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# Microbiological Analysis of Indoor Air in the Provincial Hospital of Sidi Kacem, Morocco

**Elouakfaoui Aziz[1], Mahjoub Aouane[2], Rouani Abdeljabbar[3]**

**[1]PhD Student, [2]University Professor, Laboratory of Natural Resources and Sustainable Development IBN Tofail University, Department of Biology Faculty of Science Kenitra, Morocco, [3]PhD Student, Laboratory of Materials and Subatomic Physics Ibn Tofail University, Department of Physics Faculty of Science Kenitra, Morocco.**

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**Abstract**

**Background:** The air environment of the hospital is often contaminated by pathogenic microorganisms of various origins, which constitute a risk of infection for hospitalized patients, health staff and visitors. Microbiological control of the hospital wards is an essential element in the prevention of these infections, it allows a bacterial diagnosis of the area in order to carry out preventive and corrective actions.

**Objective:** The aim of this study is to reduce the rate of nosocomial infections, through the diagnosis of bacteria present in the services area of the provincial hospital of sidi kacem in the region of Rabat-Salé-Kénitra Morocco.

**Methods:** 14 samples of the area were collected from different sites on the hospital wards, using the sedimentation technique, by exposing Petri plates containing nutrient agar, in a $1m^2$ area for 30 minutes. The plates were incubated in a temperature of 37 ± 1 °C for 48 hours. The isolates were identified by the classical biochemical gallery and API (Biomerieux, France).

**Results:** A total of eight (08) bacterial species were isolated from the air with a predominance of coagulase-negative staphylococci (36%), Bacillus sp (25%), staphylococcus aureus (20%) and E. coli (8%) followed. One (1) sample was a negative culture with a positivity rate of 93%. The distribution of isolated bacteria by department shows a predominance of bacterial strains in the intensive care unit (24%) and the emergency department (19%).

**Conclusion:** These surprising results demonstrated the importance to implement a periodic monitoring of the hospital area, and a global policy for the prevention of nosocomial infections including an air treatment protocol.

**Key words:** hospital area, nosocomial infections, microbiological control.

## Introduction

Nosocomial infection (NI) is an infection contracted in hospital after 48 hours of hospitalization. It is becoming increasingly prevalent in Morocco and abroad[1] and its occurrence is responsible for significant morbidity and mortality.[2]

**Corresponding Author: Elouakfaoui Aziz**, Reader, PhD Student Laboratory of Natural Resources and Sustainable Development Ibn Tofail University, Faculty of Science Kenitra, Morocco.

**E-mail:** elouakfaouiaziz@gmail.com

**Mobile:** +212614389623

The global frequency of these infections measured by international studies, varies from 5 to 10% of hospitalizations. And it varies greatly from one hospital sector to another, both in terms of frequency and type.[3]

The air quality in health care establishments has becoming an increasing concern[4] and requires special attention to protect patients from nosocomial infections caused by micro-organisms.[5]

The airborne micro-organisms are carried by various sized supports: dust, skin flakes, saliva droplets or micro-droplets. The latter are emitted when coughing, sneezing or speaking and remain suspended in the air and can diffuse and penetrate by inhalation to the alveoli of patients.[6]

Several factors influence the contamination of the area, namely seasons, weather conditions, ventilation systems, humidity, the presence of airborne diseases, visitors, human activities and cleaning in hospitals can also affect the air quality.[7,8]

The hospital area thus constitutes an ecological niche of microorganisms that can have a clinical significance, this contamination varies qualitatively and quantitatively from one establishment to another, within the same establishment according to the services, the patients, the care practiced and the capacity of survival of the microorganisms and to remain suspended in the area [9.10]

The microbiological monitoring of the hospital area represents a major element in the fight against nosocomial infections. It allows the identification of airborne bacteria for making a microbial diagnosis in order to carry out corrective, and preventive measures and to reduce the rate of these infections.[11]

