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Analysis of antibiotic resistance in a hospital hemodialysis unit

Analyse de la résistance aux antibiotiques dans une unité hospitalière d'hémodialyse

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Article Original

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ABSTRACT

Background: Bacterial infections represent a major cause of complications in hemodialysis patients due to their likely immunosuppressed state. The growing emergence of multidrug-resistant bacteria worsens the situation and limits therapeutic options, thereby increasing morbidity and mortality in this population. The aim of this study was to analyze the antibiotic resistance profile of bacteria isolated in the hemodialysis unit of Douala General Hospital (HGD).

Methods: We conducted a descriptive cross-sectional study over a four-month period, during which 411 samples were collected from patients and service surfaces. Antibiotic susceptibility was assessed using agar-based antibiograms. Data were analyzed using R software.

Results: The prevalence of multidrug-resistant bacteria was 45%. Among these bacteria, 59.4% of Staphylococcus aureus strains were methicillin-resistant (MRSA), and 89.7% of Enterobacteriaceae produced extended-spectrum beta-lactamases (ESBLs). High resistance rates were observed for aminoglycosides (44.4%), quinolones (36.1%), and macrolides (12.9%). All Pseudomonas aeruginosa strains were resistant to ceftazidime.

Conclusion: The high levels of bacterial resistance observed highlight the need to strengthen infection prevention measures, optimize antibiotic use, and implement strict microbiological surveillance to limit the spread of multidrug-resistant organisms (MDROs) in hemodialysis units.

RESUME

Introduction : Les infections bactériennes représentent une cause majeure de complications chez les patients hémodialysés chroniques en raison de leur immunodépression probable. L'émergence croissante de bactéries multirésistantes aggrave la situation et limite les options thérapeutiques favorisant la morbi-mortalité ces patients. Le but de cette étude était d'analyser le profil de résistance des bactéries aux antibiotiques à l'unité d'hémodialyse de l'Hôpital Général de Douala (HGD).

Méthode : Nous avons conduit une étude transversale descriptive sur une période de quatre mois au cours de laquelle 411 prélèvements ont été effectués sur les patients et sur les surfaces du service. La sensibilité aux antibiotiques a été évaluée par antibiogramme en milieu gélosé. Les données ont été analysées avec le logiciel R.

Résultats : La prévalence des bactéries multirésistantes était de 45 %. Parmi ces bactéries, 59,4 % des souches de Staphylococcus aureus étaient Méti-R, 89,7 % des entérobactéries produisaient une bêta-lactamase à spectre élargi présentaient des résistances élevées aux aminosides (44,4 %), aux quinolones (36,1 %) et aux macrolides (12,9 %). Toutes les souches de Pseudomonas aeruginosa étaient résistantes à la ceftazidime.

Conclusion : Les taux élevés de résistance bactérienne observée soulignent l'importance de renforcer la prévention des infections, d'optimiser l'utilisation des antibiotiques et de mettre en place une surveillance microbiologique stricte pour limiter la propagation de BMR dans ces services

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Introduction

Hemodialysis patients are especially vulnerable to bacterial infections, a major complication that jeopardizes both their survival and quality of life. Beyond their relative immunosuppression and frequent comorbidities, these patients rely on repeated vascular access and on multiple medical devices, factors that create a direct portal for pathogens [1,2]. In many low- and middle-income settings such as ours, dialysis units are tucked inside general hospitals. This “closed-circle” care model concentrates large numbers of fragile patients in confined spaces, often with limited staffing, inadequate microbiological surveillance, and suboptimal environmental controls. Such conditions amplify the risk of nosocomial transmission and accelerate the spread of multidrug-resistant organisms (MDROs) [3,4].

Once established, infections can quickly escalate to bacteremia or sepsis, and the persistence of suboptimally treated episodes’ further fuels resistance. Overcrowding, sporadic infection-control audits, and the still common empirical—or sometimes abusive—use of broad-spectrum antibiotics create sustained selective pressure, favoring the emergence of bacteria that evade multiple antibiotic classes [5]. In turn, MDRO infections prolong hospital stays, inflate healthcare costs, and carry considerably higher mortality among chronically dialyzed patients [6,7].

