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Incidence and risk factors of healthcare-associated infections in nine hospitals across three health regions in Guinea

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Abstract

Introduction: *healthcare-associated infections (HAIs) are a major public health problem, particularly in Guinea. The study aimed to determine the incidence and risk factors for the occurrence of HAIs.* ***Methods:*** *this prospective cohort study was conducted between August 2022 and January 2024 in the Conakry, Kankan, and Nzérékoré regions. The incidence of HAIs was calculated per 1,000 person-days, and a Cox regression model was used to identify risk factors.* ***Results:*** *among 6,759 patients (median age: 28 years) with a median hospital stay of 6 days (IQR: 3-9), 1,196 had HCAIs, with an incidence of 28.15 per 1,000 person-days [95% CI: 26.60%-29.80%]. Surgical site infections (SSIs) accounted for 86.45% of cases. Independent risk factors included health region (aHR = 0.46; p-value < 0.001), facility category (aHR = 3.05; p-value = 0.027), gender (aHR = 1.23; p-value = 0.006), diabetes (aHR = 1.79; p-value < 0.001) and timing of procedures (aHR = 1.45; p-value < 0.001).* ***Conclusion:*** *this study indicates high incidence rates despite existing prevention efforts. It highlights the need to improve prevention strategies by emphasizing follow-up on surgical schedules and paying attention to medical history, such as diabetes.*

Introduction

Healthcare-associated infections (HAIs) represent a significant public health problem worldwide due to their frequent occurrence, the complexity of their management, including multi-resistant germs leading to antimicrobial resistance, the occurrence of serious medical complications, and their socio-economic cost [1-4]. These infections are neither present on admission nor incubating in the patient at the start of treatment. They occur after 48 hours in hospital, within 30 days of surgery, or within 12 months in the case of implants or prostheses [1,5,6]. Healthcare-associated infections are one of the leading causes of morbidity and mortality in hospitals, especially in developing countries. Every year, hundreds of millions of patients contract HAIs during their hospital stay [1,4,6-8].

The data available in the literature show that the prevalence and types of HAIs vary considerably from one country to another [9-14]. The lowest rates are observed in developed countries, where these infections affect between 3% and 7% of hospitalised patients [10,11,14]. In the United States, a multi-state survey conducted in 183 hospitals revealed a point prevalence of 4% of HAIs. The most frequent infections were pulmonary, surgical site, and gastrointestinal [10].

In Europe, a surveillance study carried out in 2018 in 28 countries of the European Union and the European Economic Area estimated a prevalence of HAIs of between 3.9% and 6.5% [11].There is limited data on the occurrence of HAIs in sub-Saharan African countries [6,9,15-17]. Available data indicate that HAIs affect 5 to 15% of patients hospitalised in general wards (such as general medicine, paediatrics, pneumology, etc.) and up to 50% or more of patients in intensive care units [9,16,17]. A previous study on the incidence of HAIs in maternity wards in Mbujimayi, Democratic Republic of Congo, reported an overall incidence of 24.8% among women who had given birth [8]. In Benin, a study examining the factors associated with surgical wound infections at the Ouidah Zone Hospital in the surgical and gynaecological-obstetrics departments from 2006 to 2007 reported a prevalence of 22.8% [18].

In Guinea, few studies have been carried out on the incidence of HAIs. The available data are primarily based on prevalence studies, which are limited in scope [1,7,19]. Continuous incidence surveys, however, are essential for effective surveillance of HAIs in health services. A previous

study performed in 2016 reported a 20% prevalence of HAIs in two hospitals in Conakry [1]. An evaluation of the impact of the implementation of the WHO "hand hygiene" action plan at Faranah Regional Hospital highlighted its effectiveness, except for midwives [19]. A 2022 study conducted by Diallo *et al*. in three national hospitals in Conakry reported that 54.17% of 120 patients sampled 48 hours or more after admission to surgical units had HAIs [7].

The validity of these results is limited by the small number of patients included. While infection prevention and control (IPC) is well organized in developed countries, it is less so in developing countries. The lack of representative surveillance data over time and the failure to consider the conditions and production logic of infection prevention and control make it difficult to identify ways to improve the situation [2,15,20]. We conducted a prospective study over 18 months to examine HAIs in Guinea, incorporating ethnographic field data developed in parallel. This data focuses on actors of infection prevention and control and the culture of hospital hygiene in Guinea. the objective of the study was to determine the incidence and risk factors associated with the occurrence of HAIs and the socio-cultural and professional context of their occurrence in Guinea.

Methods

Study framework: the implementation of a pilot IPC project initiated by the Guinean government in collaboration with Expertise France resulted in the development of certain strategies. These strategies aimed at strengthening IPC in health facilities across three regions of Guinea (Conakry, Forest Guinea, and Upper Guinea) by developing a mixed-method survey combining anthropology and public health. The public health component aimed to assess the prevalence and incidence of healthcare-associated infections at the project sites. Concurrently, the socio-anthropological component aimed to describe and analyse the conditions, logics, and practices of IPC, providing an empirical account of the project's impact on healthcare workers and on the hygiene culture.

Study site: the study was conducted in nine public and private health facilities in the Conakry, Kankan, and Nzérékoré health regions (Figure 1). These facilities included public and private hospitals at all levels of the health pyramid: municipal hospitals, prefectural and regional hospitals, and the national hospital. The primary criterion for including a facility was the presence of a department where surgery was performed. In the Conakry health region, the selected facilities were the Ignace Deen University Hospital, the Matam Municipal Medical Centre, and the AKO polyclinic in Ratoma. In the Kankan health region, the selected facilities were the Kankan Regional Hospital, the Siguiri Prefectural Hospital, and the Doctor Seny Keita Medical-Surgical Clinic. In the Nzerekoré health region, the selected facilities were the Nzerekoré Regional Hospital, the Gouécké Improved Health Centre, and Huguette Clinic.