The direct involvement of hospital air in the transmission of infections is debatable and remains difficult to assess. Some consider its role to be negligible, others believe that, the covid 19 pandemic has approved to the whole world the importance of prevention against airborne diseases.[12]

The aim of our study is to investigate the pathogenic bacteria found in hospital air in order to assess the degree of aerocontamination with the aim of reducing the rate of nosocomial infections.[13]

## Materials and Methods

**Place and type of study:**

This prospective study of microbiological control of the indoor air of the services in the provincial hospital of Sidi Kacem with a total bed capacity of 202 beds was carried out over a period of six months, from January 1, 2020 to June 30, 2020.

**Sampling sites and technique:**

Fourteen (14) samples were collected in seven (7) departments of the provincial hospital of Sidi Kacem. The departments studied were: intensive care, medicine, emergency, operating theatre, surgery, pediatrics and maternity. The selection of sampling sites was based on the most critical and representative sites in each hospital department. The samples were prepared using the qualitative sedimentation technique based on the exposure of 90 mm diameter Petri plates containing nutrient agar in a 1 $m^2$ area for 30 minutes. The samples were quickly transported an ice box in a temperature of 4°C to the Provincial Laboratory of Epidemiology and Environmental Hygiene for analysis in coordination with the provincial delegation of Sidi Kacem.

**Sample analysis:**

In the laboratory, Petri dishes previously exposed to the air in the seven departments were incubated in a temperature of 37 ± 1 °C. The results reading was done after 48 hours of incubation. The number of colonies, their appearance, size and color were noted and the purification of the different types of colonies was carried out by exhaustion on Plate Count Agar (PCA) medium. The isolated bacterial strains were identified by both the classical biochemical gallery and API (Biomerieux, France). The culture media, distilled water and reagents, materials and equipment, sterilization and other conditions were regularly checked according to the requirements of NM ISO 17025.

## Results

Fourteen (14) air samples from different points of the hospital wards were analyzed in the laboratory (LPEHM) during a period of six (6) months. One (1) sample was negative. A total of eight (08) bacterial

species were isolated from the indoor air of the wards. The distribution of the bacterial strains isolated according to the hospital wards is shown in table 1. We have noted the presence of the following bacterial flora: coagulase-negative Staphylococci (36%) and Bacillus (25%) were predominant, followed by Staphylococci aureus (20%), E. coli (8%) and Klebsiela pneumoniae (4%). Finally, Pseudomonas aeruginosa with a proportion of 3%, Serratia rubidaea (2%), and streptococcus with 2%.

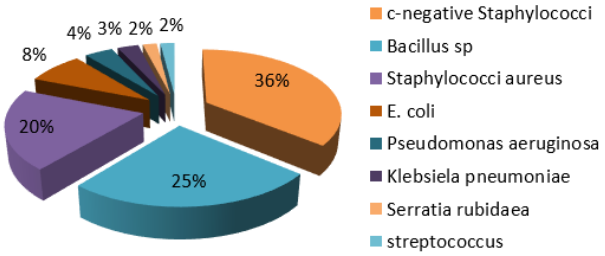


**Figure 1: Percentage and type of isolated bacteria**

The figure 2 represents the distribution of the different bacterial strains isolated from the indoor air of the hospital wards according to the gram coloration. We noticed an equality between the two types of coloration with a percentage of 50% for the two types grams+ and grams.

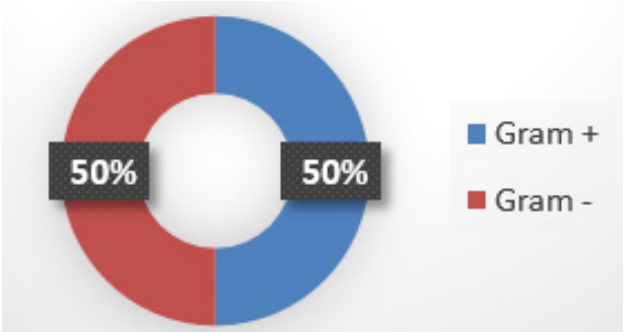


**Figure 2: Gram staining of isolated bacteria**

The figure 3 represents the distribution of the different bacterial strains isolated from the indoor air of the seven hospital departments analyzed. We noticed a predominance of bacterial strains in the intensive care unit (24%) and the emergency department (19%). The medicine department (16%) and the surgery department with (14%), the maternity department (13%), the pediatric department (10%), and the central block (4%).

