 90% in 54% (33/61) of the samples. Monosodium urate crystals were found in only 2 samples.

Gram staining was positive in 63% (40/64) of samples, predominantly showing monomicrobial flora (95%, 38/40), with Gram-positive cocci in 59% (38/64) of cases. Gram staining was negative in 36% (23/64) of samples.

Primary culture was positive in 86% (55/64). Enrichment techniques (brain-heart infusion broth and/or blood culture bottles) confirmed positivity in 41 cases and enabled pathogen isolation in 9 initially sterile samples (14%, 9/64), significantly improving diagnostic yield. Polymicrobial infections were rare, observed in only 2 samples.

Additionally, blood cultures were performed in 35 cases. In 17 cases, the same organism was isolated from the joint culture and the blood culture. Two cases yielded a different pathogen, identified as coagulase-negative *Staphylococcus*, which likely represented contamination. In the remaining 16 cases, the blood cultures remained sterile.

3. Bacteriological profile

A total of 67 bacterial isolates were identified in 64 patients. Gram-positive cocci strongly predominated (57/67 isolates, 85%).

Staphylococci were the most frequently isolated (35/67, 52%), with *Staphylococcus aureus* the leading pathogen (29/67, 43%), Coagulase-negative staphylococci accounted for 6 isolates (9%), including

one *Staphylococcus lugdunensis*, a species known for its virulence comparable to *Staphylococcus aureus*.

Streptococci ranked second (18/67, 27%), led by *Streptococcus agalactiae* (Group B, 12%, 8/67), *Streptococcus pyogenes* (Group A, 7%, 5/67), and *Streptococcus dysgalactiae* (3%, 2/67).

Gram-negative bacilli accounted for 12% (8/67), including *Pseudomonas aeruginosa* (n = 3), Enterobacteriaceae (*Escherichia coli, Klebsiella pneumoniae, Enterobacter cloacae*, one each), *Haemophilus influenzae* (n = 1), and *Campylobacter* sp. (n = 1).

Enterococci represented 4% (3/67). Rare pathogens included *Neisseria gonorrhoeae, Corynebacterium* sp and *Micrococcus* sp. (1 case each). No *Kingella kingae* was isolated, which is consistent with the predominantly adult demographic of our cohort and the limitations of conventional culture for this fastidious organism.

Complete isolate distribution is shown in **Figure 3**.