Description of the study sites

Conakry region

Ignace Deen National Hospital: located on the Kaloum peninsula in Conakry, Ignace Deen National Hospital is a tertiary-level referral medical establishment in the Guinean healthcare system. Although it offers general care, it concentrates most of the medical and surgical specialties, particularly in maternity, surgery, urology, and traumatology. Affiliated to the Faculty of Health Sciences and Techniques of the Gamal Abdel Nasser University of Conakry, Ignace Deen National Hospital plays a central role in the training of future doctors and health professionals. Its mission is threefold: to provide accessible care for the population, to provide medical training, and to promote health research. Like many Guinean public hospitals, the Ignace Deen National Hospital faces major challenges, mainly overcrowding and the need to modernise its

infrastructure. Despite these constraints, it remains a key pillar of the region's healthcare system, combining care, teaching, and research functions.

Matam municipal medical centre: located in the commune of Matam in Conakry, the Matam municipal medical centre is one of the municipal hospitals included in this pilot study. This public referral centre provides essential medical care to the commune's residents, who use it en masse due to the lack of accessible alternatives. In addition to general care and specific services such as the prevention of mother-to-child transmission of HIV, the hospital also offers specialist surgical services (maternity and surgical operations). Its main mission is to guarantee accessible healthcare for the population of Matam and to provide ongoing training for healthcare staff to improve the quality of services.

AKO polyclinic in Ratoma centre: the AKO polyclinic is one of the private health facilities included in this study. Located in the commune of Ratoma (Conakry), it offers a wide range of medical care, with an emphasis on quality and accessibility. It offers both medical and surgical specialties, including maternity and surgical procedures. This polyclinic is mainly accessible to the population of Ratoma and the surrounding area, as well as to patients seeking private care that is quicker than in public hospitals. It has a renovated infrastructure and modern health facilities.

Kankan region

Kankan regional hospital: Kankan Regional Hospital is a public referral hospital for the administrative region of Kankan, in Upper Guinea. Located in the east of the country, some 638 km from the capital Conakry, it provides secondary and tertiary care for a large population covering the city of Kankan and neighbouring prefectures (Siguiri, Mandiana, Kérouané, and Kouroussa). The hospital has several specialist departments, including trauma, visceral surgery, urology, and maternity. Its equipment, although basic, is sufficient for routine cases, but limited for complex pathologies. An essential link in the Guinean health system in Upper Guinea, the hospital nevertheless needs additional resources to provide optimum care for the population.

Siguiri prefectural hospital: located in the Kankan region of Upper Guinea, the Siguiri Prefectural Hospital is a public referral health facility for complex cases from the prefecture's health facilities. Frequently overcrowded, it provides secondary care and acts as a relay between the outlying health centres and Kankan Regional Hospital. Although the buildings are functional, they are often dilapidated and under-equipped. As in Kankan, the hospital has basic equipment, but its capacity to deal with complex cases remains limited. The hospital plays a vital role in the management of emergencies and basic care in Siguiri. However, its effectiveness is hampered by financial and infrastructure constraints.

Doctor Seny Keita Medical-surgical clinic: the Doctor Seny Keita Medical-Surgical Clinic is a private health establishment located in Kankan, Upper Guinea. It serves as a referral facility for people seeking high-quality private care, particularly for cases requiring surgical treatment in traumatology, visceral surgery, and maternity. In addition to general care, the clinic offers specialist care, particularly in traumatology, providing an alternative to the region's public health structures. With its modest infrastructure, it has limited capacity in the event of a mass influx of patients. The clinic completes the range of healthcare services available in Kankan, helping to relieve the pressure on the Regional Hospital. It is particularly renowned for the reliability of its surgical procedures and the quality of its medical follow-up.

Nzérékoré region

Nzérékoré Regional Hospital: Nzérékoré Regional Hospital, the main public health facility in the administrative region of the same name, is the

referral hospital for the Guinée Forestière region. Located in the south-east of the country, 954 km from the capital Conakry, it covers a vast, densely populated area, including the prefectures of Nzérékoré, Lola, Beyla, Macenta, Guéckédou, and Yomou. In recent years, the region has been confronted with several major epidemics, including two outbreaks of Ebola, an episode of Lassa and Marburg fevers, and the COVID-19 pandemic. As a result, the hospital serves as a sentinel site for epidemiological surveillance and provides essential secondary and tertiary care. Although it concentrates the bulk of general care and certain medical and surgical specialties, the hospital has certain limitations in terms of operational capacity. Despite these constraints, it remains an essential link in the Guinean healthcare system in the forest region.

Gouécké improved health centre: the Gouécké Improved Health Centre is a first-level health facility with a surgical unit, located in a rural area in the sub-prefecture of Gouécké. Reporting to the Nzérékoré health district, it provides primary healthcare to a population that is both rural and peri-urban, while experiencing frequent staff turnover. Among the municipal structures studied, this centre occupies an intermediate position between a health post and the Nzérékoré prefectural hospital. Its complementary services are limited to caesarean sections and uncomplicated visceral surgery. The centre plays a key role in reducing maternal and infant mortality, and is a strategic site for the early detection of epidemics in the Forest Region of Guinea. Despite limited resources, it provides essential local care in rural forest areas. Strengthening it is a priority and will require increased investment to meet the growing demand from the population.