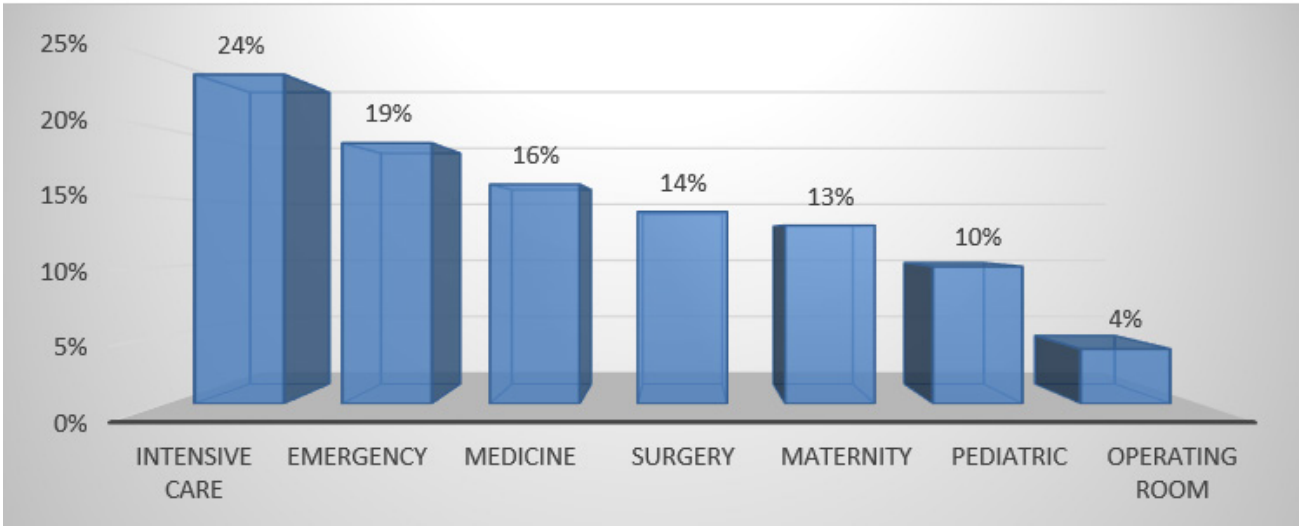


**Figure 3: Distribution of bacteria by department.**

The Microbiological analysis of the air in the hospital wards revealed the presence of Bacillus sp with a percentage ranging from 17% to 26%, coagulase negative staphylococci with a percentage ranging from 25% to 31%, Staphylococcus aureus with a percentage ranging from 11% to 30%, and E. coli with a variation ranging from 11% to 26%, these four bacterial strains are present in the air in all the wards studied. Klebsiela pneumoniae was isolated in all wards except pediatrics and the operating theatre with a percentage variation between 6% and 23%. Serratia rubidae was isolated only in the

emergency department with a percentage of 4% and in the intensive care unit with 5%. Pseudomonas aeruginosa was isolated only in the intensive care unit with a percentage of 12%. Streptococcus was isolated in two departments, emergency and surgery, with a percentage of 3% and 11% respectively.

