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Epidemiological Aspects of Nosocomial Infections in the Intensive Care Unit of the Akanda Army Training Hospital in Gabon from 2019 to 2022

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ABSTRACT

Introduction: *The development of preventive and therapeutic strategies to combat nosocomial infections (NI) in intensive care involves monitoring their microbial ecology, studying their antibiotic resistance and their transmission modalities. The aim of our study was to analyze the epidemiological aspects of NI in patients hospitalized in intensive care from 2019 to 2022.*

Patients and Method: *Retrospective study, with descriptive and analytical aims, carried out from 493 records of patients hospitalized in intensive care from January 2019 to December 2022. Included were all patients hospitalized for more than 48 hours in intensive care with confirmed presence of an IN. Clinical, biological, paraclinical and therapeutic information was collected on a standardized Epi-info 7.3 form and analyzed by Excel Microsoft office 2019.*

Results: *The rate of IN was 11.7% (58/493 patients) for a mean time of onset of 10.5 days. Of the 78 cases of IN recorded, 42% had a urinary location and 34% pulmonary. The bacteriological profile of the 79 germs was composed of 77% Gram-negative bacilli (GNB), 22.7% Gram-positive cocci (GPC). The main urinary germs were Escherichia coli, Klebsiella pneumoniae in 31.4%, at the pulmonary level Acinetobacter baumanii in 29.6%, Klebsiella pneumoniae and Pseudomonas aeruginosa in 14.8%. BMR represented 39.2% of the isolated strains, ESBL Enterobacteriaceae 45.1%, Acinetobacter baumanii 29%, Pseudomonas Aeruginosa 25.8%. Methicillin-resistant Staphylococci aureus (MRSA) were not found.*

Conclusion: *The majority of NIs are due to invasive medical devices. Handling remains the main culprit. Enterobacteriaceae dominate, with Klebsiella pneumoniae, Escherichia coli, and Acinetobacter baumanii (BMR) at the top of the list. Resistance to commonly used antibiotics (ATBs) and the low availability of suitable ATBs constitute a significant mortality factor. Therefore, measures to curb the emergence of resistant pathogens must be adopted.*

Keywords

Nosocomial infection (NI), Multi-resistant bacteria (MRB), Methicillin-resistant staphylococci aureus (MRSA), Gram-negative bacilli (GNB), Resuscitation.

Introduction

The existence of a significant reservoir of multi-resistant bacteria (MRB) in intensive care associated with invasive procedures performed on patients who are often in critical condition

contributes to increasing the risk of nosocomial infection (NI) [1-3]. Considered to be avoidable, studies on NI contribute to the development of preventive strategies [4,5]. Several European or African studies, including Gabon, have carried out epidemiological monitoring of these NI [6-16]. This study aims to update our data and aimed to analyze the bacteriological profile of NI.

Patients and Method

This is a retrospective, descriptive, and analytical study conducted over a four-year period from January 2019 to December 2022 in the intensive care unit of the Akanda Army Training Hospital (HIAA) on UTIs. UTI is defined as the occurrence of fever and/or the presence of infectious signs in laboratory tests after a 48-hour hospital stay, which may include:

- Nosocomial urinary tract infection, which is the presence of pyuria or whitish deposits in the tubing or a positive urine dipstick (BU) for leukocytes and/or nitrites associated with fever with a positive urine culture (≥ 105 microorganisms/ml) and at most 2 different microorganisms.
- Local catheter infection is the presence of localized inflammatory signs or purulence of the catheter entry orifice associated with hyperthermia or hypothermia with a quantitative CVC culture ≥ 103 CFU/ml.
- Nosocomial pneumonia:

o In non-intubated patients, occurrence or worsening of respiratory distress with a radiological image in favor.

o In intubated patients, appearance of purulent bronchial secretions associated with hyperthermia or hypothermia with or without

- Protected distal sampling (PDP) with a threshold > 103 CFU/ml;
- Quantitative bacteriology of bronchial secretions with a threshold of 106 CFU/ml.

Inclusion Criteria

Any patient of either sex, regardless of age, hospitalized in the HIAA intensive care unit for more than 48 hours and with a suspected or confirmed nosocomial infection (NI) was considered a case.

Non-inclusion Criteria

All patients hospitalized in intensive care for less than 48 hours and having confirmed IN upon admission.

Exclusion Criteria

Incomplete files and burn victims. Among the operational definitions

Data Collection

The data were recorded on an individual standardised form designed in Epi-info7 which included information from the medical records and register of the bacteriology department. The data included age, sex, origin, clinical data such as reason for hospitalisation, comorbidities, IGSII score, temperature, oxygen saturation, heart rate and respiratory rate. Paraclinical data included CBC, CRP, PCT, bacteriological examination associated with antibiotic susceptibility testing, therapeutic data such as initial antibiotic therapy, invasive procedures, secondary antibiotic therapy, evolutionary data such as length of hospitalisation and outcome.