A granular understanding of the local microbiological landscape is therefore indispensable. Mapping the prevalent bacterial species and their resistance profiles within each dialysis center will not only refine empiric treatment guidelines but also guide targeted prevention and stewardship strategies. Ultimately, strengthening routine microbiological surveillance, enforcing rigorous infection-control measures, and rationalizing antibiotic use are critical steps toward safeguarding the care of hemodialysis patients in hospital-based units.

Materials and Methods

We carried out a descriptive cross-sectional study over four months, from 8 March to 30 June 2023, in the hemodialysis center of Douala General Hospital, one of the largest dialysis facilities in Cameroon. The target population comprised all chronic or acute hemodialysis patients treated in the center during the study period and the various surfaces and devices in the dialysis room—treatment tables, chairs, machine consoles, benches, door handles, and so forth. Consenting patients and surfaces actively involved in the dialysis circuit were included. We excluded incomplete or contaminated specimens, patients who declined participation or were dialyzed emergently elsewhere, and any surfaces taken out of service during the study. Sampling followed strict aseptic protocols. Blood cultures were drawn before machine hookup after rigorous skin disinfection. Mid-stream urine samples were collected in sterile jars following patient instructions. Vascular or urinary catheter tips, removed during line change, were placed in sterile vials containing normal saline. When present, ascitic fluid was aspirated aseptically by a clinician. For environmental sampling, sterile swabs moistened with normal saline swept predefined areas before and after disinfection. All specimens were transported immediately to the laboratory. Cultures were inoculated onto standard media (EMB agar, Chapman agar, CLED, enriched chocolate agar, etc.) and incubated. Resulting colonies were identified with the automated VITEK® system, and antibiotic susceptibility was determined according to EUCAST guidelines. This approach aimed to map the bacteriological landscape of the center, characterize resistance profiles, and ultimately inform both preventive measures and antibiotic therapy for hemodialysis patients.

The evaluation of bacterial resistance profiles was performed using the antibiotic disk diffusion method on Mueller-Hinton agar, in accordance with EUCAST 2019 recommendations [8]. A standardized inoculum (0.5 McFarland) was spread onto the agar plate, and antibiotic-impregnated disks were placed on the surface. After 18 to 24 hours of incubation, inhibition zone diameters were measured to determine susceptibility, intermediate resistance, or resistance, referring to EUCAST standards (Table I). Result validation and quality control were ensured daily by the technical supervisor. After identification or incubation, bacterial and sterile samples were destroyed, and used Petri dishes were decontaminated prior to disposal.

Data were entered into an Excel spreadsheet (Microsoft Office, USA) and imported into R software version 4.4.2 for Windows Professional. Categorical variables were presented as frequencies (N, n) and percentages (%) in tables and graphs.

Table 1: Antibiotic Classes and Disk Concentrations for Susceptibility Testing

Antibiotic Class	Antibiotic	Concentration (µg)
Beta-lactams - Penicillins	Ampicillin	10
	Cloxacillin	10
	Amoxicillin/ Clavulanic Acid	20 + 10
	Oxacillin	10
	Ticarcillin	10
	Piperacillin	10
Beta-lactams - Cephalosporins	Ceftriaxone	30
	Ceftazidime	30
	Cefoxitin	30
	Cefixime	30

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Antibiotic Class	Antibiotic	Concentration (µg)
Aminoglycosides	Amikacin	30
	Gentamicin	10
	Tobramycin	10
	Kanamycin	30
Tetracyclines	Tetracycline	10
Carbapenems	Imipenem	10
	Meropenem	10
	Ertapenem	10
Macrolides	Erythromycin	10
	Clindamycin	30
Quinolones	Levofloxacin	15
	Ciprofloxacin	20
	Ofloxacin	30
Miscellaneous	Nitrofurantoin	30
	Colistin	10
	Fosfomycin	10
	Fusidic Acid	30
	Vancomycin	30
	Rifampicin	30

Table 2: Interpretation Criteria for Critical Diameters in Antibiotic Susceptibility Testing

Measured Diameter (Ø)	Interpretation
Ø ≥ Critical Diameter Lower Limit (D_CCinf)	Susceptible (S)
Ø < Critical Diameter Lower Limit (D_CCinf)	Resistant(R)
Critical Diameter Upper Limit (D_CCsup) ≤ Ø < Critical Diameter Lower Limit (D_ CCinf)	Intermediate (I)

Results

Figure 1 shows the resistance profile of Burkholderia cepacia to various antibiotics. The results reveal high resistance rates to most antibiotics tested. The highest resistance rates were observed for ampicillin (81.7%), meropenem (85.8%), and rifampicin (80.7%). Significant resistance was also recorded for piperacillin (75.0%), ertapenem (73.4%), and colistin (65.1%).