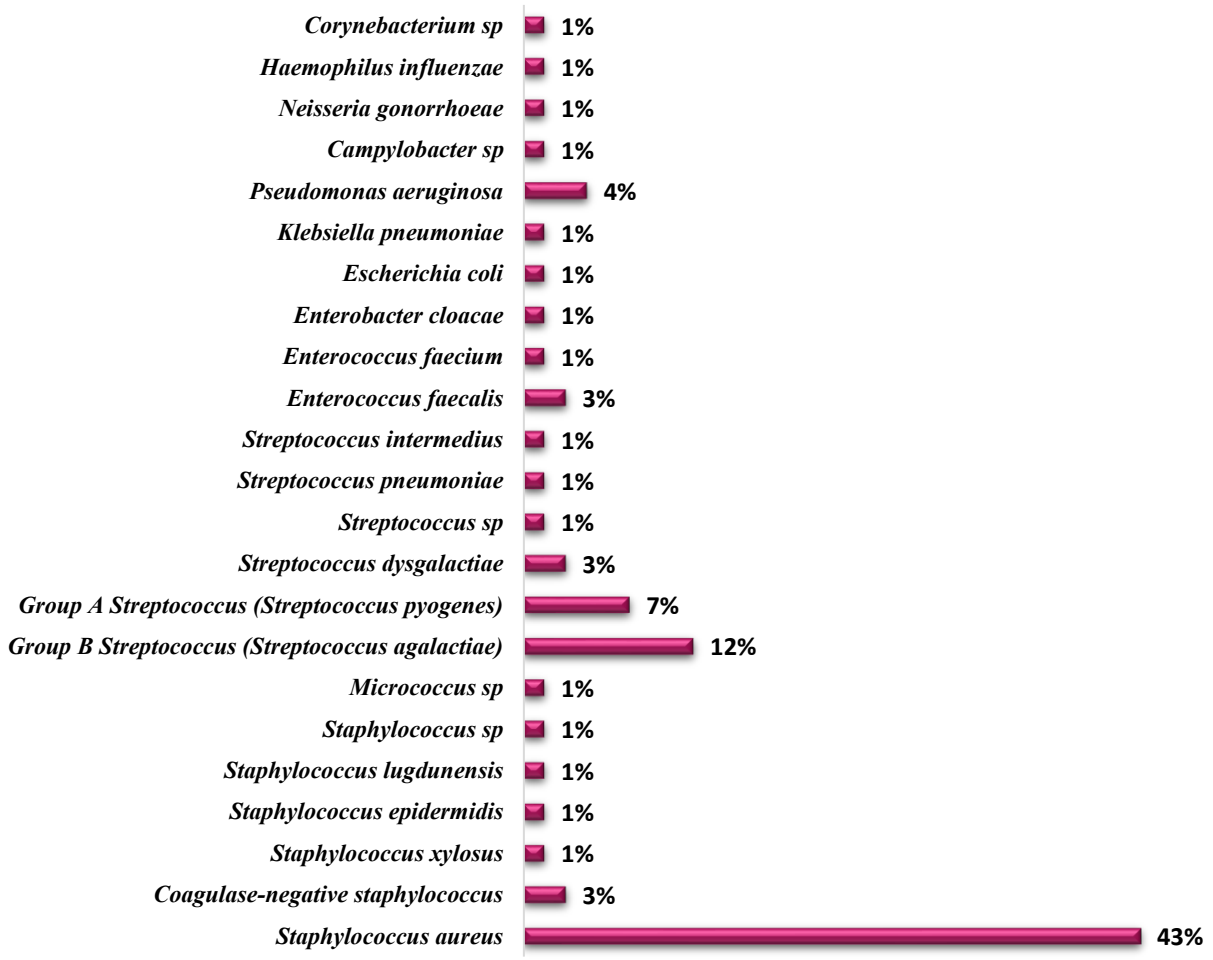


Figure 3: Distribution of bacterial isolates from cultures and enrichments (n=67)

4. Antimicrobial susceptibility profiles

✓ ***Staphylococcus aureus* (n = 29)**

High resistance was observed for Penicillin G, consistent with widespread penicillinase production. Cefoxitin susceptibility (the marker for methicillin susceptibility) was 90% (26/29), reflecting an MRSA (Methicillin-resistant *Staphylococcus* aureus) rate of 10% (3/29).

As detailed in **Table 1**, the isolates demonstrated excellent susceptibility toward Clindamycin, Erythromycin, Trimethoprim-sulfamethoxazole, Linezolid and Aminoglycosides. Broth microdilution is the reference method for determining the minimum inhibitory concentration (MIC) of Glycopeptides (such as vancomycin and teicoplanin).

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Table 1 : Antimicrobial susceptibility profile of *Staphylococcus aureus* isolates (n = 29)

Tested Antibiotics Disks	Number of isolates tested (n)	Susceptible n (%)	Resistant n (%)
Penicillin **G** 1UI	28	0 (0%)	28 (100%)
Cefoxitin 30ug	29	26 (90%)	3 (10%)
Erythromycin 15ug	29	26 (90%)	3 (10%)
Clindamycin 2ug	11	11 (100%)	0 (0%)
Gentamicin 10ug	28	27 (96%)	1 (4%)
Tobramycin 10ug	29	26 (90%)	3 (10%)
Tetracycline 30ug	27	20 (74%)	7 (26%)
Tigecycline 15ug	26	25 (96%)	1 (4%)
Norfloxacin 10ug	25	23 (92%)	2 (8%)
Ciprofloxacin 5ug	25	22 (88%) *	3 (12%)
Trimethoprim-sulfamethoxazole 1,25/23,75	29	28 (97%)	1 (3%)
Linezolid 10ug	16	16 (100%)	0 (0%)
Rifampicin 5ug	23	22 (96%)	1 (4%)
Fusidic acid 10ug	29	26 (90%)	3 (10%)
Fosfomycin 200ug	27	26 (96%)	1 (4%)
Chloramphenicol 30ug	17	15 (88%)	2 (12%)

* Categorized as Susceptible, Increased Exposure (I) according to the EUCAST guidelines [Amara *et al.,*, 2025].

✓ **Streptococci (n = 18)**

Beta-lactam susceptibility was preserved in 88% of isolates (Penicillin G, 15/18). Macrolide susceptibility was 89% (Erythromycin, 16/18). Excellent susceptibility toward Linezolid (100%). Tetracycline resistance was high (72%, 13/18).

✓ **Gram-negative bacilli (n = 8)**

Pseudomonas aeruginosa (n = 3) showed maintained susceptibility to anti-pseudomonal beta-lactams (Ceftazidime, Cefepime, Piperacillin-tazobactam), though classified as susceptible at increased exposure. The *Klebsiella pneumoniae* isolate exhibited an ESBL (Extended-spectrum beta-lactamase) producing phenotype, remaining susceptible only to carbapenems and gentamicin.