Statistical Analysis

Tables and data analysis were performed using EPI INFO 7.3 and Excel Microsoft office 2019. The association between categorical variables was based on percentages with confidence intervals (CI) and the Chi2 test. In univariate and bivariate analysis with Mac Nemar's Chi 2 test, significance for $p<0.05$.

Ethical Aspects

Study carried out after prior agreement from the Chief Medical Officer, Commander of the HIAA, the Head of the Intensive Care Department of the HIAA and respecting patient anonymity.

Results

Among the 619 patients admitted to the intensive care unit of the HIAA during the study period, the length of stay was 48 hours or more in 493 patients, 58 of whom presented with an IN, i.e. a hospital prevalence of 11.7% (Figure 1).

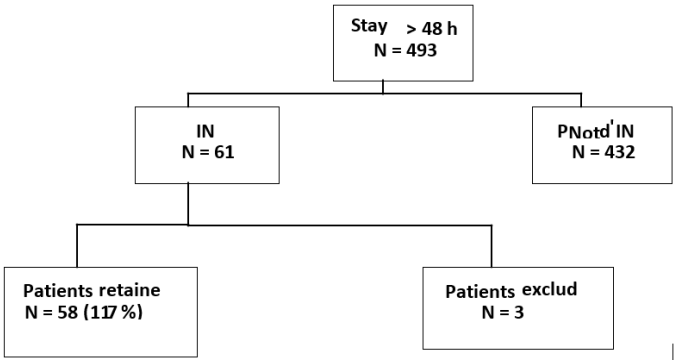

Figure 1: Flow chart.

The median age of the patients was 51 ± 17 years, with extremes of 7 to 83 years, and the most common age group was in a third of cases. The sex ratio was 0.7, i.e. 56.9% women (Figure 2).

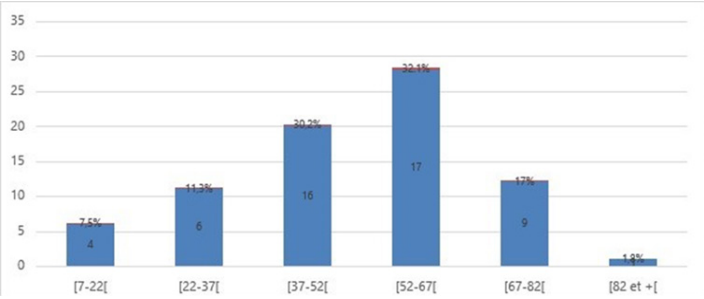

Figure 2: Distribution of patients by age group.

Of the total number of patients, 70.6% had comorbidities, with hypertension predominating in 41.4% of cases, followed by diabetes in 17.2% (Table 1).

Table 1: Distribution of comorbidities.

Comorbidities	Number (N)	Percentage (%)
HYPERTENSION	24	41,4
Diabetes	10	17,2
Obesity	1	1,7
HIV	2	3,4
Gestating	1	1,7
Sickle cell disease	1	1,7
Asthma	2	3
Neoplasia	1	1,7
None	17	29,3

Medical pathology accounted for almost all cases, i.e. 67.2% of hospital admissions (Table 2). The mean IGSII score was 28, with extremes of 6 and 51.

Table 2: Breakdown of patients by reason for hospitalisation.

Conditions		Number (N)	Percentage (%)
Medical conditions	COVID 19	39	67,2
	Febrile ACS	8	13,8
	STROKE	4	6,9
	Post-drowning OAP	1	1,7
	Tetanus	1	1,7
Surgical pathology	Post-MVA polytrauma	3	5,2
	Post scheduled programmed	2	3,4

All patients had a urinary catheter as well as a nasogastric tube (NGT) and more than half had an IOT (55.1%, n=32). The average duration of mechanical ventilation was 17.5 days, with extremes ranging from 4 to 32 days (Table 3).

Table 3: Breakdown of patients by medical device.

Medical devices	Number of patients (N)	Percentage (%)
Urinary catheter	58	100
NGTS	58	100
Orotracheal intubation	32	55,1
VVC	42	72,4
Oxygen goggles and mask	26	44,8

Antibiotic therapy was instituted in 47 patients (81%) at the start of hospitalisation, with a combination of ceftriaxone/ciprofloxacin in 67.2%, amoxicillin/clavulanic acid in 8.6% and metronidazole in 5.1% of cases. The average time to onset of infection was 10.5 days, with extremes of 3 and 46 days. One third of patients (21.7%, n=18) developed an infection within 3 to 4 days (Table 4).

