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Status of Healthcare-Associated Infections in Three Nephrology Departments in Dakar: A One-Year Prospective Multicenter Study

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Abstract

This prospective multicenter descriptive study reports the epidemiological, clinical, microbiological, and outcome profile of healthcare-associated infections (HAIs) in three nephrology departments in Dakar over 12 months. Among 1060 patients seen, 83 HAI cases with microbiological documentation were included, with most events occurring after 7 days of hospitalization and with urinary and hemodialysis catheters as frequent associated devices. Gram-negative bacilli and *Staphylococcus* spp. predominated, with a high proportion of ESBL and MDR profiles, and outcomes were mainly favorable despite reported mortality.

Keywords

Healthcare-Associated Infections, Nephrology, MDROs, ESBLs, Dakar

1. Introduction

Healthcare-associated infections (HAIs) encompass any infection occurring during or after medical care, defined by an onset time > 48 hours post-procedure, extended to 30 days for surgical site infections and up to one year in the case of implant placement [1]. They include nosocomial infections and those related to out-of-hospital care [2].

The WHO estimates a general prevalence of healthcare-associated infections

(HAIs) of 5 to 15% in short-stay facilities, with the risk increasing 2 to 20 times in developing countries [3]. In Europe, more than 3.5 million cases occur each year, causing 90,000 deaths [4]. In Africa, documentation remains incomplete despite alarming rates: for example, 28.75% of catheter-related infections in hemodialysis in Morocco [5] and a 20% prevalence in Guinea [6].

In Senegal, studies on healthcare-associated infections (HAIs) in nephrology are limited; a recent study in Dakar highlights the presence of 35.7% of positive catheters in dialysis [7]. Our work aims to fill this gap by providing a multicenter epidemiological and microbiological overview.

2. Patients and Methods

This was a prospective, descriptive, multicenter study conducted over a 12-month period, from November 1, 2023, to October 31, 2024, in three nephrology departments in Dakar: Dalal Jamm Hospital, Ouakam Military Hospital, and HOGIP. The study population included all patients hospitalized or followed up in the three nephrology departments during the study period who agreed to participate. The following were included in the study:

All patients admitted to one of the three nephrology departments, initially free of any infection upon admission, who developed a healthcare-associated infection (HAI) after ≥ 48 hours of hospitalization, according to the CDC definition of HAI. Patients followed in outpatient consultations or in chronic dialysis programs, in whom an infection occurred after an identifiable healthcare procedure, with a plausible causal link, including: Infection related to vascular access (arteriovenous fistula, central venous catheter), Urinary catheter-related infection, Peritoneal dialysis infection (peritonitis or exit site infection). Special cases of chronic hemodialysis patients: the 48-hour time limit was not applied; any localized or systemic infection occurring in the days following a hemodialysis session, and attributable to the therapeutic procedures performed, was considered a healthcare-associated infection (HAI). The following were not included: patients with a community-acquired infection (infection occurring before or within the first 48 hours of hospitalization); Cases of contamination, meaning the introduction of bacteria onto a surface or into the body during sampling, and cases of simple colonization, the presence and multiplication of bacteria on a body surface or on a medical device, without causing clinical signs of infection, were considered. Patients who developed healthcare-associated infections (HAIs) without microbiological documentation were excluded from this study. Our data were collected using a survey form entered via Google Collect software. We used the patients' medical records combined with patient interviews. Data collection focused on the following parameters: Sociodemographic data: age, sex, residence, occupation, hospital ward, length of hospital stay; Medical history/comorbidities: hypertension, diabetes, chronic kidney disease (CKD) not requiring dialysis, and chronic kidney disease requiring hemodialysis. Data collected were obtained via AVF/tunneled catheter/CVC and PD catheter. Reason for or diagnosis of hospitalization: Acute renal failure due to

