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(RESEARCH ARTICLE)

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Incidence and outcome of nosocomial infections in children under fifteen years of age at the Makiso/Kisangani General Reference Hospital in the Democratic Republic of Congo.

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Abstract

Introduction: Nosocomial infections in Kisangani hospitals constitute a public health problem. This study aims to determine the incidence of nosocomial infections and identify the most frequently encountered pathogens; and to assess the outcomes of patients under fourteen years of age admitted to the Makiso/Kisangani General Reference Hospital.

Method: This is a descriptive, cross-sectional study conducted in the pediatrics department of the Makiso/Kisangani General Reference Hospital from January 1 to June 30, 2024, and included 61 children under fifteen years of age who developed a nosocomial infection during their hospitalization.

Results: We noted that the incidence of nosocomial infections at the Makiso/Kisangani General Reference Hospital is 5%, with bacteria (74%) being the primary causative agent of these infections. 85% progressed to recovery, and 87% were completely cured after completing the treatment provided by caregivers.

Conclusion: Preventive measures must be strictly adhered to by both patients and their family members, as well as by healthcare staff in Kisangani's healthcare facilities, to limit the spread of nosocomial infections.

Keywords: Incidence; Outcome; Nosocomial Infection; Child; The Makiso/Kisangani General Reference Hospital

1. Introduction

Healthcare-associated (nosocomial) infections generally occur through the transfer of germs present on the hands of a healthcare worker when they touch the patient. Out of 100 hospitalized patients, at least 7 in high-income countries and 10 in low- and middle-income countries will contract a nosocomial infection. These infections can be caused by bacteria, viruses, fungi, or other pathogens and often occur due to exposure to microorganisms resistant to conventional treatments [1]. Nosocomial infections are a public health problem. They are responsible for excess mortality and additional costs, particularly linked to increased length of stay in healthcare facilities [2].

According to Keita et al. [3], for surgical wound infections, for example, infections occurring within 30 days of the operation or within one year if a prosthesis is inserted are considered nosocomial. However, it is recommended to assess, in each doubtful case, the plausibility of the causal link between hospitalization and infection. The risk of contracting an infection in hospital is 7%, meaning that out of 100 people hospitalized, seven of them will have a nosocomial infection. This figure varies depending on the department in which the hospitalized person is located. It can

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indeed reach 30% in a department such as intensive care. This risk has long been neglected in sub-Saharan Africa, even though the prevalence of nosocomial infections is higher than in developed countries.

According to Paicheler [4], a nosocomial infection occurs when a patient enters a hospital or clinic without an infection and "catches" one during their stay. Nosocomial infections generally occur through the transfer of germs present on the hands of a healthcare worker when they touch the patient or through contaminated objects.

In France and 6.2% in Belgium. In France, according to the Foundation for the Medical Research [5], the World Health Organization estimated on its website in 2017 that 1.4 million people contracted an infection in the hospital. The Ministry of Health estimates that nosocomial infections are responsible for 4,000 deaths each year.

The Centers for Disease Control and Prevention (CDC) survey report [6] indicates that in developed countries, these infections affect 5 to 10% of patients. The prevalence of nosocomial infections (NI) is 4.5% in the USA, 10.5% in Canada, 6.7%. Despite progress in the fight against nosocomial diseases in the United States of America, nosocomial infections still cause 75,000 deaths per year, the results of which are published in the New England Journal of Medicine, based on 2011 figures covering 183 hospitals in the United States. Thus in 2011, some 721,800 cases of nosocomial infections were diagnosed in 648,000 hospitalized patients and approximately 75,000 died during their hospitalization. The most common hospital-acquired illness was pneumonia (22%), surgical incision infection (22%), followed by gastrointestinal (17%), urethral (13%), and bloodstream (10%) infections. The most common germs associated with hospital-acquired infections were *Clostridium* (12%), *Staphylococcus aureus*, including antibiotic-resistant methicillin-resistant *Staphylococcus aureus* (MRSA) (11%), *Klebsiella* (10%), *Escherichia coli* (9%), *Enterococcus* (9%), and *Pseudomonas* (7%). *Klebsiella* and *E. coli* are becoming increasingly resistant to the last-resort antibiotics, carabapenems, the authors of the study stated.

Overall, in Africa, the prevalence of nosocomial infections varies depending on the study area. In Mali, a study conducted in the "B" Surgery Department of Point G Hospital found a prevalence of 6.7%. In Senegal, it was 10.9% in a survey conducted at Fann University Hospital. In Guinea, occasional medical theses have been conducted on the subject in several departments. Prevalences ranging from 10% to 19% have been reported in the intensive care and surgery departments of Conakry University Hospital [3].

In some developing African countries, the highest prevalence rate of these infections is estimated at 25.0%. In 2011, the prevalence of nosocomial infections was estimated at 10.9% in Senegal; 12.0% in Côte d'Ivoire; 10.0% in Benin; and 14.0% in Mali. In Congo-Brazzaville, nosocomial infections pose a real public health problem [2].