Table 4: Onset of nosocomial infection in days.

Time in days	Number (N)	Percentage(%)
[3-5]	18	21,7
[5-7]	17	20,5
[7-10]	14	16,8
[10-15]	17	20,5
[15-46]	17	20,5

Of the 78 cases of IN found, 42.2% (n=35) were of urinary origin and 33.7% (n=28) of pulmonary origin (Figure 3).

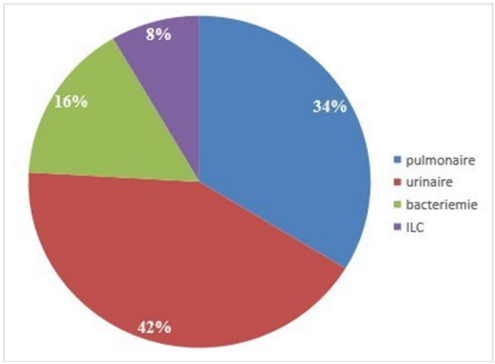

Figure 3: Site of infection.

Of the 83 episodes of infection, 79 bacteria were isolated, 77.2% (n=61) of which were BGN and 22.7% (n=18) CGP. *Klebsiella pneumoniae* was responsible for 17 isolates, followed by *Escherichia coli* and *Acinetobacter baumannii* in 14 and 12 isolates respectively.

Staphylococcus aureus was found in 5 isolates (Table 5).

Table 5: Distribution of different germs isolated.

Germs		Number (N)	Percentage (%)
BGN	*Klebsiella pneumoniae*	17	21,5
(n= 61; 77%)	*Escherichia coli*	14	17,7
	Acinetobacter baumannii	12	15,1
	Pseudomonas aeruginosa	10	12,6
	Enterobacter claocae	3	3,7
	Pseudomonas luteale	2	2,5
	Pseudomonas spp	2	2,5
	Morganella morganii	1	1,2
	Proteus mirabilis	1	1,2
CGP	*Staphylococcus aureus*	5	6,3
(n= 17; 23%)	*Staphylococcus xylosus*	4	5
	Staphylococcus hemoliticus	3	3,7
	Staphylococcus saprophyticus	3	3,7
	Staphylococcus epidermidis	1	1,2
	Staphylococcus spp	2	2,5

In the lungs, the bacteria most frequently encountered were *Escherichia coli* and *Klebsiella pneumoniae*. In the lungs, in order of frequency, we found *Acinetobacter baumanii*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* (Table 6).

Of the 79 germs isolated, one-third were sensitive to piperacilin/tazobactam, imipenem, fosfomycin and amikacin in 28.4%, 27%, 25.7% and 24.3% of cases respectively. Concerning the sensitivity profile:

- *Klebsiella pneumoniae* was 14.3% resistant to piperacillin/tazobactam, 50% to gentamicin and 28.6% to tetracycline. However, it was still 94% sensitive to imipenem and 79% to amikacin.
- *Escherichia coli* showed resistance to ofloxacin, ciprofloxacin, amikacin and ampicillin at 77%, 76.9%, 62.9%

and 15.4% respectively. However, sensitivity to carbopenems in particular was noted, with 78% to imipenem and 62% to meropenem, and fosfomycin remained very active at 85%.

Table 6: Distribution of number of germs according to site of infection.

Location	Germs	N	%
Urinary	*Escherichia coli*	11	31,4
(n= 35; 44, 3%)	*Klebsiella pneumoniae*	11	31,4
	Pseudomonas aeruginosa	5	14,3
	Acinetobacter baumannii	3	8,6
	Pseudomonas luteale	1	2,8
	Staphylococcus homoliticus	1	2,8
	Staphylococcus aureus	1	2,8
	Escherichia claocae	1	2,8
	Staphylococcus xylosus	1	2,8
Pulmonary	*Acinetobacter baumannii*	8	29,6
(n= 27; 34.2%)	*Pseudomonas aeruginosa*	4	14,8
	Klebsiella pneumoniae	4	14,8
	Staphylococcus aureus	3	11,1
	Staphylococcus xylosus	2	7,4
	Escherichia coli	1	3,7
	Pseudomonas luteale	1	3,7
	Morganella morganu	1	3,7
	Escherichia claocae	1	3,7
	pseudomonas mirabilis	1	3,7
	pseudomonas spp.	1	3,7
Bacteremia	*Klebsiella pneumoniae*	3	30
(n= 10; 12.6%)	*Staphylococcus spp.*	2	20
	Staphylococcus aureus	1	10
	Staphylococcus epidermis	2	20
	Staphylococcus xylosus	1	10
ILC	*Staphylococcus hemoliticus*	2	28,7
(n= 7; 8.8%)	*Staphylococcus saprophyticus*	1	14,2
	Acinetobacter baumannii	1	14,2
	Escherichia coli	2	28,7
	Escherichia claocae	1	14,2