CKD, fever, severe anemia, HAT, infection related to dialysis equipment. Medical devices in place/Invasive procedures received during hospitalization: Urinary catheter, central venous catheter, tunneled catheter, JJ stent, urinary catheter, nephrostomy, PD catheter, other procedures. Clinical examination: Fever, chills, profuse sweating, heart rate, respiratory rate. Paraclinical data: Complete blood count (CBC), hemoglobin level (THb), WBC, CRP, procalcitonin, blood culture, urine culture, culture of catheter tips, culture of tunneled catheter locks, culture of catheter insertion site swabs, culture of effluent, pus. Infectious states and foci of infection: Systemic inflammatory response syndrome (SIRS), sepsis, septic shock, urinary tract infection, dialysis catheter infection, tunneled catheter infection, peritonitis. Treatment data: Empirical antibiotic therapy before diagnosis, antibiotic therapy after diagnosis. Outcome: under antibiotic therapy. Length of hospital stay was defined as the number of days spent in the hospital for hospitalized patients and for hemodialysis patients; the day of the session was considered a day of hospitalization.

3. Results

1060 patients attended our services, and 83 patients were included in the study, representing a cumulative incidence of 7.83%, or 7.83 patients per 100 patients admitted, with a 95% confidence interval [6.2; 9.5]. The incidence rate was: (83 HAI cases)/(725 patient-days) × 1000, or 114.5 cases per 1000 patient-days, with a 95% confidence interval [89.9; 139.1]. This included a single infection episode per patient and one pathogen per patient (see Table 1). The mean age of the patients was 49.9 ± 3.2 years, with a range of 22 to 82 years, a standard deviation of 14.84 years, and a 95% confidence interval of 46 to 53.11 years.

The most represented age group was patients aged 32 to 41 years, accounting for 25.3% of the study. There were 42 men and 41 women, resulting in a male-to-female ratio of 1.02. The majority of our patients (94%) came from the Dakar region. Clinical symptoms were primarily fever (97.6%) in 81 patients, accompanied by chills (61.4%), tachycardia (47.0%), tachypnea (41.0%), profuse sweating (15.7%), and abdominal pain (12.05%) in 10 patients.

Length of hospital stay: We observed that over 67.8% of infections occurred during hospital stays exceeding 7 days (see Figure 1).

Isolated germs.

Classification of identified germs according to morphology and species

In our morphological study, 43 of our patients had Gram-negative bacilli (51.80%). The most frequently represented species was *Escherichia coli* (25 patients, 30.12%), followed by Gram-positive cocci (32 patients, 38.55%), and the predominant species was *Staphylococcus aureus* (30 patients, 36.14%). See Table 1.

Comorbidities

Regarding the comorbidities of our patients, 92.80% had hypertension, 42.16% had non-dialysis-dependent CKD, 20.50% had diabetes, and 18.0% had non-dialysis-dependent CKD. See Table 2.

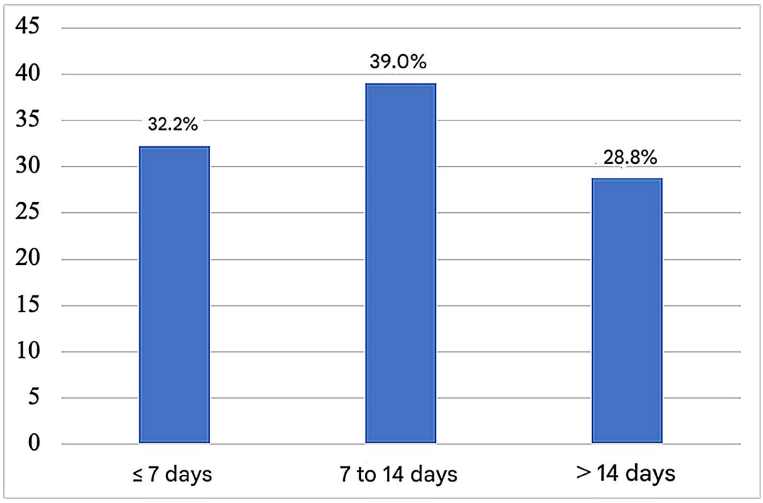

Figure 1. Distribution of patients according to length of hospital stay.