Huguette clinic: the Huguette Clinic is a private medical establishment located in the heart of Nzérékoré, offering general and specialist care, particularly in gynaeco-obstetrics and visceral surgery. It presents itself as an alternative to public facilities, with higher quality standards. However, its capacity remains limited in the event of a massive influx of patients, and its charges, which are higher than those of public hospitals, represent an obstacle for low-income patients. Despite these constraints, the Huguette polyclinic plays an essential role in the provision of healthcare in Nzérékoré, offering fast and effective solutions, albeit at a cost.

Type and period of study: this study was a prospective cohort study of patients admitted and hospitalized for 48 hours or more following surgery in the surgery, maternity, traumatology, and urology departments of the selected health facilities between 1st August 2022 to 31stJanuary 2024. The ethnography component was conducted over six months from November 2022 to April 2023. It involved approximately 400 hours of participant observation (day and night) during surgical procedures, consultations, and inpatient ward visits. Additionally, 200 semi-structured interviews and numerous informal discussions were conducted.

Inclusion criteria: all patients who voluntarily agreed to take part in the survey were included in this study. All patients hospitalised for at least 48 hours after surgery in the visceral surgery, maternity, traumatology, and urology departments were also included.

Non-inclusion criteria: this study did not include patients who refused to take part in the survey; in-patients who did not undergo surgery; patients who underwent surgery and were followed up on an out-patient basis (without hospitalization); patients who underwent surgery for a hospital stay of less than 48 hours; patients who underwent surgery and were managed outside the visceral surgery, maternity, traumatology and urology departments.

Study population and sampling: patients admitted and hospitalised for 48 hours or more following surgery in the visceral surgery, maternity, trauma, and urology departments of selected health facilities in the Conakry, Kankan, and Nzérékoré health regions were included in the study. Patients

who met the inclusion criteria were recruited consecutively and exhaustively between 1st August 2022 to 31st January 2024. To optimise the accuracy of estimates of healthcare-associated infections (HAIs) in Guinea, our study included 6,759 participants over 18 months (from August 2022 to January 2024). This number is the result of a compromise between feasibility, the representativeness of the Guinean health facilities targeted, the need for precision in the absence of reference data, and the requirements of future studies on HAIs in Guinea.

Data collection: the data was collected by selected interviewers trained from among the nursing staff of the concerned hospitals. The socio-demographic and clinical characteristics of the patients were recorded during their hospitalization to identify elements indicative of healthcare-associated infections. Patients included in the cohort were monitored from the date of discharge from the operating theatre (date of operation) until discharge from the hospital. The reasons for ending follow-up were either the end of hospitalisation or the development of a healthcare-associated infection, mainly at the surgical site. coinfected patients, i.e., patients who developed more than one healthcare-associated infection, were not included in the count of those who developed a single healthcare-associated infection. These data were initially collected using a standardised questionnaire and reported via an electronic form on the Kobotoolbox™ application.

A baseline, data on the socio-demographic and clinical characteristics of the hospitalized patients, as well as the characteristics of the nursing staff responsible for the patients, were collected. The socio-demographic and clinical characteristics included health region, category of health structure and service, type of hospital, and patient information such as age, sex, medical history, duration of hospital stay, timing of the operation, and details of pre-operative and post-operative prophylaxis. The characteristics of the nursing staff included the profile of the surgeon, years of experience, and the duration of the operation in the operating theatre. During follow-up in the hospital wards involved in the study, the data collected concerned the presence or absence of healthcare-associated infections and the type of healthcare-associated infection (surgical site infection, urinary catheter infection, and vascular catheter infection).

Definition of healthcare-associated infection: healthcare-associated infections were operationally defined according to clinical evidence derived from direct observation of the patient or from review of clinical information contained in the patient's record during hospitalization. These definitions were based on those provided by the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) [5,21,22].

Data processing:data collected on the Kobotoolbox™ application was exported to Excel 2016, processed, and analyzed using Stata V16 software. The map was created using QGIS 3.36.1 software [23]. Parallel surveys conducted by the anthropologists helped refine the research questions and discuss our results to better identify the risk factors illuminated by the ethnography. The anthropological survey data used to discuss our results were collected in national languages (Sosoxui, Maninkakan, Pulaar, Kpɛlɛɛwoo). They were then transcribed onto a computer and anonymised in French, and analyzed using a thematic and conceptual approach, paying particular attention to emic categories.

Statistical analysis: for infected patients, the length of the period at risk of HAIs was estimated in days by subtracting the date of the operation from the date of the HAI diagnosis. For non-infected patients, the length of the period at risk of HAIs was calculated in days by subtracting the date of the last visit from the date of the operation. The incidence rate of HAIs was calculated by dividing the number of new cases of healthcare-associated infections during the study period by the total number of person-days at risk

during the same period. The description of the qualitative variables included the clinical and socio-demographic characteristics of the patients and the characteristics of the healthcare staff responsible for the hospitalized patients. These variables were expressed as absolute frequency and proportions. Quantitative variables were expressed as medians followed by their interquartile range (IQR) when the normality of the data was violated with the Shapiro-Wilk test.

The Nelson-Aalen approach was used to build the curves of cumulative hazard of occurrence of HAIs and estimate the hazard functions based on time spent in the study, by health service. Risk factors for the occurrence of HAIs were studied using a Cox proportional hazards regression model stratified by health service and age. In the univariate analysis, the factors associated with the occurrence of HAIs at the 20% threshold were retained for the multivariate analysis. Wald´s test was used for testing the covariate effect in the final model. A significant difference is observed if P <5%. The proportionality of the hazard assumption in this model was evaluated using the Schoenfeld global test for goodness of fit [24].