**Table 1: Percentage of bacteria isolated from the air by department**

| Services<br>Germes isolés | emergency | Medicine | Pediatric | Surgey | Maternity | Intensive care | Operating room |
|---|---|---|---|---|---|---|---|
| S. aureus. | 13% | 18% | 23% | 16% | 20% | 11% | 30% |
| Serratia rubidaea | 4% | - | - | - | - | 5% | - |
| E.coli. | 20% | 11% | 26% | 13% | 15% | 18% | 15% |
| Pseudomonas aeruginosa | – | – | – | – | – | 12% | – |
| Bacillus sp | 24% | 19% | 26% | 20% | 22% | 17% | 24% |
| streptococcus | 3% | – | – | 11% | – | – | – |
| Klebsiela pneumoniae | 6% | 23% | – | 13% | 11% | 12% | – |
| coagulase negative staphylococci | 30% | 29% | 25% | 27% | 32% | 25% | 31% |
| Total | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

## Discussion

The hospital is a place where treatment is provided but it is also a place where the risk of infection is very high and where germs are becoming increasingly resistant. As a result, hospital-acquired infections are recognized as major public health problems because of their frequency, their socio-economic cost and their severity, which affects patients and their families as well as all health professionals.[14.15]

These acquired infections are a worrying reality, especially in high-risk departments that recruit patients who are extremely vulnerable to colonization and consequently to infection.[16]

The scientific evidence for the responsibility of air contamination in nosocomial infections is often difficult to demonstrate because we don't know if this contamination is the cause or the consequence of the infection.(13) However, some studies have reported the incrimination of environmental reservoirs in the genesis of these infections for example Dagata and al. 1999[17], Rampling and al. 2001[18] Zeana and al. 2003[19], Kac and al. 2004[20], and Carling and al. 2008)[21]

Microbiological air monitoring is part of the policy for the control of nosocomial infections and is essential for assessing the quality of air in hospitals. However, these controls are only justified in controlled environment areas. These controls are quality indicators of infectious risk management and require a rigorous and standardized methodology, from sampling methods and analysis techniques to the interpretation of results.[22]

The aim of our study is to research the microorganisms and more specifically the pathogenic bacteria found in hospital air in order to investigate the microbiological quality of hospital air, to evaluate the degree of bio-contamination, and to identify the bacteria that are often the cause of nosocomial infections, and to verify the effectiveness of air treatment processes.

In our study, a total of fourteen (14) microbiological samples were taken and analyzed in the context of the microbiological control of the air in the provincial hospital of Sidi Kacem. A positivity rate of 93% was detected with one (n = 1) sample being found negative. Other studies have shown a similar percentage of contamination for example:

Bekkari and al (2016) for example reported a positivity rate of 92%.[23] kunwar and al (2019) at Kathmandu District Hospital reported a positivity

rate of around 95%.[24] Cabo verde and al (2015) found a percentage of 86.29%.[(5)] Abbas Lamia and al (2017) revealed a contamination percentage of 60% in a study conducted in the public hospital establishment mohamed boudiaf in the wilaya of bouira in Algeria. [(13)] Benmahdi and al (2014) in Algeria found a positivity rate in the order of 96.30%.[25]

In our study, the most contaminated areas were the care rooms and patient wards. This could be related to the fact that these rooms are commonly used by medical staff, patients and visitors and to a lack of air treatment practices.[12]

The results found in our study show a predominance of bacterial species coagulase negative staphylococci with a percentage of 36%, and Bacillus sp with 25%, followed by S. aureus with a percentage of 20%, Klebsiela pneumoniae (4%). Finally, Pseudomonas aeruginosa with 3%, E. coli (8%), Serratia rubidaea (2%), and Streptococcus with 2%. The classification according to gram staining showed an equality between the two types with a percentage of 50% for Gram (+) and Gram (-).