According to a study conducted by Kasongo [7], in the Democratic Republic of Congo, in 2011, the prevalence of nosocomial infections in hospitals in Kinshasa was estimated at 15.0%. Nosocomial infections are not the "price to pay" for medical progress, as they are at least partially preventable, as some countries have shown by developing prevention policies. In developed countries, nosocomial infections are one of the ten leading causes of mortality, and between 20 and 30% of these infections are considered preventable by simple and effective methods.

The overall objective of this study is to contribute to improving the care of patients admitted to the Makiso/Kisangani General Referral Hospital. Specifically, the study aims to: determine the incidence of nosocomial infection and identify the most frequently encountered pathogens; evaluate the outcome of patients under fourteen years of age admitted to the Makiso/Kisangani general referral hospital.

2. Methodology

2.1. Materials

2.1.1. Description of the Research Site

This study was conducted at the Makiso-Kisangani General Referral Hospital, a healthcare institution located in the Plateau Médical District, in the commune of Makiso, Tshopo Province, The Democratic Republic of Congo.

It is the hospital for the Makiso-Kisangani health zone and is bordered to the north by the Congolese GENOCOST Memorial, formerly known as the Red Cross Cemetery or the Six-Day War Victims Cemetery; to the south by the office of the Tshopo Provincial Health Division and the Kisangani University Clinics; to the east by the offices of the Provincial Coordination Offices of the Expanded Program on Immunization and the National Malaria Control Program; and to the west by the Prince Alwaleed Referral Health Center.

2.1.2. Study Population and Sample

The study population comprised all patients admitted to the various departments of the Makiso/Kisangani General Referral Hospital from January 1 to June 30, 2024, i.e., 1,280 patients. From this population, we randomly selected 61 patients ranging in age from one to fourteen years, hospitalized in the Pediatrics Department of the Makiso/Kisangani General Referral Hospital.

Several criteria were defined to be included in this study.

Inclusion Criteria

Be admitted to the pediatrics department during our study period;

- Have spent at least seventy-two hours in the hospital;
- Be under fourteen years of age;
- Have a file available and containing the minimum information necessary for this study;
- Have developed a nosocomial infection during their hospital stay.

Non-inclusion Criteria

Patients who did not meet the inclusion criteria were excluded from this study.

2.2. Methods

2.2.1. Study Type

This is a descriptive, cross-sectional study conducted at the Makiso/Kisangani General Referral Hospital from January 1 to June 30, 2024.

2.2.2. Data Collection Technique

To collect the data for this study, we used a document review. We reviewed the various patient files, hospitalization records and records from various departments archived at the Makiso/Kisangani General Reference Hospital. To make data collection easy and fast, we used the Google Form application. We configured a data collection sheet on the application.

The collected data were directly updated in the Google server. The following variables were included: patient's date of birth, sex, history of hospitalization, history of infectious diseases, current weight in kilograms, height in cm, nutritional status, hospitalization department, date of admission, clinical symptoms on admission, comorbidity, date of diagnosis of the infection, site of infection, pathogen identified, new symptoms appearing after admission, treatment administered for the infection, duration of treatment (in days), progression of the infection, date of outcome and modality of outcome.

2.2.3. Data Processing Technique

Once data collection was complete, we exported the data to Excel for processing and analysis using SPSS 20.0 software, which produced the various graphs.

2.3. Ethical Aspects

We obtained approval from the authorities at the Makiso/Kisangani General Referral Hospital, who provided us with the tools we needed: patient records and registers for data collection and analysis.

Data collection was carried out with strict respect for the confidentiality of the study subjects' personal data; all information collected was anonymized to protect the patients' identities. The data file was password-protected to prevent unauthorized access. 2.4 Study Limitations

2.3.1. Limitations Related to the Pediatric Population

Clinical Definitions: The criteria for defining and classifying nosocomial infections may be less clear in children due to often atypical clinical manifestations and difficulty expressing symptoms.

Specific Risk Factors: The risk factors associated with nosocomial infections in children may differ from those in adults (prematurity, immunodeficiencies, specific treatments).

Vulnerability to Infections: Children, especially younger children, are more vulnerable to infections due to an immature immune system.

2.3.2. Limitations related to the context of the Makiso-Kisangani GRH

The results of this study are limited to the context of the Makiso/Kisangani General Reference Hospital and cannot be extrapolated to other healthcare facilities. However, they can be used to compare the improvement in the quality of care within this hospital over time.

Limited resources: The limited human, material, and financial resources of the hospital influence, in one way or another, the quality of the collected data and the implementation of preventive measures.

Environmental factors: Socio-economic conditions, sanitation, as well as hygiene practices impact the frequency of nosocomial infections.

2.3.3. Other Specific Limitations of this Study

Underreporting: Underreporting of infections may be particularly significant in children due to the difficulty in diagnosing certain infections and the lack of awareness among healthcare professionals. Impact of Endemic Infectious Diseases: The presence of endemic infectious diseases in the region may complicate the diagnosis and monitoring of nosocomial infections. To minimize the impact of these limitations, we worked closely with the medical and nursing staff of the Makiso/Kisangani general reference hospital and used standardized definitions of pediatric nosocomial infections.