Ethics approval: in accordance with the principles of the Declaration of Helsinki, our study was approved by the National Ethics and Health Research Committee of Guinea, under authorization number 168/CNERS/21. Participation in this study required free and informed written consent. For participants who were minors, consent was obtained from their parents or legal guardians, in compliance with both national legislation and the requirements of our institution.

Results

Characteristics of the patients and health care workers: a total of 6,759 patients, with a median age of 28 years (IQR: 21 - 39 years) were included in the study. The majority of surgeries were performed in the Kankan region (44.25%), followed by the Conakry region (33.01%) and Nzérékoré (22.74%). Most surgeries were conducted in public hospitals (94.67%), with only 5.33% taking place in private hospitals. Nearly half the patients (48.82%) were admitted to maternity wards (Table 1). Patients received care for a median duration of 6 days (IQR: 3-9 days). A majority of operations (51.61%) were conducted between 8 am and 2 pm. The median duration of surgery was 48 minute (IQR: 36-68) and the median experience of the nursing staff was 9 years (IQR: 5-15) (Table 1).

Incidence and incidence rate of HAIs: among the 6,759 patients followed during their hospitalisation over 18 months, 1,196 had developed a HAI, representing a cumulative incidence of 17.69% [95%CI: 16.80% - 18.62%]. Among the 1,196 HAIs, surgical site infections were the most commonly encountered (86.45%), followed by vascular catheter infections (6.69%) and Urinary catheter infections. (2.28%). We also reported 4.18% of concomitant infections (surgical site infection, vascular catheter infection and urinary catheter infection simultaneously; also, urinary catheter infection and vascular catheter infection simultaneously). Cumulative follow-up was 42,474 person-days. The overall incidence rate was 28.15 per 1,000 person-days; [95% CI: 26.60 - 29.80]. According to the type of the hospital, the incidence rate was 28.93 per 1,000 person-days [95% CI: 27.32 - 30.64] in the public sector, compared with 13.01 per 1000 person-days [95% CI: 08.92 - 18.97] in the private sector (p-value < 0.001). The Conakry region had the highest incidence rate at 40.69 per 1,000 person-days (95% CI: 37.64 - 43.99), indicating a significant difference observed among the three regions (Table 2).

Among health facilities, the national hospital had the highest incidence rate at 45.37 per 1,000 person-days [95% CI: 41.64 - 49.44], and the trauma department recorded the highest incidence rate at 48.84 per 1,000 person-days [95% CI: 43.47 - 54.87], both showing statistically significant differences. Men experienced a high

incidence rate of 37.98 per 1,000 person-days [95% CI: 35.15 - 41.05], with a statistically significant difference. The 46 to 65 age group had the highest incidence rate at 33.41 per 1,000 person-days [95% CI: 29.00 - 38.49], although this difference was not statistically significant (Table 1). The dynamics of HAIs occurrence show an increase during the first 9 days of patient follow-up. Our results indicate that the probability of non-occurrence of HAIs decreases over time, suggesting that the risk of developing an HAI increase as time progresses after surgery (Figure 2). This highlights the need for developing effective postoperative surveillance strategies during the first 10 days of surgery. In the different hospital wards, the rate of occurrence of HAIs was significantly higher between the 3rd and 8th day of hospitalization, after which it decreased in the maternity and visceral surgery wards. Conversely, in the traumatology department, there was a gradual increase in HAI cases after the 10th day of hospitalization, which then slowed down again by 14thday of hospitalization. In the urology department, however, the onset of healthcare-associated infections was relatively slow and steady over the follow-up period (Figure 2).

Risk factors of HAIs: in the univariate analysis, the factors associated with the occurrence of HAIs included health region, facility category, type of hospital, type of hospital ward, sex, pre-hospital treatment, history of diabetes, preoperative prophylaxis, postoperative prophylaxis, timing of surgery, hospital treatment, operator profile, and years of practical experience of operators (Table 3, Table 4). In the multivariate analysis, the following factors were independently associated with the occurrence of HAIs: health region (aHR = 0.46; p-value < 0.001), facility category (aHR= 3.05; p-value = 0.027), gender (aHR = 1.23; p-value = 0.006), history of diabetes (aHR = 1.79 p-value < 0.001) and the timing of interventions (aHR =1.45 p-value < 0.001) (Table 3, Table 4).

Discussion

This study aimed to analyze the incidence and risk factors associated with healthcare-associated infections (HAIs) in Guinea. Our findings revealed that despite the implementation of hygiene and biosafety training and the provision of personal protective equipment (PPE) following the Ebola and COVID-19 epidemics, approximately one in five patients developed HAIs during their hospital stay. These results align with previous research [1,2,4,5,7-9,18,25-27], highlighting the persistent challenge of HAIs in African healthcare settings. The prevalence of HAIs varies depending on factors such as the type of healthcare facility, length of hospital stay, and patient profiles [2,20,28,29].