Conversely, relatively low resistance levels were noted for certain antibiotics, such as imipenem (7.0%), levofloxacin (3.0%), and fosfomycin (5.1%), indicating that Burkholderia cepacia exhibits a strong resistance capacity. These results highlight the importance of selecting antibiotics carefully in clinical management to avoid therapeutic failures (Figure 1).

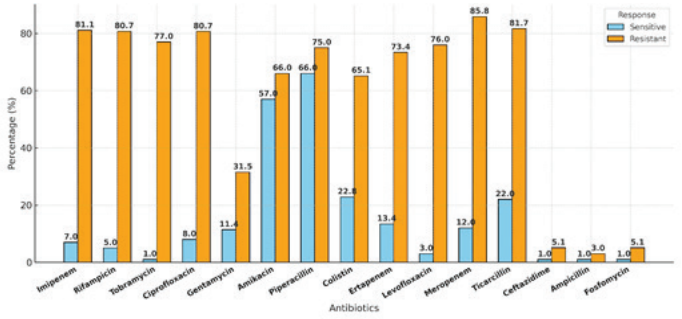

Figure 1: Resitance profile of Burkholderia cepacia to Antibiotics

Figure 2 presents the resistance profile of Escherichia coli to various antibiotics. The results show high resistance rates for the majority of antibiotics tested, with particularly marked resistance rates for ampicillin (91.7%), cefixime (91.7%), and cefotaxime (91.7%). Other antibiotics such as piperacillin (75%), amoxicillin-clavulanic acid (83.3%), and ertapenem (73.4%) also exhibited high resistance levels.

Conversely, relatively lower resistance rates were observed for certain antibiotics such as imipenem (58.3% sensitivity), amikacin (31.5%), and gentamicin (11.4%). Resistance was nearly universal for some antibiotics like levofloxacin and meropenem, with only 3% sensitivity (Figure 2).

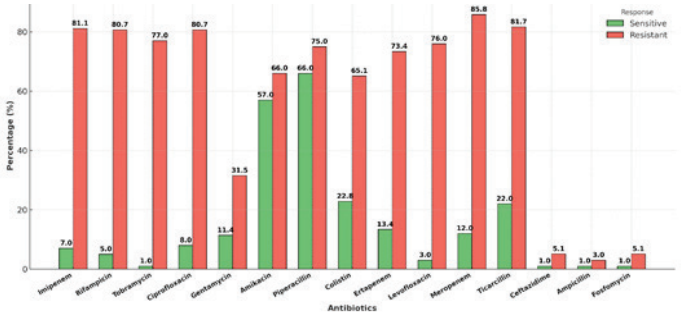

Figure 2: Resistance profile of Escherichia coli to antibiotics

Figure 3 presents the resistance profile of Pseudomonas aeruginosa to the antibiotics tested. The results show very high resistance rates for many antibiotics, notably ceftazidime (100%), piperacillin (85.8%), rifampicin (80.7%), and tobramycin (77%). These antibiotics appear to be almost entirely ineffective against this pathogen in this setting.

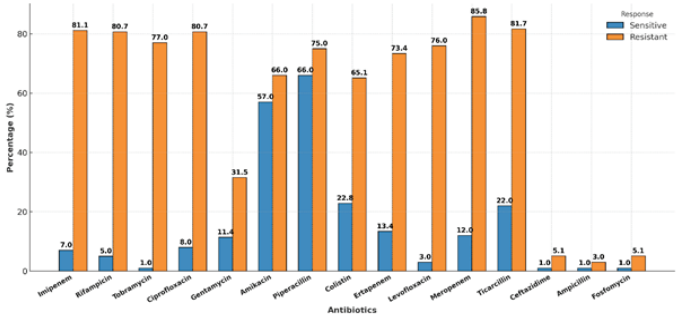

Figure 3: Resistance profile of pseudomonas aeruginosa to antibiotics

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Figure 4 illustrates the resistance profile of Klebsiella pneumoniae to various antibiotics. The results show very high resistance rates for most of the antibiotics tested, notably for cefixime, ceftazidime, ampicillin, cefotaxime, and amoxicillin-clavulanic acid, where resistance reached 100%. Other antibiotics, such as piperacillin (92.8%), colistin (85.7%), and gentamicin (64.2%), also exhibited concerning resistance rates.