3. Results

3.1. Incidence of nosocomial infection at the Makiso/Kisangani GRH

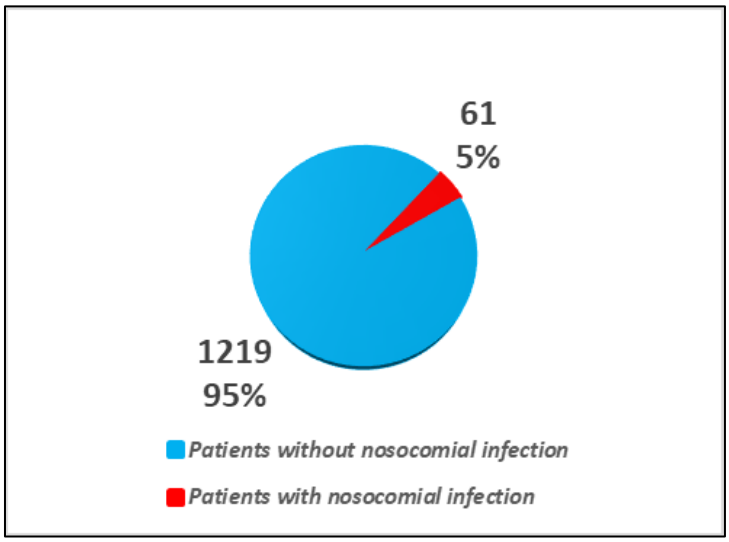

Figure 1 Incidence of nosocomial infections at GRH Makiso-Kisangani from January 1 to June 30, 2024**.**

This figure shows that out of 1280 patients admitted for hospitalization, 61 patients, or 5%, developed a nosocomial infection during the period from January 1 to June 30, 2024, at the Makiso/Kisangani general reference hospital. This situation could be explained by the low level of hygiene observed both among patients and in hospital services.

3.2. Patient characteristics

3.2.1. Age groups

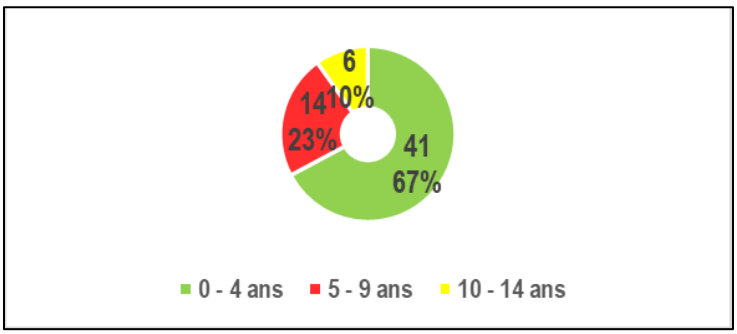

Figure 2 Distribution of patients with nosocomial infections by age group

This graph shows that 41 patients, or 67%, are aged between 0 and 4 years; 14, or 23%, are aged between 5 and 9 years and 6, or 10%, are aged between 10 and 14 years. This distribution can be explained by the fact that the older a child grows, the more his or her immune system matures and the more resistant it is to infections.

3.2.2. Gender

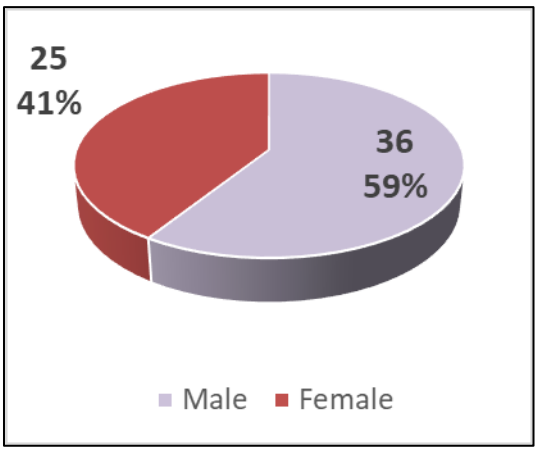

Figure 3 Distribution of patients with nosocomial infection by sex

It appears from this figure that 36 subjects in the study, or 59%, were male, while 25, or 41%, were female. This distribution is due to pure chance.

3.3. Clinical data on nosocomial infection

3.3.1. History of hospitalization

From this figure, it appears that 25 respondents, or 41%, have been hospitalized at least once compared to 36, or 59%. This situation may be explained by a poor standard of living and hygiene conditions of the population, making them vulnerable to diseases.

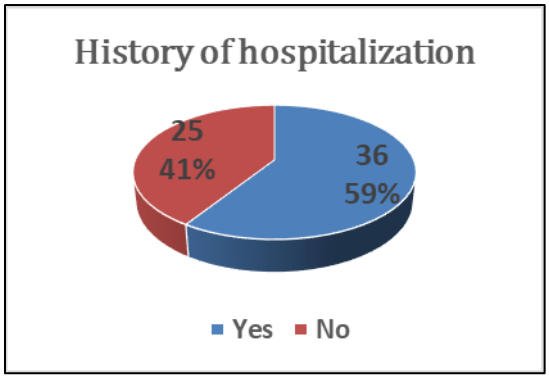

Figure 4 Distribution of patients according to hospitalization history

3.3.2. History of nosocomial infections

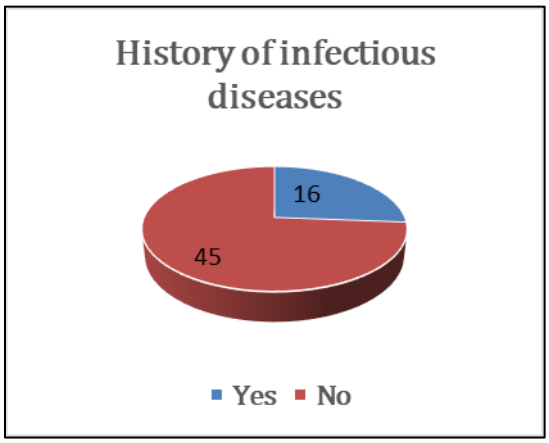

Figure 5 Distribution of patients according to the history of infection.