In many African countries, research on HAIs is limited in scope, often focusing on short-term, cross-sectional studies [1,4,7,19,30] or specific departments within a single hospital at one point in time [1,4,7,8,19,30-32]. While social sciences research explores perceptions of contagion risk, social judgment [33,34], and ethical issues in the caregiver-patient relationship [35,36], it rarely incorporates quantitative HAI analyses. The high incidence of HAIs in this study can be attributed to failures in compliance with hygiene measures before, during, and after surgical procedures. Ethnographic field data identified numerous instances of non-compliance, such as the reuse of "cleaning towels" after caesarean operations, the reuse of urinary catheters among multiple parturient women, and inadequate vulvo-vaginal cleansing post-surgery. Surgical wound dressings often failed to meet infection prevention standards, becoming sources of infection. Equipment sterilization was inconsistent, partly due to unreliable electricity supplies, which led to the use of dry heat sterilizers instead of autoclaves - the first ones operate for a shorter time than the second ones and are therefore less affected by power outages. Additionally, critical tasks were frequently delegated to untrained staff.

The commercialization of care within the public health system further exacerbated these issues. The perception of low remuneration among staff, or the absence of remuneration for non-permanent workers, prompted care teams to charge patients directly, thereby undermining infection prevention practices. For instance, inadequate glove usage and the reuse of single-use materials were commonly observed. Ethnographic surveys also highlighted systemic challenges, including the use of outdated or inappropriate sutures, inadequate adaptation of operating theaters for specific surgeries, and non-functional laundry services that failed to meet linen demands. Shortages of essential surgical equipment, such as dressing boxes and PPE, further hindered infection control efforts despite official deliveries of equipment. A 2022 study in Guinea examining maternal health services during COVID-19 similarly noted deficiencies in sanitary hygiene among patients, visitors, and healthcare staff, particularly in peripheral and intermediate health facilities [37]. Haidara *et al.* [18] identified organizational factors, such as late referrals, inadequate supplies of dressings and decontamination products, and overcrowded hospital wards, as contributors to HAIs.

Among the 1,196 HAIs recorded, surgical site infections were the most prevalent, consistent with findings from Poirier *et al.*, who identified these as the most common HAI type in national surveillance programs [38]. However, the World Health Organization (WHO) reports that globally, urinary tract infections constitute 80% of HAIs, with surgical site infections accounting for 0.5%-15% [5]. The higher incidence of surgical site infections in our study may reflect Guinea´s reliance on open surgical techniques and suboptimal adherence to aseptic practices, in contrast to countries adopting advanced techniques like laparoscopy supported by robust HAI surveillance systems [3,5,6,13,26,38].

The majority of patients (81.18%) in our study were admitted to maternity and surgical wards. Compared with the trauma and urology wards, these two wards (maternity and visceral surgery) had a shorter duration of hospitalisation. By day 9 of follow-up, approximately 82% of patients in these two wards were no longer hospitalised, which explains the observed decrease in hospitalisations from day 10 onwards. The remaining patients were mainly managed in traumatology and urology. Furthermore, the increase in infections beyond the 10thday of hospitalisation confirms that longer hospital stays increase the risk of HAIs. Indeed, patients on trauma and urology wards, whose length of stay was longer, had a higher overall incidence of infections than those on maternity and surgical wards.

HAI risks were associated with healthcare region, facility type, patient sex, history of diabetes, and surgical timing. Public health facilities exhibited a 2.90-fold higher HAI risk compared to private facilities, likely due to financial disparities. Private clinics often cater to insured patients and prioritize scheduled surgeries, while public hospitals manage higher patient volumes and emergencies. Ethnographic observations also revealed that private clinics sometimes emphasized reputation protection through systematic prophylactic antibiotic use, rather than strict adherence to infection prevention measures. Surgeries performed between 3PM-6PM and 7PM-7AM had higher HAI risks than those conducted in the morning (8AM-2PM). This pattern reflects ethnographic findings showing that department heads typically supervise morning operations, ensuring adherence to protocols. Reduced supervision in the afternoons, as senior staff often departed for private clinics, leaving fewer personnel without certified training - interns, nurses, or midwives - to manage procedures.

Our study highlights the urgent need for systematic HAI surveillance in Guinea, with regular reporting across all healthcare facilities. Establishing bacteriological identification of infections is essential to address rising antimicrobial resistance, which threatens

healthcare effectiveness. Integrating public health and anthropology allowed us to explore the infection prevention ecosystem [39]. Emphasizing the importance of qualified supervision for surgical procedures, economic factors, and formalizing the recruitment of non-permanent healthcare workers - Euphemistically referred to as “trainees” - to mitigate unofficial patient charges and improve infection control practices.

Limitations: the primary limitation of our study pertains to the definition of healthcare-associated infection based on clinical criteria. Although this definition aligns with the WHO standard, it may result in an underestimation of the infection rate. Consequently, we were unable to describe the pathogens responsible for the infections. Despite these limitations, the study has several strengths: it encompasses a wide range of health facilities, includes a large sample size (several thousand individuals), and provides comprehensive follow-up throughout the entire post-surgery hospitalization period. Additionally, the study benefits from the triangulation of epidemiological and anthropological data collected concurrently. To the best of our knowledge, this prospective cohort study determining the incidence rate in nine health facilities across four hospital wards is the first of its kind in Guinea.

Conclusion

In our study, the incidence of healthcare-associated infections was notably high, with surgical site infections emerging as the most frequent type. Our data underscore the importance of preventive strategies, such as appropriate preoperative prophylaxis to mitigate antimicrobial resistance (AMR), rigorous monitoring of the timing of surgical procedures, and consideration of patients' medical histories, particularly regarding diabetes. These interventions are crucial for reducing the incidence of healthcare-associated infections and improving clinical outcomes for hospitalized patients. The simultaneous conduct of public health and anthropological surveys enabled us to understand infection prevention and control within the broader ecosystem, including factors such as the status and remuneration of health workers, distribution of roles. Other relevant aspects not fully explored here include ethics in care, patient sorting, and social legitimacy of patients.