✓ **Multidrug-resistant organisms (MDR)**

Four multidrug-resistant (MDR) strains were identified: 3 MRSA (methicillin-resistant *S. aureus*) representing 10% of *S. aureus* isolates (3/29) and 1 ESBL-producing *Klebsiella pneumoniae*. Overall MDR prevalence was 6% (4/64 cases).

DISCUSSION

✓ **Epidemiological findings**

Our study reports the microbiological profile of 64 culture-confirmed septic arthritis cases over 9 years at a Moroccan military reference hospital.

Our incidence rate of 6.9% (64/922) is consistent with Moroccan series from comparable military hospital settings, ranging from 5% to 8.3% (**Table 2**).

Regarding the male predominance, it likely reflects a selection bias inherent to the military population studied, which is predominantly male. This trend is consistently observed across all reported series; our study noted a male-to-female (M/F) sex ratio of 2.2, which is slightly lower than other Moroccan cohorts that report ratios up to 5.25, as summarized in **Table 2**. This finding has also been reported in the literature [Vostrel & Hoffmeyer, 2006].

Table 2: Comparison of epidemiological characteristics of septic arthritis with other moroccan series

Series	Study period	Study location	Positivity rate	Predominance	Sex Ratio
A. Zaizi [Zaizi, 2009]	2007 -2009	HMIMV, Rabat	8.3%	Male	2.5
S. Falahi [Falahi, 2018]	2012 -2017	HMA, Marrakech	5.11%	Male	3
M. Ouajnati [Ouajnati, 2022]	2014 - 2020	HMA, Marrakech	5%	Male	5.25
Our study	2016 - 2024	HMIMV, Rabat	6.9%	Male	2.2

HMIMV : Mohammed V Military Instruction Hospital (Rabat); HMA : Avicenne Military Hospital (Marrakech)

The predominance of older patients (60–79 years, 39%) aligns with published data highlighting increased susceptibility in elderly patients with comorbidities [Ferreyra *et al.,*, 2016; Stahl *et al.,*, 2023; Vostrel & Hoffmeyer, 2006].

The concentration of cases in the Emergency Department (33%) and Rheumatology (17%) reflects the acute clinical presentation typical of native joint septic arthritis.

✓ **Bacteriological findings**

The diagnostic contribution of enrichment techniques (particularly blood culture bottle inoculation) enabled pathogen recovery in 14% of initially sterile samples, confirming the value of this approach, especially when prior antibiotic therapy has been administered or in cases involving fastidious organisms. The high efficiency of this method is firmly established in the literature [Lebron *et al*, 2025; Lartigue *et al*, 2022; Ross, 2017].

The predominance of Gram-positive cocci (85% of isolates), with *Staphylococcus aureus* as the leading pathogen (43%), is consistent with international data reporting 40–60% for this organism in native joint infections [He *et al*, 2023; Mathews *et al*, 2010; Wang & Wang, 2021].

The comparatively higher proportion of streptococci in our series (27% vs 15–20% in European series) deserves attention, particularly the prominence of *Streptococcus agalactiae* (Group B, 12%), whose incidence in invasive infections is increasingly recognized among elderly patients with underlying chronic conditions [Dubost *et al*, 2004; Lebron *et al*, 2025; Stahl *et al*, 2023; Vostrel & Hoffmeyer, 2006].

Gram-negative bacilli (12%) were within the range (10% to 20%) expected for this type of infection and are consistent with both national and international comparative data [Lebron *et al*, 2025; He *et al*, 2023; Stahl *et al*, 2023; Vostrel & Hoffmeyer, 2006].

The three *Pseudomonas aeruginosa* isolates and the ESBL-producing *K. pneumoniae* highlight the importance of considering Gram-negative coverage in patients with specific risk factors (advanced age, urinary tract infection, diabetes, prior antibiotic exposure, healthcare-associated settings).

No *Kingella kingae* was isolated in this series, likely reflecting the adult demographic composition of the cohort. This organism, a leading cause of septic arthritis in children under 4 years, is notoriously difficult to recover by conventional culture [Isnard *et al*, 2016; Lartigue *et al*, 2022]. The absence of systematic molecular testing (PCR) in our laboratory workflow represents a recognized limitation, and molecular diagnostics should be routinely implemented for pediatric cases.

The isolation of *Neisseria gonorrhoeae* in a 16-year-old female serves as a reminder that gonococcal arthritis, though rare in our predominantly older and male cohort, should remain on the differential in sexually active young adults. Similarly, the isolation of *Campylobacter* sp (A fastidious, microaerophilic organism that requires specific culture conditions) underlines the need for adapted microbiological techniques in atypical clinical presentations.

A comparative summary of MRSA rates across national, European, and North American studies is presented in **Table 3**.