From this graph, we see that 26% of the subjects in the study have developed a nosocomial infection at least once. This is likely due to the immunological immaturity of young children, but also to living conditions and hygiene that do not protect them from serious illnesses.

3.3.3. Nutritional status

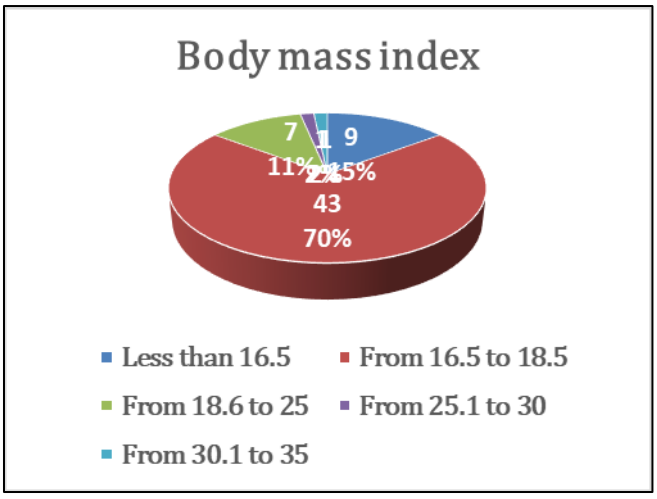

Figure 6 Distribution of patients according to nutritional status

This chart shows us that the majority of the subjects surveyed, namely 70%, had a body mass index ranging from 16.5 to 18.5. This means they had experienced weight loss. These results could be explained by the morbid condition that prevented normal nutrition of the subjects.

3.3.4. Clinical symptoms at admission

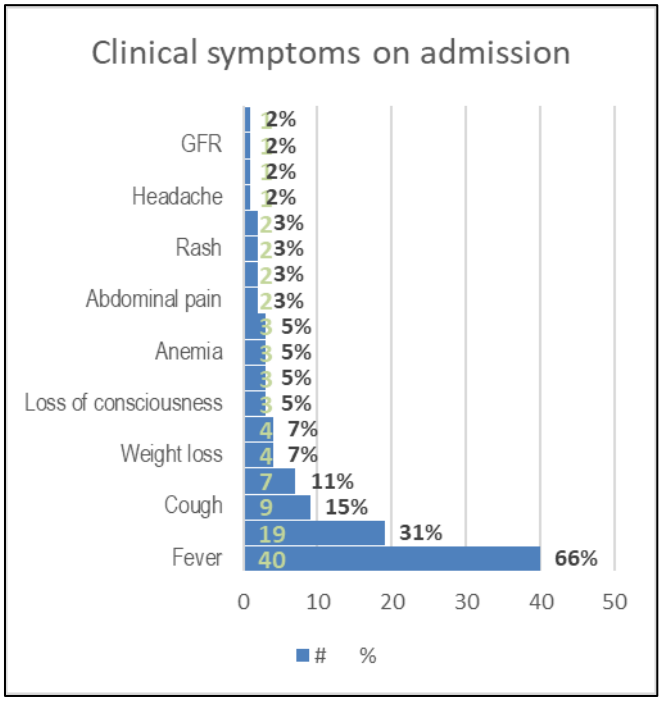

Figure 7 Clinical symptoms at admission of patients It emerges

From this graph that 40 subjects in the study, or 66%, presented with fever at admission, followed by asthenia, which affected 31% of the subjects, and 15% presented with cough. This situation can be explained by the fact that fever is one of the major signs of most infectious diseases.

3.4. Identification of the infection

3.4.1. Delay in diagnosing nosocomial infection

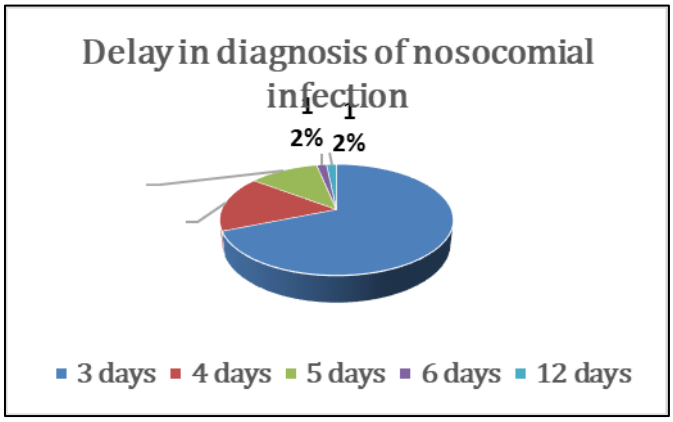

Figure 8 Delay in the diagnosis of nosocomial infection

This graph illustrates that the majority of study subjects, i.e., 69%, were diagnosed with a nosocomial infection on the third day of their hospitalization. 10, or 16%, on the fourth day. These results reflect the danger of our hospital environments where microbial circulation is not controlled.