What is known about this topic

- *Infection prevention and control is less well organised in developing countries.*
- *The lack of surveillance data over time and the failure to take into account the conditions and production logic of infection prevention and control make it difficult to identify ways of improving the situation.*

What this study adds

- *Outstanding feature of the work is the high incidence of HAIs, especially the surgical site infections, despite the various aseptic techniques employed before, during, and after surgical procedures. Our results underline the importance of preventive strategies such as limiting the prescription of prophylactic antibiotics pre-operatively, strict control of the timing of surgical procedures, and awareness of medical history, particularly in cases of diabetes;*
- *The study also stresses that these measures can only have an effect if they are combined with interventions that take account of the ecosystem of infection prevention and control.*

Competing interests

The authors declare no competing interests.

Authors' contributions

The study protocol was developed by Mory 1 Kourouma, Mamadou Mouminy Barry, Abdoulaye Bah, Amadou Tidiane Barry, Tiguidanke Camara,

Mariama Sylla and Frédéric Le Marcis and revised by Abdoulaye Toure, Castro Gbêmêmali Hounmenou, Cécé Kpamou. The data were analysed by Mory 1 Kourouma, Kadio Jean Jacques Olivier Kadio and Mamoudou 2 Toure. The first draft of the manuscript was written by Mory 1 Kourouma and critically reviewed by Abdoulaye Toure, Frédéric Le Marcis, Castro Gbêmêmali Hounmenou, Kadio Jean Jacques Olivier Kadio and Cécé Kpamou. All authors participated in the interpretation, read and approved the final version of this manuscript.

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Table 1: sociodemographic and clinical characteristics of patients operated on and profiles of medical staff in the health regions of Conakry, Kankan and Nzérékoré from August 2022 to January 2024		
Characteristics	**Number of surgical interventions** (n = 6759)	**Percentage**
Age (IQR), years	28 (21 - 39)	
Sex		
Female	4 623	68.40
Male	2 136	31.60
Previous history (yes)	6 140	90.84
Diabetic (yes)	153	2.26
Hypertension (yes)	371	05.49
Obesity (yes)	88	01.30
Immunosuppression (yes)	38	0.56
Treatment before arrival at hospital (yes)	618	09.14
Antibiotic prescribed in hospital (yes)	6 556	97.00
Preoperative antibiotic prophylaxis (yes)	3 379	51.54
Post-operative antibiotic prophylaxis (yes)	6 207	94.68
Treatment received in hospital (yes)	2 748	41.92
Timing of interventions		
8 am ?? 2 pm	3 488	51.61
3 pm ?? 6 pm	2 125	31.44
Night (7 pm - 7 am)	1 145	16.95
Time spent in the study (days)		
Less than 4	1 886	27.90
Stay of 4 to 6	2 096	31.01
Stay of 7 to 9	1814	26.84
Stay longer than 10	963	14.25
Operator profile		
Nurse/midwife	306	4.53
General practitioner	4 460	65.99
Specialist	1 993	29.49
Duration of the operation in the operating theatre (minutes)		
Less than 15	71	01.05
18 to 120	6119	90.53
More than 120	569	08.42
Operator's year of experience (years)		
Less than 3	583	08.63
3 to 5	1 392	20.59
6 to 10	2 249	33.27
11 to 20	1924	28.47
More than 20	611	09.04
Type sanitary structure		
Private clinic	362	5.36
National hospital	1 441	21.32
Prefectural hospital	1399	20.7
Regional hospital	2 448	36.22
Municipal hospital	1 109	16.41
Hospitalisation service		
Maternity	3 300	48.82
Visceral surgery	2187	32.36
Traumatology	685	10.13
Urology	587	8.69
n (observations); **IQR** (interquartile range)		

Table 2: incidence and incidence rate according to sociodemographic characteristics of patients hospitalised in the health facilities of Conakry, Kankan and Nzérékoré (n = 1196)

Characteristics	**Number of HAI cases**	**Incidence rate (per 1,000 person-days)**	**95% CI**
Global incidence	1196	28.15	[26.60 - 29.80]
Facility category			
Private	27	13.01	[08.92 - 18.97]
Public	1169	28.93	[27.32 - 30.64]
Region			
Conakry	633	40.69	[37.64 - 43.99]
Kankan	310	23.28	[20.83 - 26.03]
Nzérékoré	253	18.59	[16.43 - 21.02]
Type sanitary structure			
Private clinic	28	13.39	[9.25 - 19.40]
National hospital	522	45.37	[41.64 - 49.44]
Prefectural hospital	71	15.98	[12.66 - 20.16]
Regional hospital	398	22.83	[20.69 - 25.19]
Municipal hospital	177	25.24	[21.79 - 29.25]
Hospitalisation service			
Maternity	264	17.04	[15.10 - 19.22]
Visceral surgery	487	28.79	[26.34 - 31.46]
Traumatology	283	48.84	[43.47 - 54.87]
Urology	162	37.90	[32.49 - 44.21]
Sex			
Female	557	21.71	[19.98 - 23.59]
Male	639	37.98	[35.15 - 41.05]
Age (years)			
Under 18	156	31.77	[27.15 - 37.17]
18 to 35	586	25.76	[23.76 - 27.94]
36 to 45	153	29.29	[25.00 - 34.33]
46 to 65	192	33.41	[29.00 - 38.49]
Over 66	109	28.27	[23.43 - 34.11]