However, significant sensitivity was observed for antibiotics such as imipenem (71.4%), amikacin (57.1%), and meropenem (66.6%), suggesting that they may be more effective in the treatment of infections caused by Klebsiella pneumoniae (Figure 4).

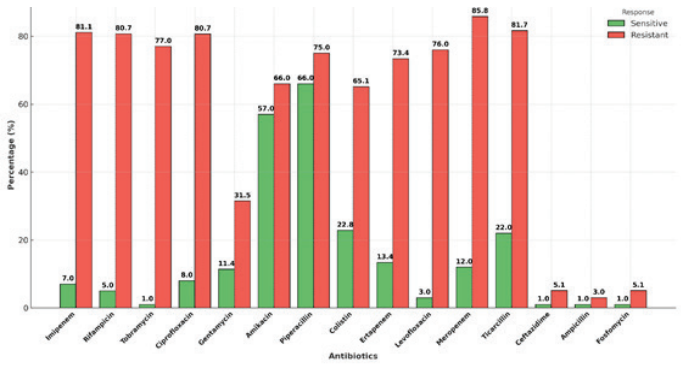

Figure 4: Resistance profile of Klebiella pneumoniae to Antibiotics

Figure 5 illustrates the resistance profile of Staphylococcus aureus to the antibiotics tested. The results reveal high resistance rates for many antibiotics, notably clindamycin, cotrimoxazole, fusidic acid, and erythromycin, with resistance rates reaching 62.5% or higher. In contrast, complete sensitivity (100%) was observed for gentamicin, while moderate sensitivities were noted for tobramycin (75%) and ciprofloxacin (75%) (Figure 5).

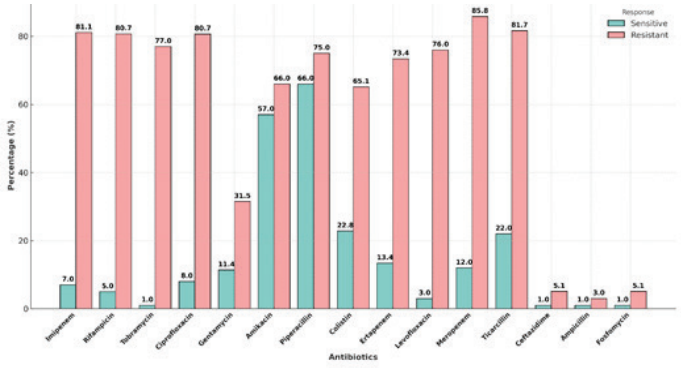

Figure 5: Resistance profile of Staphylococcus aureus to anbiotics

Discussion

Our study aimed to analyze the antibiotic-resistant bacterial profile in the hemodialysis unit of Douala General Hospital, notably to map multidrug-resistant bacteria (MDRB) and their antibiotic-susceptibility patterns. Among the 411 samples analyzed, almost half (45 %) harbored an MDRB. Specifically, 59.4 % of Staphylococcus aureus isolates were methicillin-resistant, 89.7 % of Enterobacterales produced an extended-spectrum β-lactamase—showing high resistance rates to aminoglycosides (44.4 %), quinolones (36.1 %), and, to a lesser extent, macrolides (12.9 %)—while all Pseudomonas aeruginosa isolates were non-susceptible to ceftazidime. These findings attest to substantial antibiotic pressure and an alarming spread of MDRB among immunocompromised patients and potentially contaminated surfaces, underscoring the urgent need to strengthen infection-prevention measures, rationalize antibiotic use, and implement strict microbiological surveillance to curb the dissemination of these highly resistant pathogens.