3.4.2. Site of the nosocomial infection

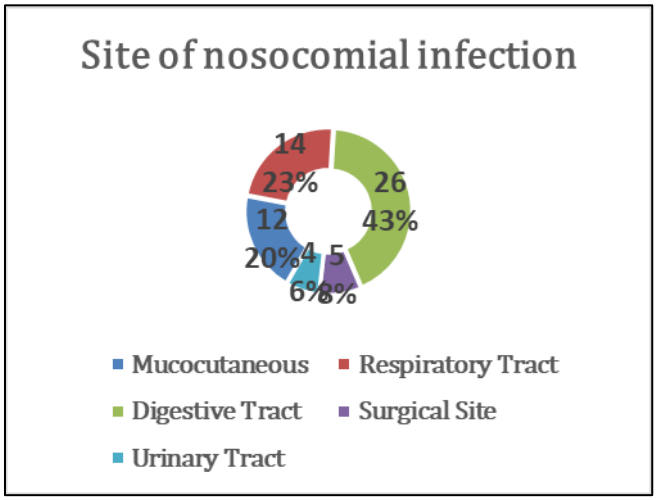

Figure 9 Distribution of patients according to the site of nosocomial infection.

From this graph, it appears that 26 out of 61 subjects surveyed, or 43%, presented infections of the digestive tract. 14, or 23%, presented respiratory infections. There are 20% who presented cutaneous-mucosal infections, 8% of surgical site infections, and 6% of urinary tract infections. These results could be explained by the lack of control over the food of hospitalized patients, the circulation of contaminated air, the lack of hygiene in bedding, and asepsis during patient care.

3.4.3. Identification of the causative agent

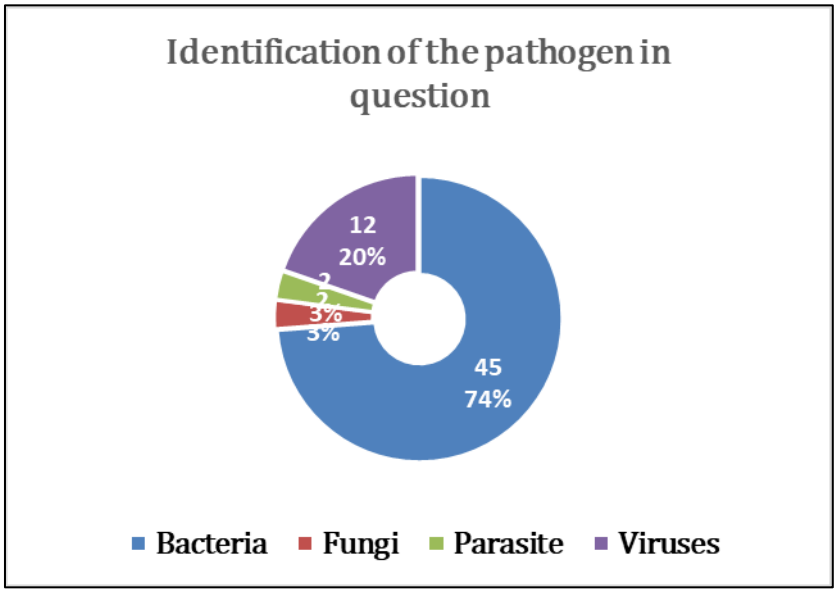

Figure 10 Identification of the pathogen responsible for the nosocomial infection

The pathogens responsible for nosocomial infections in this study appear in the following order: 74% bacteria, 20% viruses, and 3% respectively parasites and fungi. This situation could be explained not only by the signs and symptoms presented by the patients but also by some tests conducted to identify the pathogens.

3.4.4. New symptoms that appeared after hospitalization

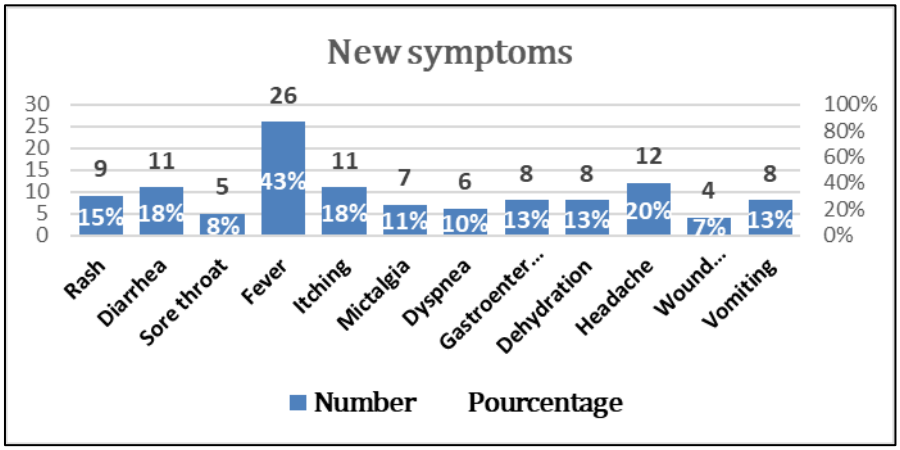

Figure 11 Distribution of patients according to new symptoms appearing after hospitalization

From this figure, we note that fever was present in 26 out of 61 subjects, or 43%; headache in 12, or 20%; followed by other signs such as diarrhea, rash, itching, ... fever being the hallmark of an infectious disease.