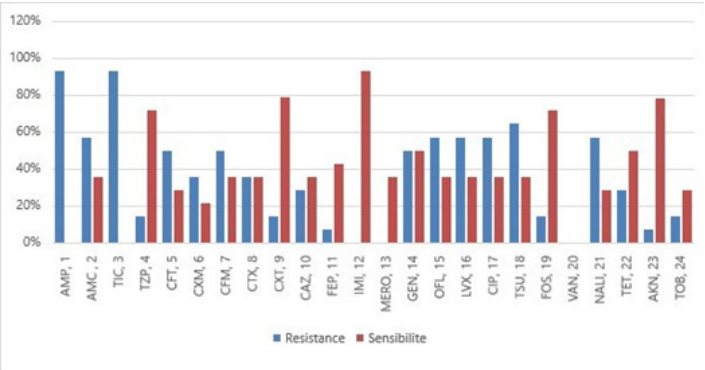

Figure 4: Sensitivity and resistance profile of *klebsiella pneumoniae.*

- Acinetobacter *baumanii* was 50% resistant to imipenem, 70% resistant to ticarcillin and more than 50% resistant to the beta-lactam antibiotics and quinolones tested. However, aminoglycosides remained sensitive, with amikacin at 50% and tobramycin at 40%.

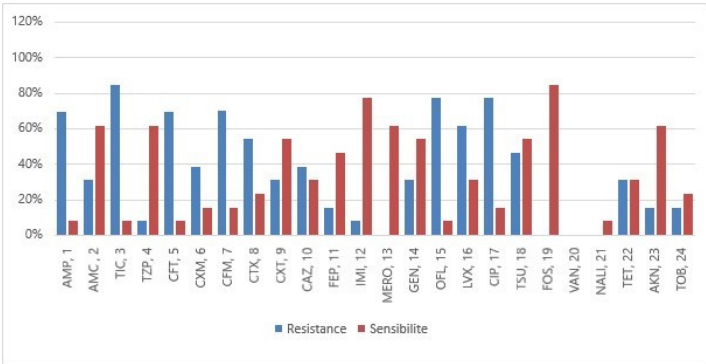

Figure 5: Susceptibility and resistance profile of *Escherichia coli.*

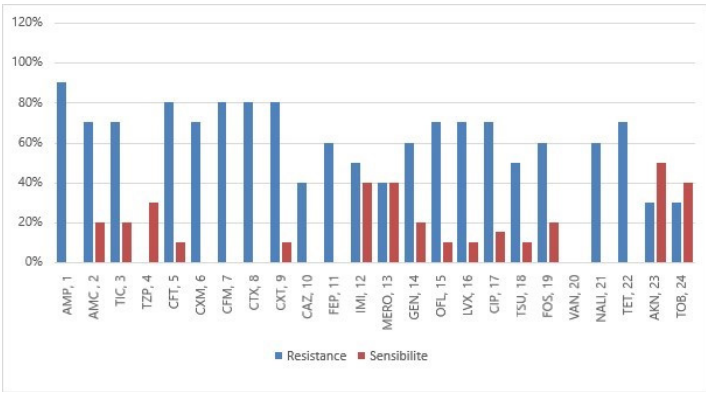

Figure 6: Sensitivity and resistance profile of *acinetobacter baumanii.*

- *Staphylococcus aureus* had 80% resistance to gentamycin and 40% to levofloxacin and ofloxacin. However, there was a 60% sensitivity to tetracycline and a 40% sensitivity to vancomycin.

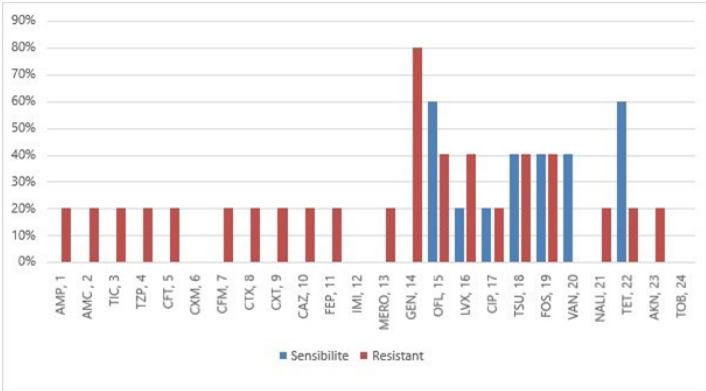

Figure 7: *Staphylococcus aureus* sensitivity and resistance profile.