n (observations); **CI**: confidence interval

Table 3: risk factors associated with the occurrence of HAI with care according to characteristics related to hospital establishments and caregivers				
Characteristics	**Univariate**		**Multivariate**	
	HR [95% CI]	**p- value**	**aHR [95% CI]**	**p- value**
Region				
Conakry	Reference		Reference	
Kankan	0.71 [0.62 - 0.82]	<0.001	0.87 [0.29 - 2.54]	< 0.925
Nzérékoré	0.40 [0.34 - 0.46]	<0.001	0.46 [0.39 - 0.55]	< 0.001
Facility category				
Private	Reference		Reference	
Public	2.14 [1.46 - 3.14]	0.001	3.05 [1.13 - 8.21]	< 0.027
Type sanitary structure				
Private clinic	Reference		-	-
National hospital	3.02 [2.06 - 4.42]	<0.001	-	-
Prefectural hospital	1.91 [1.23 - 2.97]	0.004	-	-
Regional hospital	1.57 [1.07 - 2.31]	0.020	-	-
Municipal hospital	1.84 [1.23 - 2.75]	0.003	-	-
Hospitalisation service				
Maternity	Reference		-	-
Visceral surgery	1.35 [1.16 - 1.58]	< 0.001	-	-
Traumatology	2.20 [1.85 - 2.61]	< 0.001	-	-
Urology	1.83 [1.51 - 2.24]	< 0.001	-	-
Timing of interventions				
8 am - 2 pm	Reference		Reference	
3 pm - 6 pm	1.46 [1.29 - 1.65]	< 0.001	1.45 [1.27 - 1.65]	< 0.001
Night (7 pm - 7 am)	1.23 [1.04 - 1.45]	0.012	1.45 [1.21 - 1.72]	< 0.001
Operator profile				
Nurse/midwife	Reference		-	-
General practitioner	1.51 [1.11- 2.06]	0.009	-	-
Specialist	2.20 [1.61 - 3.01]	< 0.001	-	-
Duration of the operation in the operating theatre (minutes)				
Less than 15	Reference		-	-
18 to 120	1.41 [0 .70 - 2.84]	0.325	-	-
More than 120	1.67 [0.82 - 3.39]	0.155	-	-
Operator's year of experience (years)				
Less than 3	Reference		Reference	
3 to 5	1.53 [1.18 - 1.97]	0.001	1.15 [0.87 - 1.50]	0.306
6 to 10	1.35 [1.07 - 1.69]	0.009	1.24 [0.97 - 1.58]	0.081
11 to 20	1.34 [1.07 - 1.69]	0.010	1.00 [0.78 - 1.28]	0.951
More than 20	1.29 [0.98 - 1.69]	0.063	1.11 [0.83 - 1.50]	0.459
HR: Hazard Ratio; aHR: adjusted Hazard Ratio; CI: Confidence Interval				

Table 4: risk factors associated with the occurrence of HAI with care according to the socio-demographic and clinical characteristics and therapeutics of the patients operated				
Characteristics	**Univariate**		**Multivariate**	
	HR [95% CI]	**p- value**	**aHR [95% CI]**	**p- value**
Age (years)				
Under 18	Reference		-	-
18 to 35	0.90 [0.75 - 1.07]	0.268	-	-
36 to 45	0.99 [0.79 - 1.23]	0.941	-	-
46 to 65	1.00 [0.81 - 1.24]	0.946	-	-
Over 66	0.85 [0.67 - 1.09)	0.219	-	-
Sex				
Female	Reference		Reference	
Male	1.52 [1.36 - 1.71]	< 0.001	1.23 [1.06- 1.42]	0.006
Treatment before arrival at the hospital				
No	Reference		-	-
Yes	1.21 [1.04 - 1.42]	0.013	-	-
Diabetic				
No	Reference		Reference	
Yes	1.74 [1.33 - 2.85]	< 0.001	1.79 [1.33 - 2.42]	< 0.001
Hypertension				
No	Reference		Reference	
Yes	1.15 [0.93 - 1.41]	0.178	1.26 [0.99 - 1.61]	< 0.060
Immunosuppression				
No	Reference		-	-
Yes	1.47 [0.83 - 2.60]	0.182	-	-
Antibiotic prescribed in hospital			-	-
No	Reference		-	-
Yes	1.69 [0.80 - 3.57]	0.166	-	-
Post-operative antibiotic prophylaxis				
No	Reference		-	-
Yes	1.50 [1.09 - 2.05]	0.011	-	-
Preoperative antibiotic prophylaxis				
No	Reference		-	-
Yes	1.40 [1.24 - 1.58]	< 0.001	-	-
Treatment received in hospital				
No	Reference		-	-
Yes	0.57 [0.50 - 0.65]	< 0.001	-	-
HR: hazard ratio; **aHR**: adjusted hazard ratio; **CI**: confidence interval.				