Several studies have found similar results to ours for example: Bekkari and al (2016) who found as results coagulase negative Staphylococci (48%), followed by Bacillus sp (14%), Staphylococcus aureus and Aeromonas salmonicida (8%) for each, Gram negative cocci (7%) and Pseudomonas vesicularis (5%). Other bacteria such as Lactobacillus, Pseudomonas putrificiens, Streptococcus, Aeromonas hydrophila, Serratia liquificiens, putrificiens, Serratia rubidaea and Stenotromonas maltophila were isolated in small proportions.[23]

Benmahdi and al (2014) found The bacteria isolated were coagulase negative staphylococci CNS (84.38%). Acinetobacter baumannii (5.47%). Klebsiella pneumoniae. (3.13%), S. aureus (3.13%), E. coli (2.34%) and Pseudomonas aeruginosa (1.56%).[25]

Cabo verde et. al. (2015) found the following results: Gram-positive cocci with (88%) Staphylococcus (51%), Micrococcus (37%), Gram-negative cocci (5%), Neisseria (4%) Gram-positive rods (2%), Gram-negative rods (2%), Shigella (3%), Proteus (2%) and other (3%).[5]

Abbas Lamia and al (2017) found results as follows: 33.33% for hemolytic Streptococcus sp, a similar rate of 22.22% for S. aureus and S. epidermidis, 16.66% for E. coli and lastly K. pneumoniae with a rate of 5.55%.[13]

Several studies have shown that bacterial strains; Bacillus sp, coagulase negative staphylococci, Staphylococcus epidermidis, Staphylococcus aureus, Escherichia Coli, and Pseudomonas aeruginosa, Acinitobacter (especially A. baumani), and Klebsiella pneumoniae are omnipresent in the hospital environment and can generate a risk of infection for patients, health professionals and visitors. The particularity of these germs is that they have often acquired resistance to antibiotics, such as MRSA (methicillin-resistant staphylococcus aureus) or EBLSE (extended-spectrum beta-lactamase-producing Enterobacteriaceae).[26,27,10,28]

In our study, the distribution of germs by department showed a predominance of bacterial strains in the intensive care unit (24%), and in the emergency department (19%). The other services of medicine and surgery with (16%) and (14%) respectively, maternity (13%), pediatrics (10%), and the central block (4%). In this context other studies have shown similar results: Bekkari and al (2016): All hospital departments studied had a diverse microbial load: trauma (20%), surgery (17%), intensive care (16%), central operating room (14%), neonatology (13%), kitchen (10%), cardiovascular gastrology (7%) and emergency (4%).[23]

Abbas Lamia and al (2017) found that among the strains isolated in hospital setting, the pediatric department occupied the first place with 33.33% of the strains isolated, followed by 27.78% in oncology, and the operative bloc with 23.45%.[13]

Kunwar and al (2019) found that the bacterial load was found to be high in the emergency department (55.8%) compared to the general department (44.2%). There was no significant difference between the bacterial load of the two departments (general and emergency) of different hospitals.[24]

Several studies have shown the existence of pathogenic bacterial strains in hospital air that can cause serious infections for patients, health professionals and visitors. From this reality, we can

see that microbiological control of hospital air is a strategic element in the fight against nosocomial infections. This makes it necessary to develop standardized and periodic procedures and protocols for the management of aerocontamination risks through: a periodic treatment of the air in high-risk areas, a training programme for health professionals in this sense, and periodic microbiological monitoring of the air.

## Conclusion

Our study of the microbiological analysis of the air in the seven hospital wards showed a significant colonization of the air by bacterial species of human and environmental origin that have the potential to infect hospitalized patients, health professionals and visitors. This makes it necessary to carry out periodic microbiological control of hospital air, the principal bacterial strains isolated being: coagulase negative staphylococci 36%, bacillus sp 25%, staphylococcus aureus 20% and E. coli (8%). The overall contamination rate is around 93%, with a variation between departments, the most contaminated places being the care rooms and the hospitalization rooms of patients. The aim of our study is to reduce the rate of nosocomial infections. Our results show the importance of installing a risk management system based on preventive measures.

**Conflicts of Interest:** All authors have no conflict interest to declare.

**Source of Funding:** The source of the research cost from self.

**Ethical Clearance** : Nil

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