AMP: amoxicillin; AMC: amoxicillin+ Clavulanic acid; TIC: ticarcillin; TZP: piperacillin + tazobactam; CFT: cefalotin; CXM: cefuroxime; CFM: cefexime; CTX: cefotaxime; CXT: cefoxitin; CAZ: ceftazidime; FEP: cefepime; IMI: imipenem; MERO: meropeneme; GEN: gentamicin; OFL: ofloxacin; LVX: levofloxacin; CIP: ciprofloxacin; TSU: cotrimoxazole FOS: fosfomycin; VAN: vancomycin; NALI: nalixidic acid; TET: tetracycline; AKN: amikacin; TOB: tobramycin.

In our series, multidrug-resistant bacteria (MDR) represented 39.2% (n=31) of the strains isolated (Table 8). Enterobacteriaceae producing extended-spectrum beta-lactamases (ESBL) accounted for 45.1% (n=14). Multi-resistant *Acinetobacter baumanii* accounted for 29% (n=9) and ceftazidime-resistant *pseudomonas aeruginosa* for 25.8% (n=1). Meticillin-resistant *Staphylococcus aureus* (MRSA) was not found.

Table 8: Breakdown of BMR isolated.

BMR	N	%
Enterobacteriaceae ESBL	14	45,1
Klebsiella pneumoniae	5	16,1
Escherichia coli	5	16,1
Enterobacter claocae	3	9,6
Morganella morganii	1	3,2
Multi-resistant *Acinetobacter baumanii*	9	29
Ceftazidime-resistant *Pseudomonas aeruginosa*	8	25,8

Of the 83 cases of nosocomial infections, antibiotic therapy was appropriate in 39.2% (n=29) of cases, and the imipenem/amikacin combination was sensitive in 48.2% (Figure 8).

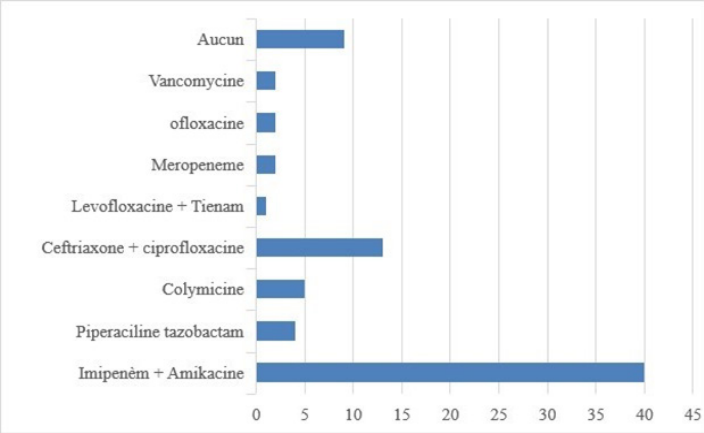

Figure 8: Secondary antibiotic therapy.

During the study, 27 deaths were recorded, representing 47% of cases.

A bivariate analysis revealed that the risk factors for NI included female gender, that its occurrence was not correlated with comorbidities or the reason for hospitalisation, and that its occurrence was significantly associated with the length of hospitalisation (Table 9).

In multivariate analysis, the poor prognostic factor found was length of hospitalisation ranging from 42 to 47 days.

Table 9: Risk factors for the occurrence of hospital-acquired infections.

	Total	IN		P
		N	OR [95% CI]	
Sex				
Male	243	34		
Female	250	49	1,71[1,02 - 2,86]	**0,0394**
Age				0,5317
[0-22]	28	7	1	
[22-43]	85	15	0,64 [0,24 - 1,87]	0,40
[44-65]	155	48	1,35 [0,56 - 3,61]	0,53
>65	66	13	0,74 [0,26 - 2,19]	0,57
Intubation				< 0,001
Yes	52	52		
No	199	26	0,13[0,07 - 0,22]	
Comorbidities				
HYPERTENSION	145	24	3,34[1,6-6,93]	0,8
Diabetes	74	10	37[12,37 -110,63]	
HIV	190	2		
Cancer	84	1	135,66[28,43 -647,23]	
Reason for hospitalisation	173	39	1,56[0,56- 4,37]	0,36
COVID 19	20	8	0,66[0,78 - 46,14]	
Febrile ACS STROKE	59	6	0,66[0,18 -2,46]	
Post-stroke polytrauma Length of hospital stay in days	12	4	2[0,42 - 9,41]	
[1-15]	263	33	1	
[16-30]	46	27	9,90[5,01 - 20,06]	< 0,001
>30	25	23	80,15[22,35 -514,22]	< 0,001