Table 1. Distribution of patients according to morphology and isolated species.

Morphology and Species	Effective	Percentage %
Gram-negative bacillus	**43**	51.80
Escherichia coli	25	30.12
Klebsiella pneumoniae	7	8.43
Pseudomonas aeruginosa	7	8.43
Enterococcus spp	3	3.61
Enterococcus cloacae	1	1.12
Gram-Positive Cocci	32	38.55
Staphylococcus aureus	30	36.14
Staphylococcus haemolyticus	2	2.40
Gram-negative cocci	6	7.22
Acinetobacter baumannii	3	3.61
Achromobacter denitrificans	2	2.40
Proteus mirabilis	1	1.20
Yeast	2	2.40
Candida parapsilosis	1	1.20
Candida albicans	1	1.20

Table 2. Distribution of patients according to comorbidities.

Comorbidity	Number	Percentage
Hypertension	77	92.8%
Non-dialysis-dependent CKD:	35	42.2%
Stage 3a CKD	3	3.6%

Continued

Stage 3b CKD:	7	8.4%
Stage 4 CKD	10	12.0%
Stage 5 ND CKD	15	18.1%
Diabetes	17	20.5%
Hepatitis B	7	8.4%
Heart disease	5	6.0%
HIV	2	2.4%
Multiple myeloma	1	1.2%

Bacteria isolated according to profiles: Multidrug-resistant bacteria (MDRB), ESBL and non-MDRB/ESBL.

Based on the analysis of the various biological fluids, we had isolated 83 bacteria including 32 ESBL bacteria (37.65%), 28 MDR bacteria (32.94%), and 25 non-MRSA/ESBL bacteria (29.41%). See Table 3.

Table 3. Distribution of the different bacteria identified according to the profiles of MDR, ESBL and non-MRSD/ESBL.

Profiles	Number	Percentage
BLSE	32	37.65%
BMR	28	32.94%
Non-MRSA/Non-ESBL	23	29.41%
Total	83	100%

Distribution of our patients according to infectious foci

Regarding the sources of infection, 44.58% of patients had an infection originating from a urinary catheter, 27.71% from a central venous dialysis catheter, 12.05% from a peritoneal dialysis catheter, 10.84% from an abscess on an arteriovenous fistula, and 4.82% from a tunneled catheter. See Figure 2.

Treatment

Probabilistic antibiotic therapy and antibiotics used in probabilistic treatment

Eighty-two (82) out of 83 patients received empirical treatment before the microbiology results were available, representing 98.80%; the antibiotics used were ceftriaxone (67.50%) and ciprofloxacin (37.80%). See Figure 3.

Duration of empirical antibiotic therapy

The duration of probabilistic antibiotic therapy was ≥3 days in 86.60% of our patients and 13.40% had a duration of probabilistic antibiotic therapy ≤of 3 days.

Infectious states

Sepsis accounted for 68.70%, SIRS 21.70%, and septic shock 9.60%. See Figure 4.

Etiological treatment

Antibiotics used after diagnosis.

Imipenem was the most used antibiotic after diagnosis 27.70%, followed by vancomycin 21.70% and gentamicin 12.00%. See Table 4.