The 45% prevalence of multidrug-resistant bacteria (MDROs) observed in our study reflects the growing severity of antimicrobial resistance, particularly in hospital settings in low- and middle-income countries such as Cameroon. This prevalence aligns with findings from similar studies conducted in Africa, such as one carried out in Dakar, which reported a high presence of MDROs, notably extended-spectrum beta-lactamase (ESBL)-producing Enterobacteriaceae, highlighting similar challenges in managing nosocomial infections [9,10]. In Europe, a multicenter study conducted by the BMR-Raisin network also reported a comparable prevalence of ESBL-producing strains and methicillin-resistant Staphylococcus aureus (MRSA) in hospital units [11]. However, although concerning, our prevalence remains slightly lower than that reported in certain other African regions, which may be attributed to differences in infection management practices, antibiotic use, or data collection methodologies [12].

The Escherichia coli isolates (11.4%) demonstrated high resistance rates to aminoglycosides (44.4%) and quinolones (36.1%), consistent with observations made in Abidjan and Ouagadougou [13,14]. A study conducted in Niger similarly reported resistance to quinolones and aminoglycosides among clinical isolates of E. coli [15]. Such resistances could result from the overuse of these antibiotic classes, often empirically prescribed for urinary tract infections without prior microbiological confirmation. Our findings underscore the importance of proper management of E. coli infections in hemodialysis units, where these bacteria can easily spread due to the frequent use of catheters and medical devices.

Regarding Staphylococcus aureus, the results showed that 59.4% of the isolates were methicillin-resistant (MRSA). This rate is consistent with findings from studies conducted in West Africa, particularly in Cocody-Abidjan, where similar proportions were reported [16]. Globally, studies in Europe and North America have reported varying MRSA rates, often lower in regions with rigorous infection control

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measures [17]. These results highlight the importance of preventing MRSA infections, especially among hemodialysis patients. A study by Mahoudeau et al. in Strasbourg also documented the necessity of systematic screening for nasal carriers of S. aureus to prevent transmission [18].

Finally, the complete resistance of Pseudomonas aeruginosa to ceftazidime (100%) is particularly alarming. This finding is consistent with data from similar studies conducted in Yaoundé, where a high proportion of multidrug-resistant strains was also identified [19]. A study in France reported that resistance of P. aeruginosa to carbapenems and cephalosporins constitutes a major cause of morbidity and mortality in nosocomial infections [20]. This pathogen, known for its ability to develop intrinsic resistance to a wide range of antibiotics, represents a major challenge for treating hospital-acquired infections. These findings emphasize the need for rational use of last-resort antibiotics, such as colistin, and increased surveillance to limit the spread of these strains.

Although consistent with published data, our study provides a unique contribution by focusing on a population of hemodialysis patients—a particularly vulnerable group. Unlike most studies that focus on intensive care units or urinary infections, our approach provides specific and actionable data to improve infection management in hemodialysis units.

Conclusion

Our findings offer important perspectives for optimizing antibiotic treatments in hemodialysis settings, strengthening infection prevention and control measures, and guiding public health policies for more effective antibiotic management. However, further efforts are needed to integrate these data into broader strategies against nosocomial infections and antimicrobial resistance.

Ethical Approval and Consent to Participate: The study received administrative authorisation and ethical approval from the General Hospital of Douala. Written informed consent to participate in this study was provided by the legal guardians/next of kin of the participants.

Availability of Data and Equipment: The original data supporting the conclusions of this article will be made available by the authors without undue reservation.

Conflicts of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Authors' Contributions: ENLPJ designed the experimental approach and the writing plan. ENLPJ and NNE recruited the participants and conducted the laboratory analyses. ENLPJ performed the statistical analysis and prepared all the figures. ENLPJ drafted the manuscript. ENLPJ, NNA, and FMEHD reviewed the manuscript. All the authors made substantial, direct, and intellectual contributions to the work and approved it for publication.