Discussion

The prevalence of IN in this study was 11.7%. This result is similar to several studies described in the literature, notably in Cameroon in 2013 by Njall et al. which was 12% [8], in Mali in 2019 by Abeghe who reported a prevalence of 12.3% [17] and in Morocco in 2014 by Maoulainine et al. with a prevalence of 13% [18]. This could be due to the characteristics of the population. Indeed, the mean age was 51 years and the mean length of hospitalisation was 28 days in the present study, which is comparable to the studies by Abeghe and Njall et al., which respectively had a mean age of 45.4 ± 20.8 years and 49.6 ± 1.8 years, as well as a length of hospitalisation of 21.7 ± 12.7 days and 11.7 ± 12.1 days. However, this rate is still lower than those reported in certain studies, notably Tunisia in 2018 by Merzougui et al., which was 30.6% [19], Algeria in 2022 by Benzaid et al., with a rate of 59% [20], and Brazil in 2014 by Santos et al., which was 27.3% [21]. This can be explained by the methodological approach chosen, which was different. These studies were prospective, which helped to reduce case wastage. Lower rates were found in China in 2019, in France in 2012 and in Nigeria in 2018, which reported a prevalence of 7.6%, 9.7% and 2.4% respectively [22-24]. These rates could be explained by the fact that the technical facilities in these intensive care units are much more advanced. In particular, the existence of partitioned cubicles, the presence of a water point in front of each cubicle and the fact that the control of infectious risks is very rigorous. According to Gastmeier et al., the prevalence of infections varies according to the level of technology and the size of the healthcare establishment [25].

Medical pathologies were the most frequent, with COVID-19 at the top of the list, accounting for 67.2%. This predominance of medical pathologies was also found in Gabon by Baderhwa.

Gabon, by Baderhwa in 2019 and by Ossaga in 2016 in Senegal with respective rates of 92.4% and 52% [16,25]. Contrary to the results observed by Merzougui et al. in Tunisia, by Nzoghé Nguéma et al. in Gabon and by Leye et al. in Senegal for whom traumatic pathology was the main reason for admission with rates of 53%, 27% and 28.8% respectively [5,15,26]. This difference can be explained by the fact that from 2020 to 2021, the HIAA intensive care unit was specifically dedicated to the management of patients suffering from the severe form of COVID-19. The absence of a trauma department within the HIAA also justifies the low rate of traumatic pathology obtained.

The average time to onset of NI was 10.5 days. This delay in onset is similar to that found in the study by Nouetchognou et al. in 2018 [27], which found an average of 11 days, and by Merzougui et al. in 2018, which was 10±2 days [5]. A study by Njall et al. found a delay of 4.4 ± 3.2 days [8]. This could be justified by the nurse-bed ratio, which was > 0.5. However, in the HIAA intensive care unit, this ratio was 0.4. A nurse-bed ratio > 0.5 significantly increases the risk of cross-infection [28]. Although our ratio could be improved like the one found in Australia, which was 0.2 [29]. In addition, the time taken to change certain invasive devices such as urinary catheters, VVCs and intubation tubes are factors which have an impact on the time taken for the onset and occurrence of HAIs.

Length of stay is an important risk factor for patients [29]. The most common length of stay was 10-20 days with 24 positive samples. Our results are similar to those of Baderhwa in Gabon in 2019, Benzaid et al. in Algeria and Arnoni et al. in India, who found a mean length of hospitalisation of 20.8 days ± 12.3 days, 12-21 days and 13 days respectively [16,20,30]. This observation can be explained by the fact that patients suffering from the severe form of COVID-19 only achieved a favourable outcome after a fortnight in the absence of other visceral failures. The onset of UTI after 10 days was also a factor in prolonging the length of hospital stay.

Urinary tract infection was the most frequent UTI, accounting for 42%. This predominance of urinary tract infections has also been described in the literature by Richard MJ et al. in the United States and by Branger et al. in France.

Branger et al. in France, who reported 31% and 40% respectively [31,32]. In Africa, particularly in Senegal and Mali in 2019, urinary tract infection was also in first place, with rates of 47.85% and 46.1% respectively [33,34]. These authors describe urinary catheterisation as the main risk factor for urinary tract infections. This is explained by the fact that all the patients were subject to bladder catheterisation. The failure to comply with asepsis rules when inserting a urinary catheter found several answers in this survey. These included non-compliance with written procedures for bladder catheterisation, failure to systematically rub or wash hands before the procedure, and insufficient staffing levels.

Nosocomial pneumopathies ranked 2nd with a frequency of 34%. This observation can be explained by the fact that, according to Touzani O., intubation increases the risk of occurrence of PN by 7 to 21 times [35]. This reinforces the results we obtained, in which 54% of patients had an IOT. The majority of patients were suffering from the severe pulmonary form of COVID-19 requiring mechanical ventilation. Placement on mechanical ventilation was not in itself a risk factor, but rather the management of the intubated patient: failure to respect suctioning schedules, which were not carried out in a closed suctioning system, making it necessary to disconnect patients from the ventilator for iterative suctioning; failure to respect aseptic measures during suctioning due to insufficient staff. It is important to note that the suction catheter was reused on the same patient, even though it had previously been immersed in a Betadine-enriched water solution. We also deplore the lack of asepsis of certain non-invasive oxygenation devices, such as bubblers, goggles and masks, which could be a source of contamination.