Table 3: Comparison of Methicillin-Resistant *Staphylococcus aureus* (MRSA) rates across different studies

Series	Study period	Country	MRSA Rate (%)
Jean-Jacques Dubost *et al.,* (30 years) [Dubost *et al*, 2014]	1979 -2008	France, Clermont-Ferrand	13%, 11%, 15% respectively in each decade
Straub *et al.,* (18 years) [Straub et al, 2025]	2007-2024	Austria, Vienna	4.41%
Olivier Clerc *et al.,* (10 years) [Clerc *et al*, 2011]	1999 - 2008	Switzerland, Lausanne	4.7%
Ana Cipriano *et al.,* (9 years) [Cipriano *et al*, 2021]	2009 - 2017	Portugal, Porto	7%
John J. Ross *et al.,* (29 years) [Ross *et al*, 2020]	1990 - 2018	Boston, Massachusetts, USA	17.9 %
Valerie C. Gobao *et al.,* (5 years) [*Gobao et al,* 2021]	2012–2016	Pennsylvania, USA	23%
A. Zaizi (3 years) [Zaizi, 2009]	2007 -2009	Morocco, Rabat	11%
M. Ouajnati (7 years) [Ouajnati, 2022]	2014 - 2020	Morocco, Marrakech	0%
Our study (9 years)	2016 - 2024	Morocco, Rabat	10%

The MRSA rate observed (10.3% of S. aureus) is comparable to that reported in a study conducted at the same institution between 2007 and 2009, which found a rate of 11%, and remains consistent with the national estimation of methicillin resistance in Morocco. This result also concords with the rates reported in numerous European series, ranging from 4 to 15%, but remains significantly lower than North American series, where the opioid epidemic has contributed to a substantial increase in MRSA infections. However, the identification of an isolated case of ESBL-producing strains underlines the need for active surveillance.

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Our findings demonstrate a bacterial ecology heavily dominated by Gram-positive cocci, primarily driven by methicillin-susceptible *Staphylococcus aureus* and streptococci, which remains consistent with conventional data on native septic arthritis. Notably, the high rate of susceptibility to anti-staphylococcal beta-lactams observed in our series strongly supports the implementation of a targeted, narrow-spectrum empirical regimen as a first-line strategy. In this context, agents such as cefazolin or penicillinase-resistant penicillins (e.g., cloxacillin or oxacillin) represent the cornerstone of initial therapy, ensuring optimal bactericidal activity while minimizing unnecessary selective pressure.

Conversely, broadening to cover Gram-negative bacilli or methicillin-resistant *Staphylococcus aureus* (MRSA) must not be systematic. Our data reveal a relatively low prevalence of MRSA (10%) and a low frequency of multidrug-resistant Enterobacteriaceae, aligning with broader regional trends. Consequently, deploying heavy empirical coverage such as glycopeptides (vancomycin, teicoplanin) or antipseudomonal beta-lactams should be reserved for patients with specific risk factors, with prompt de-escalation guided by culture and susceptibility results.

The strengths of this study include its long observation period (9 years), which provides a robust and representative picture of local epidemiology; the exclusive inclusion of bacteriologically confirmed cases, ensuring microbiological reliability; and the detailed analysis of individual antimicrobial susceptibility profiles enabling pathogen-specific therapeutic guidance.

Meanwhile the limitations of this study include its retrospective single-center design, the exclusion of culture-negative cases (potentially underestimating true incidence), and the relatively small sample size limiting statistical power.

CONCLUSION

Septic arthritis in our setting remains a rare but severe condition, dominated by *Staphylococcus aureus*, with a low prevalence of multidrug-resistant organisms. A rigorous cytobacteriological approach (including systematic use of enrichment techniques) is critical to maximize diagnostic yield. These findings support local ecology-adapted empirical antibiotic therapy and underscore the importance of regularly updating treatment protocols in response to evolving antimicrobial resistance patterns.

DECLARATIONS

Author contributions:

- Conceptualization, Methodology, Validation: S.I. and M.C.;
- Investigation, Formal Analysis, Visualization, Writing – Original draft: S.I.;
- Writing – review and editing: S.I., H.E., M.A.O. and M.C.;
- Supervision: E.B., Y.B.L. and M.C.;
- Project administration: M.C.
- All authors have read and agreed to the published version of the manuscript.

Conflicts of interest: The authors declare no conflicts of interest related to this article.

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Ethical approval: Data confidentiality and patient anonymity were strictly preserved throughout the study. The study was approved by the Ethics Committee of Mohammed V Military Instruction Hospital and was conducted in accordance with the institutional guidelines and with the Declaration of Helsinki and its later amendments.

Data Summary

The study variables were compiled into an operating database. The anonymized dataset supporting the findings of this study is available from the corresponding author upon reasonable request.

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