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References

1. Safdar N, Maki DG. The Pathogenesis of Catheter-Related Bloodstream Infection with Noncuffed Short-Term Central Venous Catheters. Critical Care Medicine. 2002;30(1):62–7.
2. Li PK, Szeto CC, Piraino B, de Arteaga J, Fan S, Figueiredo AE, et al. ISPD Peritonitis Recommendations: 2016 Update on Prevention and Treatment. Peritoneal Dialysis International. 2016;36(5):481–508.
3. Tacconelli E, Carrara E, Savoldi A, Harbarth S, Mendelson M, Monnet DL, et al. Discovery, research, and development of new antibiotics: the WHO priority list of antibiotic-resistant bacteria and tuberculosis. Lancet Infect Dis. 2018;18(3):318–27.
4. Facciolà A, Pellicanò GF, Visalli G, Paolucci IA, Rullo EV, Ceccarelli M, et al. The role of the hospital environment in healthcare-associated infections: a general review of the literature. European Review for Medical and Pharmacological Sciences. 2019;23(3):1266–78.
5. Bourgain C, Bertrand M, Seringe E. Les bactéries hautement résistantes émergentes en service d'hémodialyse et de néphrologie : pertinence des prélèvements systématiques. La Revue du Praticien. 2020;70(7):755–9.
6. Kliger AS. Maintaining Safety in the Dialysis Facility. Clinical Journal of the American Society of Nephrology. 2015;10(4):688–95.
7. Soussy CJ. Résistance bactérienne aux antibiotiques. La Revue du Praticien. 1986;36(5):759–64.
8. The European Committee on Antimicrobial Susceptibility Testing (EUCAST). Breakpoint tables for interpretation of MICs and zone diameters. Version 9.0, 2019. Available at: http://www.eucast.org.
9. Eno Ngoyi, Moyen R, Nguimbi E, Kobawila SC. Resistance to quinolones of bacteria responsible for urinary tract infections at the University and Hospital Center. Annals of Health Sciences. 2016;12(3):45-52.
10. Okallaa Ebongue C, Tsiazok MD, Mefo'o JP, Ngaba GP, Beyiha G, Adiogo D. Sensitivity and evolution of antibiotic resistance of Escherichia coli isolates at Douala General Hospital. Journal of Infection and Public Health. 2021;14(3):179-185.
11. Eyebe S, Ayangma C, Kona S, Iroume C, Zoumabo AC, Lyongha E, et al. Antibiotic resistance profile and risk factors for colonization by multidrug-resistant Pseudomonas aeruginosa: A retrospective study over 4 years. Pan African Medical Journal. 2020;25:250-258.
12. Sbiti M, Lahmadi K. Epidemiological profile of extended-spectrum β-lactamase-producing uropathogenic Enterobacteriaceae. Moroccan Journal of Microbiology. 2018;10(2):75-83.
13. Arnaud I, Jarlier V, Carbonne-Berger A, Maugat S, Bajolet O, Dumartin C, et al. Multidrug-resistant bacteria (MDR) in hospital settings: extended-spectrum β-lactamase-producing Enterobacteriaceae (ESBL) and methicillin-resistant Staphylococcus aureus (MRSA). BMR-Raisin Network Report. 2002-2010;18(4):225-238.
14. Mhaya A. Study of antibiotic resistance mechanisms in hospitalized patients using culturomics, genomics, and metagenomics approaches. Thesis. Tunis: University of Tunis; 2017.

15. EUCAST: European committee on antimicrobial susceptibility testing. EUCAST QC Tables V1.2. 2020. Available from: https://www.eucast.org.

16. Mahoudeau I, Elkhaïli H, Delabranche X, Freitas I, Meunier O, Prevost G, et al. Epidemiology of Staphylococcus aureus infections in Strasbourg hospitals. Journal of Hospital Epidemiology. 2015;25(2):102-108.

17. Infection of the Burkholderia cepacia complex in an adult cystic fibrosis unit in Madrid. Enfermedades Infecciosas y Microbiología Clínica. 2013;31(5):362-369.

18. Freeny J, Croze M. Enterobacteriaceae and their antibiotic resistance: General information in Clinical Bacteriology Handbook. 2nd ed. Paris: ESKA. 2017;87-189.

19. Koffi-Nevry R, Koussemom M, Apata A, Edoh V, Kakou C. Prevalence of Salmonella, Escherichia coli, and Staphylococcus aureus in food and fecal material from hospital environments in Abidjan. African Journal of Microbiology Research. 2017;12(5):356-362.

20. Njall C, Eyebe S. Bacterial ecology of nosocomial infections in the intensive care unit of Laquintinie Hospital in Douala (Cameroon). Pan African Medical Journal. 2013;14:140.

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