Bacteremia was the third most common type of infection, with a rate of 16%. This result is consistent with that of Abeghe TA, who found a rate of 14.8% [17]. This can be explained by the complications associated with localised infections, which are becoming more widespread due to delays in initiating specific treatment as a result of long waiting times for microbiological test results and reduced availability of antibiotics in hospital pharmacies. However, higher rates were found in the study by Dicko et al. and Savey A et al. with 44.8% and 21.9% respectively [33,36]. This difference can be explained by the low demand for blood cultures, since blood culture bags are not supplied by the hospital and are charged to the patient.

In microbiological terms, the literature shows that 50-90% of nosocomial infections are confirmed bacteriologically [37]. In this survey, microbiological confirmation was carried out for 79 of the 83 infectious episodes, with a predominance of BGN (77.2%). This observation has also been made in several countries around the world, including China in 2018, France in 2001, Cameroon in 2013 and Mali in 2022, with BGN rates of 60.5%, 84.6%, 76.5% and 40.1% respectively [1,8,32,33]. Among the bacteria isolated, *Klebsiella pneumoniae* was the most common germ (21.5%), followed by Escherichia *coli (*17.7%), *Acinetobacter baumannii* (15.1%) and *Pseudomonas aeruginosa* (12.6%). Similar results were also found in several studies, but at different frequencies. A multicentre study carried out in 27 hospitals found, in descending order, *Ecscherichia coli, Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Klebsiella pneumoniae* [38], while the study by Iliyasu et al. in Nigeria found *Staphylococcus aureus* (41.7%), *Klebsiella pneumoniae* (21.4%) *and Escherichia coli* (15.5%) [39]. As did Garba et al. in Niger with *Ecscherichia coli* (40%) followed by *Pseudomonas aerugenosa* (15.4%) [34]. In Gabon, this trend towards *Klebsiella pneumoniae* was also described by Mandji et al. in 2008 at the HIAOBO, by Nzoghé Nguéma et al., in 2015 at the CHUA, and in the two studies carried out at the CHUL in 2013 and again in 2019, which found it at 59.2%, 38.8%, 57.1% and 23.3% respectively [13-16]. These authors explain this predominance of BGN by: the use of non-chlorinated tap water for

cleaning patients' baths and bed linen; the absence of chlorhexidine during these baths. In fact, it has been documented that daily chlorhexidine baths for patients can help to control *Klebsiella* in hospital [36]; contamination by faecal germs such as *Escherichia. coli* and *Enterobacter* due to the lack of strict compliance with hand hygiene as a result of staff attrition, as described in the two studies carried out at the CHUL and in Niger in 2019, which found a low rate of compliance with hand hygiene by all staff, i.e. 29.4% and 11% respectively [16,40]. These explanations were also found in our study.

With regard to urinary tract infection, in descending order we found *Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa* and *Acinetobacter baumannii.* The germ most frequently found in the literature for UTIs is Escherichia coli [41-43]. According to some authors, this is justified by the fact that these infections are more frequent in female patients. This was the case in this study, where female patients predominated, with a sex ratio of 0.7. This observation argues in favour of exogenous contamination linked either to anatomical proximity to the perineum or to being worn during care. In the lungs, the main germs were *acinetobacter baumannii, Pseudomonas aeruginosa, Klebsiella pneumoniae* and *Staphylococcus aureus*. These results are in line with the work of Qassimi [44] and Amor et al., who found *Acinetobacter baumannii* to be the predominant germ, and *Pseudomonas aeruginosa* to be the second germ of NPs according to these authors [45]. On the other hand, Shimi et al. found *Pseudomonas aeruginosa* to be in the forefront. BGN are responsible for more than 60% of PN [46]. More recent studies have found *Acinetobacter baumannii* to be the most frequent germ [46-48]. These bacteria produce "slime" (a polysaccharide substance that promotes adhesion to the surface of inert materials), which increases their ability to colonise intubation tubes and, once implanted, to resist antibiotics and phagocytosis. The main germs responsible for nosocomial bacteraemia in our work were *Klebsiella pneumoniae, Staphylococcus spp* and *Staphylococcus aureus.* This is similar to the studies by Samake [42] who found a predominance of *Klebsiella pneumoniae*, followed by *Escherichia coli* and *Staphylococcus aureus*, and by Qassimi who found a predominance of *Staphylococcus aureus* followed by *Klebsiella pneumoniae* [44]. On the other hand, Savey A et al. found a predominance of Staphylococcus coag - (22%) in bacteremia [41]. Humans are the main reservoir of Staphylococcus aureus, whether they are sick or healthy carriers. Usually found on the skin, staphylococci can be transmitted by hand. This difference in the number of germs isolated between the studies can be explained by the variability of bacterial ecology between the facilities.

