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# Microbiological assessment of Hospital Indoor Air Quality in Ekpoma, Edo State, Nigeria.

Omoigberale M. N. O.<sup>1\*</sup>, Amengialue, O. O.<sup>2</sup> and Iyamu, M. I.<sup>1</sup>

<sup>1</sup> Department of Microbiology, Faculty of Natural Sciences, Ambrose Alli University, Ekpoma, Edo State, Nigeria.

<sup>2</sup> Department of Microbiology, College of Natural and Applied Sciences, Wellspring University, Benin City, Edo State, Nigeria

Corresponding author's Email: [may.oyas@yahoo.com](mailto:may.oyas@yahoo.com)

Accepted 10<sup>th</sup> June 2013.

A quantitative and qualitative study of indoor air in two hospitals in Ekpoma, Edo State was carried out. Samples were collected using the settle plate method for the enumeration of bacterial and fungal isolates. This study is aimed at checking the microbial concentration of indoor air as it relates to hospital type, ward and sampling time. The total heterotrophic microbial population varied in the wards sampled from hospital to hospital. The bacterial population ranged from 18cfu/m<sup>3</sup> to 288cfu/m<sup>3</sup> in Faithdome hospital and 8cfu/m<sup>3</sup> to 494cfu/m<sup>3</sup> in Eromosele hospital. The fungal population ranged from 9cfu/m<sup>3</sup> to 26cfu/m<sup>3</sup> in Faithdome hospital and 3cfu/m<sup>3</sup> to 45cfu/m<sup>3</sup> in Eromosele hospital. The microbial flora isolated included six bacterial and six fungal genera among which are *Staphylococcus aureus*, *Klebsiella* spp, *Streptococcus* spp, *Bacillus* spp, *Pseudomonas* spp, *Escherichia coli*, *Aspergillus* spp, *Penicillium* spp, *Candida* spp, *Trichophyton* spp, *Microsporium* spp and *Rhizopus* spp. The degree of microbial distribution was highest in the waiting room and lowest in the theatre.

**Keywords** : Nosocomial infection, Indoor air, *Staphylococcus aureus*

## INTRODUCTION

Air is a resource that supplies us with oxygen which is essential for our bodies to live. Pure air is a mixture of gases that are invisible, colorless and odorless consisting of 78% nitrogen, 21% oxygen and other gases as well as varying amounts of water vapor. (Murray *et al.*, 1995). This pure air can become contaminated in various ways affecting humans, plants and animals. Air pollution is the introduction into the atmosphere of chemicals, particulate matter or biological materials that causes discomfort, disease or death to humans, damage to other living organisms including food crops. Both indoor air and outdoor air can become polluted by pesticides. These pesticides contain active and inert substances such as cyclodiene which is associated with symptoms such as dizziness, headaches, weakness, muscle twitching and nausea (Hays *et al.*, 1995).

Indoor air quality is a term which refers to the air quality within and around buildings and structures especially as it relates to the health and comfort of its occupants. Indoor air can be polluted by various compounds such as carbon monoxide, volatile organic compounds (VOCs), particulate matter and microbial contaminants (moulds, bacteria, viruses) and any action that introduces harmful contaminants into the air within the building. The concern for quality indoor air is necessary especially in institutionalized settings that accommodate a large number of people such as hospitals, nursing homes, prisons, schools, family houses, offices, dispensaries, hotels and classes

because contaminated air can cause both mild and severely irritating health conditions. (Tambeker *et al.*, 2007). The quality of air in hospitals in relation to microbial contamination at a given time period is determined by the quality of air entering into the building, the number of occupants in the building, their physical activities and resultant aerosol generation, human traffic and the efficiency of ventilation. (Adebolu and Vhirterhre, 2002).

Nosocomial infections are infections acquired by patients when admitted into hospital wards for proper management of their ailment but while on admission, some patients acquire other ailments other than the one they were admitted for. This results from contact with a carrier of the pathogen directly or indirectly through inanimate objects. Improper/unhygienic ventilation system can continually be a source of nosocomial infection (Allyife *et al.*, 1999). Sneezing has been described as the most vigorous mechanisms of generating millions of air borne

microbial infections into the hospital environment (Pasquaria *et al.*, 2000). While the larger droplets fall to the ground or nearby surfaces, smaller ones are rapidly evaporated into a non-volatile form where they remain suspended in the air thereby serving as a source of infection when inhaled by other occupants of the hospital including staff