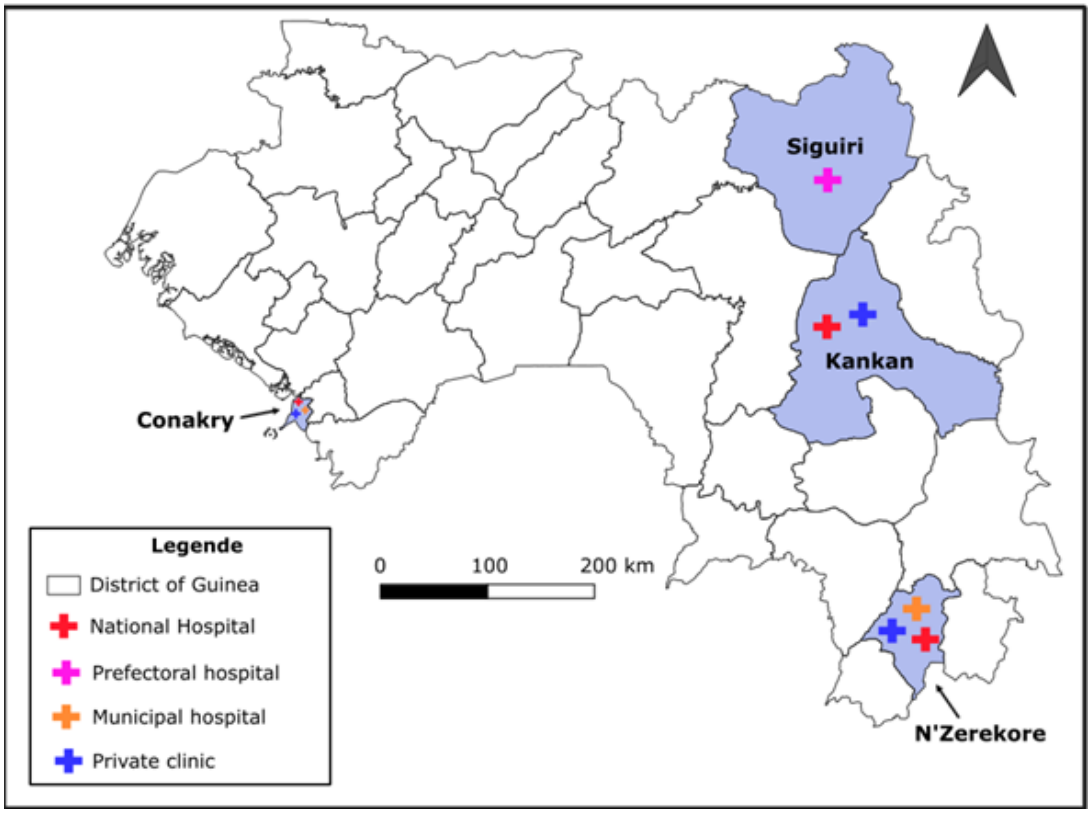

Figure 1: graphical representation of the target health districts in our study (Conakry, Kankan, Siguiri and Nzérékoré districts)

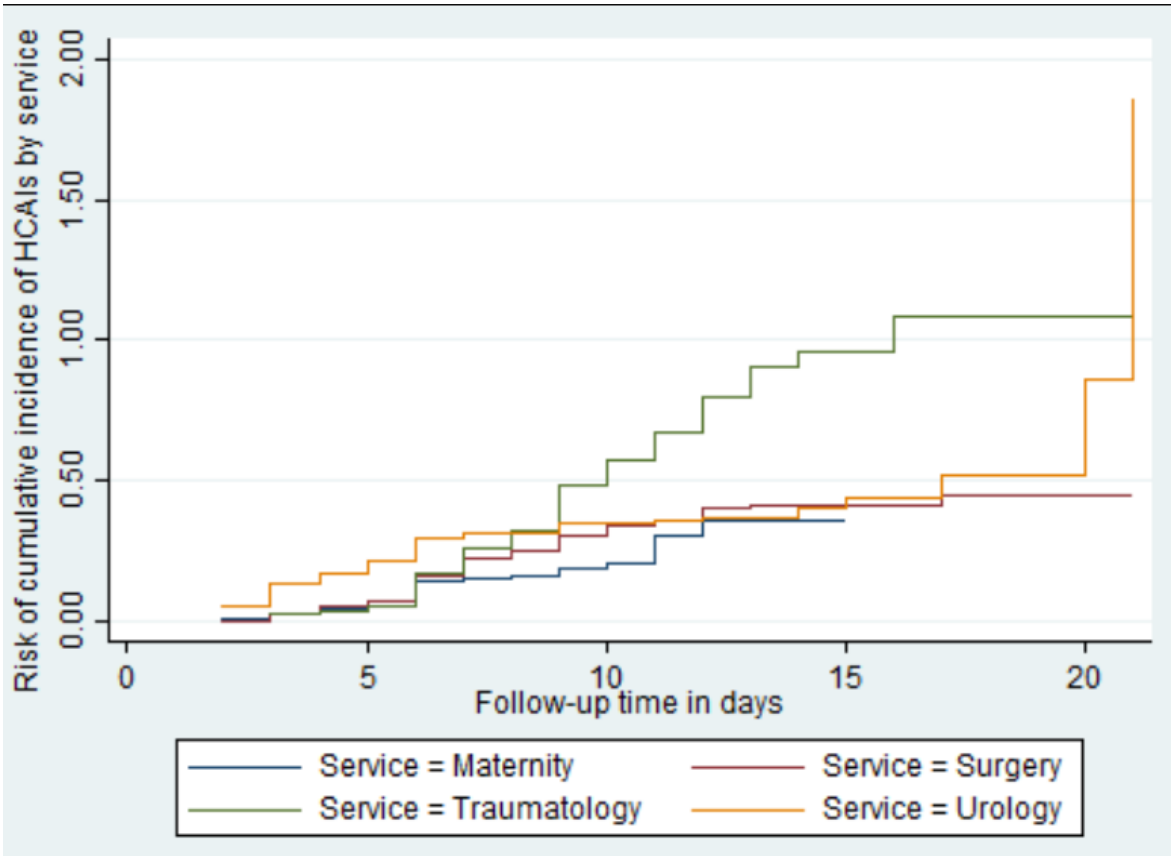

Figure 2: risk curve of the cumulative incidence over time according to the service of patients hospitalised in the health structures of Conakry, Kankan and Nzérékoré