BGN are naturally resistant to a large number of antibiotics. *Klebsiella pneumoniae* was highly resistant to penicillins, in particular ampicillin (92.9%) and amoxicillin clavulanic acid (57.1%). It was also resistant to the quinolones ofloxacin (50%) and ciprofloxacin (57.1%). However, imipenem, amikacin and piperacillin/tazobactam remained highly active at 92.9%, 78.1% and 71.4% respectively. These results are in agreement with those of Ossaga in Senegal, who found *klebsiella pneumoniae* sensitive to imipenem and amikacin at unspecified levels. Resistance to ampicillin and amoxicillin-clavulanic acid was observed in all strains, while resistance to quinolones was 29.1% [25]. For *Escherichia coli*, sensitivity to beta-lactam antibiotics was 76.9% for imipenem, 62% for amoxicillin + clavulanic acid and 61.5% for meropenem. Resistance to quinolones was 77% for ofloxacin and 76.9% for ciprofloxacin. Resistance to 3rd generation cephalosporins such as cefixime was 69.7%, cefotaxime 53.8% and cefalotin 69.2%. For *Acinetobacter baumanii*, resistance to quinolones was 70% for ciprofloxacin, ofloxacin and levofloxacin; betalactam antibiotics, notably ampicillin at 90% and amoxicillin clavulanic acid at 70%; and cefotaxime, cefixime and cefuroximen at 80%. Sensitivity was 50% for amikacin, and 40% for imipenem and meropenem. Sensitivity to *Staphylococcus aureus* was 60% for fosfomycin and 33.3% for amikacin. Resistance to aminoglycosides such as gentamicin and tobramycin was 80% and 40% respectively, and to quinolones including ofloxacin and levofloxacin 40%. Resistance to certain aminoglycosides, such as gentamicin (50%) and sensitivity to amikacin (100%), was found by Njall et al. in Cameroon [8].

In our series, the bacterial sensitivity profile showed 37.8% BMR. This is similar to the results obtained by Trubiano and Padiglione in Australia and Zilberberg et al. in the United States [49-51]. This multi-resistance could be explained by: the accumulation of natural and/or acquired resistance, and the frequent use of non-targeted antibiotic therapy.

The case-fatality rate was 47%, which is similar to the results obtained in Tunisia (44.7%) [5] and Senegal (48%) in 2016. Other researchers have reported lower mortality rates, for example the Réseau REA-Raisin in France which was 16.7% [3] and Vincent et al. in the United States who found 25% [52]. The higher mortality observed in this study compared with that reported in developed countries may be explained by the low availability of suitable ATBs, resulting in delays in their administration, and the absence of devices such as extracellular membrane oxygenation and haemodialysis for multi-visceral failure such as severe ARDS and ARF.The direct responsibility of IN in the occurrence of death is difficult to establish, particularly in patients with multiple pathologies, immunodepression or multiple visceral failures [53]. In fact, a French study showed no significant excess mortality from these infections after adjusting for the severity of the patients before the infection occurred [54]. However, it is accepted that nosocomial infections are the cause of increased mortality and morbidity [8].

In a bivariate analysis with logistic regression, the factors associated with the occurrence of hospital-acquired infections were: female gender, intubation and length of hospital stay. This result is consistent with that of Amazian et al. in a multicentre study involving 27 hospitals, which found that risk factors included a stay of more than eight days, urinary catheterisation, the presence of a central catheter, ventilation, age and female gender [38]. Length of hospital stay was associated with the prevalence of hospital-acquired infections. This relationship is logical, especially as the

risk of acquiring a UTI increases in patients who stay longer in intensive care. Bladder catheterisation was not studied because the entire study population had bladder catheterisation.

Age between 52 and 67 and IGSII score were found to be poor prognostic factors. The germ isolated and the site of infection were not correlated with death. This result may be explained by the small number of different germs found. The IGSII score was associated with mortality. This correlation can be explained by the fact that severe patients had a reduced probability of survival.

Conclusion

The prevalence of nosocomial infections in intensive care units remains high and is dominated by urinary tract infections, followed by pneumonia. The majority of pathogens found were gram-negative Bacile resistant to first-line antibiotics. These UTIs were mainly linked to carriage, the presence of invasive medical devices, and mortality due to the low availability of suitable ATBs.

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