3.4.5. Treatment received for nosocomial infection

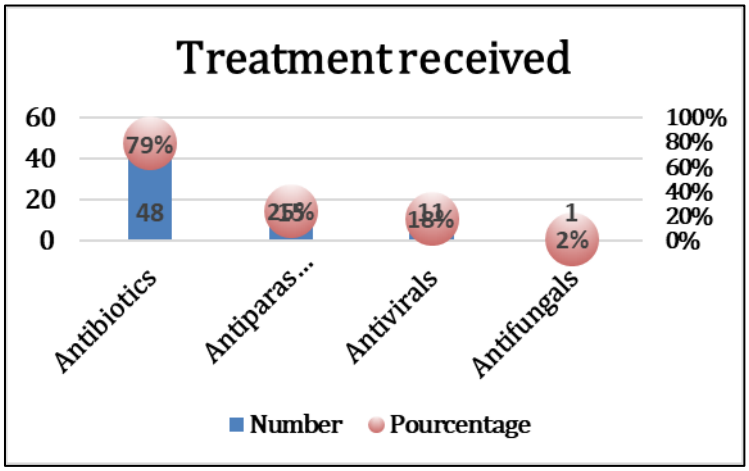

Figure 12 Distribution of patients according to the treatment received for the nosocomial infection.

From this figure, 48 out of 61 subjects in the study, or 79%, were treated with antibiotics; 15, or 25%, with antiparasitics; 11, or 18%, with antivirals, and 1, or 2%, with antifungals. This therapeutic distribution would be a consequence of the identification of the germs involved in nosocomial infections.

3.4.6. Duration of treatment received by patients

This below figure shows that 52 subjects out of 61, or 85%, received treatment lasting between 5 to 8 days; 4, or 7%, had treatment lasting between 9 and 11 days; 3, or 5%, had treatment lasting 1 to 4 days, and 2, or 3%, had treatment lasting between 12 and 15 days. This situation could be explained by the types of nosocomial infections that the subjects contracted. The earlier the infection is diagnosed, the shorter the treatment duration.

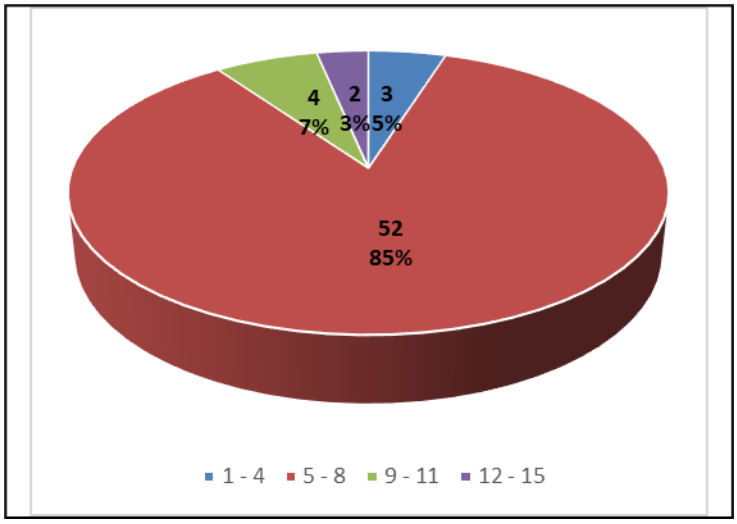

Figure 13 Distribution of subjects in the survey by duration of treatment received

3.4.7. Evolution of nosocomial infection

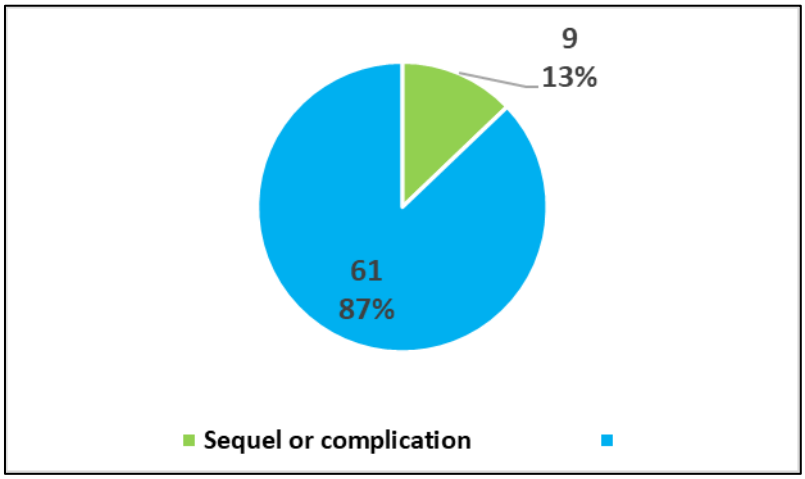

Figure 14 Distribution of the study subjects according to the evolution of nosocomial infection

From this figure, we notice that 52 subjects in the study progressed towards healing while 9, or 15%, experienced sequelae and/or complications. These results could be explained by the severity of nosocomial infections and the quality of patient care . 3.3.8 Length of hospitalization.