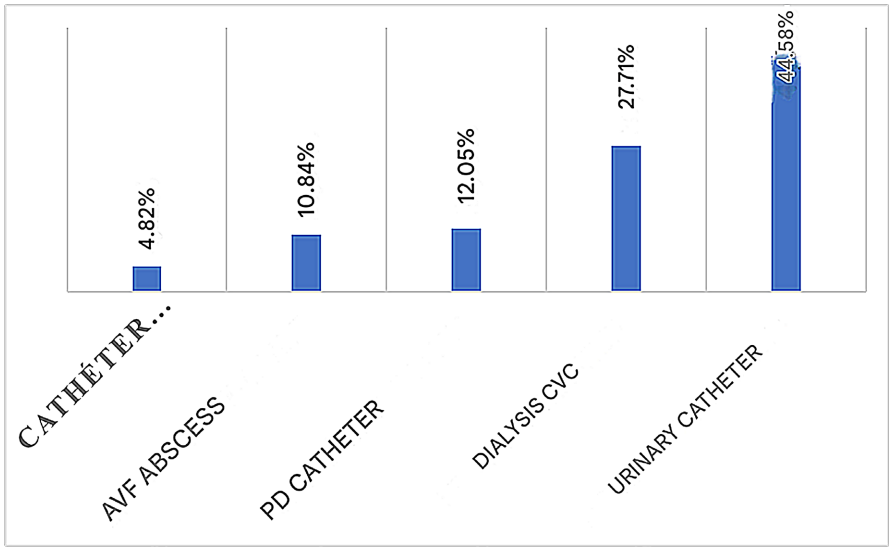

Figure 2. Distribution of our patients according to infectious foci.

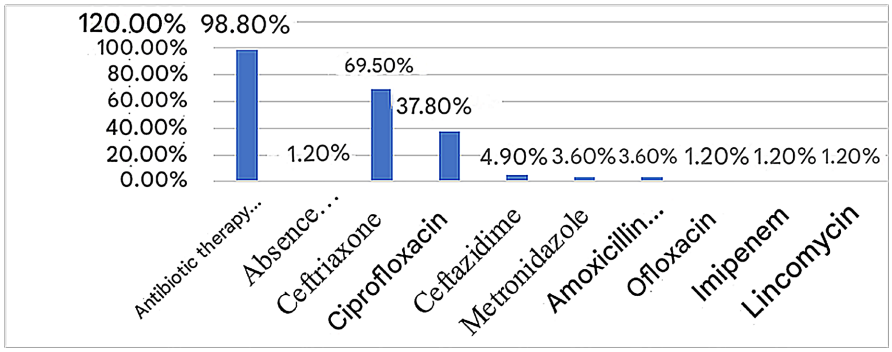

Figure 3. Distribution of patients according to empirical antibiotic therapy and antibiotics used as first-line treatment.

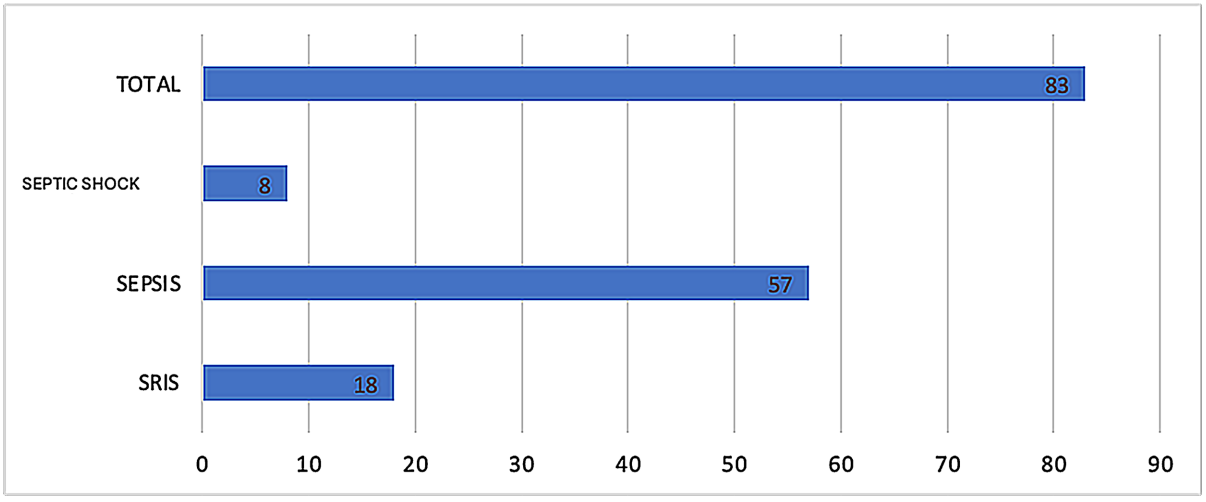

Figure 4. Distribution of our patients according to infectious conditions.