3.4.8. Duration of hospitalization

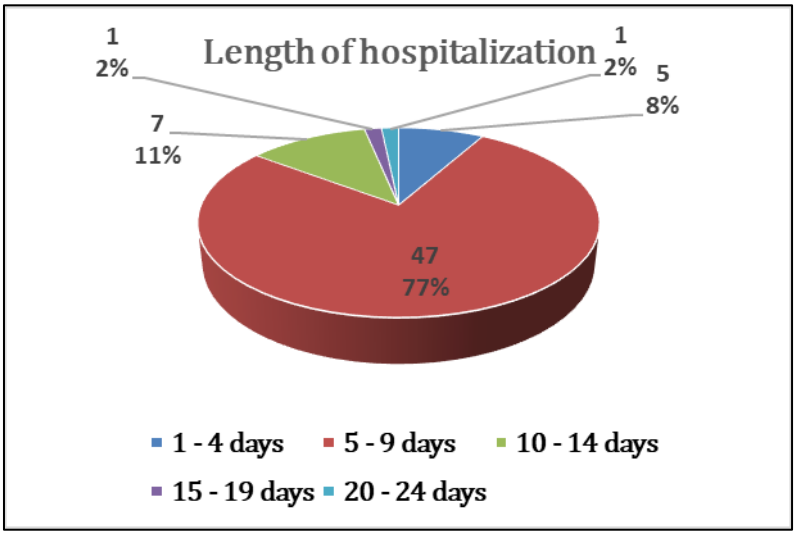

Figure 15 Distribution of patients by Duration of hospitalization

From this graph, we note that 47 subjects in the study, or 77%, spent 5 to 9 days in the hospital; 7, or 11%, spent between 10 and 14 days in the hospital. With an average length of hospitalization of 14.5 days. The situation is likely due to the emergence and severity of the nosocomial infections involved.

3.4.9. Method of discharge

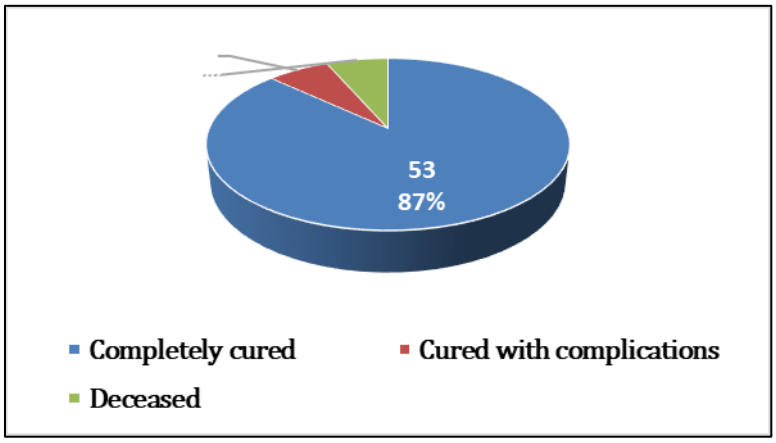

Figure 16 Distribution of patients by discharge modality

From this graph, it appears that out of all our subjects in the study, 53, or 87%, were discharged completely healed; 4 had complications and 4 others died. These results could be explained by the virulence of the germs involved, the quality of care provided, and the immune response of the patients.

4. Discussion

The discussion only concerns the results related to the specific objectives of the study. Therefore, it effectively relates to the following variables: prevalence of nosocomial infections, the responsible infectious agents, and the outcome of nosocomial anti-infection treatment.

4.1. On the incidence of nosocomial infections

We found that 5% of patients admitted to the General Reference Hospital of Makiso/Kisangani developed a nosocomial infection during the period from January 1 to June 30, 2024. Our results appear to be slightly lower than those of Cirhulwire et al [8] in 2024, who in their study on the prevalence and factors favoring nosocomial infections in the city of Goma found that at the General Reference Hospital CBCA, 17% of patients developed a nosocomial infection, at the

General Reference Hospital Charité Maternelle 14.2%, and overall, 16% of patients developed one; our results are slightly higher than those found by Beye et al [9] in Mali in 2024, where 12.3% developed a nosocomial infection. This difference may likely stem from the hygienic conditions of the hospital, the quality of care, and adherence to standards.

4.2. Clinical Symptoms at Admission

This study shows that 66% of the subjects presented with fever at admission. In 2020, Coulibaly and his colleagues [15] found in a study conducted in Mali that fever was the primary reason for consultation. Their results corroborate ours and could be explained by the fact that fever is one of the first signs of infection. 4.6 Delays in Diagnosis of Nosocomial Infection. The majority of the subjects in the study, 69%, were diagnosed with a nosocomial infection on the third day of hospitalization. Our results are almost the same as those of Abdellaoui [11], who found that nosocomial infections appeared on average in 4 days. The rapid onset of a nosocomial infection can be explained by several interacting factors. It is important to note that the speed at which an infection manifests depends on several variables, including the type of microorganism involved, its virulence, the immunological state of the patient, and the site of infection.

4.3. Sites of nosocomial infection

This study reveals that 43% of subjects presented with digestive infections. In the study by Bopaka et al [2], urinary infection was the most predominant at 64%, while Lyazidi et al [16], in their study on the prevalence of nosocomial infections at the Ibn Rochd University Hospital Center in Casablanca, Morocco in 2022, found that nosocomial pneumonia represented the most common site with a prevalence of 1.8%. This difference may result from the fact that at the General Reference Hospital of Makiso/Kisangani, there is no catering service for hospitalized patients, which thus forces them to consume food and drinks from outside exposed to all kinds of contamination due to handling.

4.4. Identification of the Pathogenic Agent

In this series, we found that 74% of patients had a nosocomial infection caused by bacteria, whereas Bopaka et al [2] found in their article published in 2021 that the germs responsible for nosocomial infections were bacteria in 62% of cases. A study published by Public Health France in 2023 showed that the microorganisms most involved in nosocomial infections are bacteria of the type *Escherichia coli* (22.2% of isolated germs), *Staphylococcus aureus* (12.2%), *Enterococcus faecalis* (7%), and *Pseudomonas aeruginosa* (6.9%). These results are likely due to differences in hygiene conditions in the two study settings. However, bacteria remained, despite the different proportions, the primary agents implicated in the occurrence of nosocomial infections.

4.5. Treatment Received for Nosocomial Infection

Regarding treatment, we noted that 79% of the subjects in the study were treated with antibiotics, while Azzouzi [17] in his study conducted in 2021 in Morocco found 70%. According to Charline [18], the treatment for a nosocomial infection varies depending on the bacteria present and the symptoms it causes. Medical management varies from one patient to another.

4.6. Duration of treatment received by patients

From this study, it is shown that 85% of the subjects studied received treatment for nosocomial infection for 5 to 8 days. Our results corroborate those of Wolff and Chastre [19], who concluded that 'in the majority of infections, it is unnecessary to prolong antibiotic treatment beyond seven to eight days.' The severity of the infections does not justify prolonging antibiotic treatment.

4.7. Evolution of nosocomial infection

From this study, we observed that 85% of the subjects studied progressed towards recovery while 15% had sequelae and/or complications. The high recovery rate may be due to early detection and initiation of treatment.

4.8. Duration of hospitalization

We observe that 77% of the subjects in the study spent between 5 and 9 days hospitalized; 7, or 11%, spent between 10 and 14 days hospitalized. The average length of hospital stay was 8 days in the study by Bopaka [2]. Our results would be consecutive to the treatment initiated and the evolution of the patient. However, this duration depends on the timeliness of the diagnosis of the infection and the introduction of treatment, which must be tailored, as well as the response of the organism.

4.9. Issue

It turns out that 87% of the subjects in the study were completely healed; 4, or 6.5%, had complications and 4 others, or 6.5%, died. Our results differ from those of Meftah et al [20], who reported a mortality rate of 30% in their study on the characteristics of nosocomial infection in a pulmonology department. Meanwhile, the lethality in the study by Keita et al [3] was 8.1% among patients who developed an infection during care.

5. Conclusion

We conducted a study focused on the incidence and outcome of nosocomial infections in children under fifteen years old at the Makiso/Kisangani General Reference Hospital.

Nosocomial infections in our hospitals constitute a real health problem for which it is essential to combat their spread in order to preserve the well-being of hospitalized patients. It is therefore the responsibility of healthcare professionals to systematically apply hygiene and asepsis during medical procedures; the use of sterilized equipment is also essential.

Therefore, it is essential to understand the causes, symptoms, and preventive measures to mitigate these risks and improve patient outcomes.

At the end of this study, we obtained the following results:

- 5% of patients admitted to the General Reference Hospital of Makiso/Kisangani developed a nosocomial infection during the period from January 1 to June 30, 2024.
- 74% of the patients had nosocomial infections caused by bacteria.
- 85% progressed towards recovery and 87% were discharged completely cured.

Considering these results, we conclude in these terms:

- Nosocomial infection remains a problem at the General Reference Hospital of Makiso/Kisangani with an incidence of 5% among children admitted for hospitalization.
- Poorly managed, a nosocomial infection leads to prolonged hospital stays of up to nearly a month, potentially resulting in the patient's death (7%).
- Preventive measures must be strictly observed by both patients and their family members as well as by the healthcare staff of the General Reference Hospital of Makiso/Kisangani.

Compliance with ethical standards

Disclosure of conflict of interest

There is no conflict of interest in this study.

Authors' contribution

The design, collection, and data processing were carried out by Bienvenu LOMANDE ATAMBANAKA, formatting and text processing were done by Raymond ASSANI RAMAZANI, and the reading was conducted by Raymond ASSANI RAMAZANI, Olivier BOTOKOMOY MPASI, and Jacquie BOMELA YENGA.

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