Table 4. Distribution of patients according to the different antibiotics used after diagnosis.

Antibiotics	Staff	Percentage (%)
Imipenem	23	27.7
Vancomycin	18	21.7
Gentamicin	10	12.0
Amikacine	8	9.6
Amoxicillin + Clavulanic acid	8	9.6
Ceftriaxone	7	8.4
Ciprofloxacin	7	8.4
Fosfomycin	3	3.6
Ceftazidime	2	2.4
Cefixime	2	2.4
Levofloxacin	2	2.4
Fusidic acid	1	1.2
Rovamycin	1	1.2

Evolution

Under antibiotic therapy, the evolution was marked by 75 cases of recovery, *i.e.* 90.40%, however, death occurred in 8 patients, *i.e.* 9.60%, including 7.20% of deaths from septic shock and 2.40% of deaths from pulmonary embolism.

Acutisation, 35 out of 83 patients acutised, *i.e.* 42.16%; 28 out of 35 patients recovered baseline renal function, *i.e.* 80% and 7 patients did not recover, *i.e.* 20%.

4. Discussion

The cumulative incidence (7.83%) is lower than average in other African series (up to 20%), but higher than European (~6.5%) and American (3-4%) data [8]-[12]. This reflects a context of increased risk linked to limited resources and the high prevalence of invasive devices in our setting.

From a bacterial perspective: based on the morphology of the identified bacteria and the predominant species, Gram-negative bacilli represent 51.8% of the pathogens identified in this study, with *Escherichia coli being the most prevalent* (30.12%), followed by *Klebsiella pneumoniae and* Pseudomonas *aeruginosa* (8.43% each). Gram-positive cocci represent 38.55% of cases, with a strong predominance of *Staphylococcus aureus* (36.14%), consistent with an African series reporting 74.1% Gram-negative isolates with *E. coli.* 37.6% and *K. pneumoniae* 8.3%, our 36.14% of *S. aureus* are consistent with the predominance observed for this organism in European and American series of nephrology bacteremia, while the proportion of Gram-negative bacteria (51.8%) is slightly higher than in some European series where Gram-positive bacteria may predominate or be close [13]-[15]. This difference could be explained by the mixing of urine culture and blood culture results.

The blood culture reveals a predominance of *Staphylococcus*. 52.38%, several studies in Africa and Europe confirm this predominance of *Staphylococcus* in blood cultures of dialysis patients, but ours are more than twice the European average [16]-[19]. This could be explained by the fact that many of the patients in this study had a central venous catheter (CVC) as their vascular access, *Staphylococcus* being the primary pathogen responsible for cutaneous bacteremia, and also by the heavy infectious burden carried by the invasive devices used in nephrology patients. The presence of Enterobacteriaceae The results of the urine culture (ECBU) predominate (74.35%), with *Escherichia coli being the most common* (43.58%). Our results are consistent with the literature; enterobacteria are considered the main agents of urinary tract infections in patients with renal insufficiency or undergoing dialysis, due to their frequent exposure to invasive urinary devices (probes, catheters) and repeated antibiotic treatments [20]-[24]. *Staphylococcus* accounts for 45.45%. Of the germs identified in the analysis of the catheter lock and tip, Enterobacteriaceae were present in 33.33% of cases with an ESBL resistance profile. Our results are consistent with international observations [25]-[27]. Gram-positive cocci, particularly *Staphylococcus aureus,* have historically been the main bacteria involved in dialysis catheter-related infections, especially in the context of vascular access via temporary or tunneled catheters. Bacteriological analysis of pus and swab samples from dialysis catheters reveals a notable predominance of *Staphylococcus aureus* (80%). This predominance of *S. aureus* is consistent with data from the African, European, and American literature [28] [29]. This underscores that this germ is one of the main agents of catheter-related infections in dialysis patients.

According to the resistance profile, ESBLs represented 37.65% and MDR bacteria 32.94%. This distribution is similar to bacterial profiles observed in other hospital settings, particularly in African studies where the prevalence of ESBLs and multidrug resistance is also high [30]-[32]. This highlights significant antibiotic selection pressure and a considerable resistance burden.

Infection according to medical devices:

Urinary catheter-related infections (represented 44.6%) are consistent with data from a recent meta-analysis conducted in Africa, which reports an aggregate prevalence of catheter-associated urinary tract infections (CAUTIs) of 43.28%, higher than that observed in European countries [33] [34]. The high frequency of urinary catheter use in our study could be explained by the fact that, in certain situations in a nephrology setting, the urinary catheter allows for hourly monitoring of urine output and anticipation of certain complications. Infection of the central venous hemodialysis catheter represented 27.7%, a result almost identical to some African observations [35] [36]. This proportion reflects the reality in African countries where arteriovenous fistulas are not readily available, especially at the initiation of hemodialysis. Under antibiotic therapy, 75 cases recovered, representing 90.40% of cases in our series; however, death occurred in 8 patients (9.60%), including 7.20% of deaths from septic shock and 2.40% from pulmonary

embolism. These results illustrate the particular severity of bacteremia in patients with renal failure. This is confirmed by several studies: In hemodialysis, an Indian study reports a mortality rate of 6.6% for catheter-related infections [37]. A Spanish registry describes a 30-day mortality rate of 8.7%, after tunneled catheter-related bacteremia [38]. The difference in our mortality rates of 9.6% can be explained by particularly high-risk patient profiles (renal failure, severe infections), as well as the impact of inappropriate probabilistic treatments in a nephrological context. In sub-Saharan Africa, mortality from sepsis is estimated at 19% (standard sepsis) and 39% (severe sepsis), while 30-day mortality can reach 54% for severe sepsis [39]. A study in Malawi indicates in-hospital mortality of 23.7% for sepsis and 28.1% for severe sepsis [40]. These data highlight that although our mortality rate of 9.6% remains significant, it is lower than the figures observed in many African settings or in critical care, but higher than some hemodialysis cohorts.

5. Conclusions

This multicenter study provides a precise map of healthcare-associated infections (HAIs) in nephrology in Dakar, highlighting their significant frequency and bacterial diversity with high resistance. Our results emphasize essential measures:

Reduce the use of invasive devices, particularly urinary probes and catheters, through strict protocols.

Reduce the length of hospital stay.

Optimize the time to obtain microbiological results (antibiograms within 72 hours) in order to adapt antibiotic therapy early.

Strengthen surveillance and infection prevention campaigns in hospitals, particularly in nephrology departments.

A multidisciplinary approach is needed to reduce morbidity and mortality related to healthcare-associated infections in these fragile services.

Methodological limitations: Its prospective descriptive nature, while allowing for real-time data collection, does not permit the establishment of causal links due to the lack of a control group or multivariate analyses. The absence of molecular typing of bacterial strains restricts the exploration of antibiotic resistance mechanisms.

Scope and generalizability: Confined to three hospitals in Dakar over one year, the study limits the generalizability of results to the national level and does not capture seasonal or epidemic variations in healthcare-associated infections (HAIs). A multicenter extension and a longer observation period would have improved the extrapolability of the findings.

Bias and follow-up: Selection bias arises from the exclusion of patients presenting with clinical signs of HAIs without microbiological confirmation, potentially underestimating the true incidence. Finally, the lack of long-term follow-up precludes the assessment of post-hospital renal or infectious sequelae.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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