Hospital acquired infections are an important cause of morbidity and mortality in hospitals in both the developing and developed worlds. The rate of this

infection varies from 5-10% in the developed countries to 25% or more in developing countries. These infections are mostly caused by microorganisms or surfaces contaminated by the microorganisms or air currents and dust containing microbial infections nuclei. (Odimayo *et al.*, 2008). Bacteria that can be spread through the air include; *Mycobacterium tuberculosis*, *Bacillus anthracis*, *Bordetella pertussis* which cause pulmonary tuberculosis, pulmonary anthrax and whooping cough respectively (Sadharsanam *et al.*, 2008). Nosocomial infections can cause severe pneumonia, infections of the urinary tract, bloodstream and other parts of the body. The microorganisms implicated can enter the body through wounds, catheters as well as by inhalation. (Prescott *et al.*, 1999). In the tropics, researchers have identified microorganisms such as: *Staphylococcus aureus*, *Escherichia coli*, *Candida spp*, *Streptococcus spp*, *Klebsiella*, *Penicillium*, *Aspergillus* and *Bacillus spp* are some of the most commonly isolated microorganisms from hospital environments. Moulds are particularly important as a source of indoor air pollution because of their ability to produce harmful spores and mycotoxins (Prigane *et al.*, 2004). These pathogens are capable of causing hospital acquired infections that range from gastroenteritis, bedsores and urinary tract infection. (Odinayo *et al.*, 2008).

Factors that predispose patients to nosocomial infection include; Invasive devices such as catheters and surgical drains, patients treatment which can leave them immunosuppressed and immunodeficient since patients in the hospitals are usually already in a poor state of health. This study is therefore aimed at checking the microbial concentration of indoor air in two hospitals (Faithdome hospital and Eromosele hospital) in Ekpoma and to compare the microbial counts as it relates to the hospital, type of ward and sampling time.

## MATERIALS AND METHODS

### STUDY AREA.

The study was carried out in two privately owned hospitals within Ekpoma, Esan West local government area of Edo State namely; Faithdome hospital and Eromosele hospital. Five wards were used for sample collection in each hospital. These wards included; the male ward, female ward, operating theater, waiting room and children's ward.

### SAMPLING

Passive monitoring using the settle plate method was done by exposing petri dishes containing culture media at different locations in the wards examined. The sampling was done in the morning and evening. Culture plates containing nutrient agar and sabouraud dextrose

agar were exposed on a stool and allowed to stay for 30 minutes. Thereafter, the plates were covered and transferred immediately to the laboratory for incubation.

## MICROBIOLOGICAL EXAMINATION

All nutrient agar plates were incubated at 37°C for 48 hours. The total numbers of bacterial colony forming units per cubic meter were counted and recorded. The colonial morphology of the colonies formed were noted and identical colonies were sub cultured into nutrient agar plates and incubated at 37°C for 24 hours and stored for further examination. Sabouraud dextrose agar plates were incubated at a room temperature of 20°C for 5 to 7 days. The fungal colonies were enumerated after which morphological and colonial characteristics of each colony was identified according to the manual of Barnet and Hunter, (1972). Microscopic examination of the fungal hyphal characteristics was carried out. This was done by taking a tiny portion of the fungal colony using an inoculating needle and macerating it on a clean slide. Lactophenol cotton blue was then added to the microscopic slide after which a cover slip was placed on the emulsion before observing microscopically.

## STATISTICAL ANALYSIS

SPSS was used to carry out T – test on the microbial counts to test for statistical significance as it relates to the sampling time, the hospital and the ward.

## RESULTS

The total viable count for bacteria obtained from Faithdome hospital and Eromosele hospital is shown in Table 1. The lowest count was 18cfu/m<sup>3</sup> obtained for the theatre while the highest count of 288cfu/m<sup>3</sup> was obtained for the waiting room in Faithdome hospital. For Eromosele hospital the highest bacterial count of 492cfu/m<sup>3</sup> was obtained from the evening sample in the waiting room while the lowest count of 8cfu/m<sup>3</sup> was obtained for the theatre.

For fungi count in Faithdome hospital, the lowest count was 9cfu/m<sup>3</sup> obtained for the waiting room and the highest count of 26cfu/m<sup>3</sup> was obtained in the male ward. In Eromosele hospital, the highest fungal count of 45cfu/m<sup>3</sup> was obtained in the evening in the male ward while the lowest count of 3cfu/m<sup>3</sup> was obtained in the theatre (Table 2). Table 3 shows the frequency of occurrence of microorganisms isolated from five wards in Faithdome and Eromosele hospitals.

**TABLE 1: CONCENTRATION OF BACTERIA POPULATION IN INDOOR AIR OF FIVE WARDS IN FAITHDOME AND EROMOSELE HOSPITAL IN EKPOMA (cfu/m<sup>3</sup>)**

| STUDY AREA                       | SAMPLING TIME |             |
|----------------------------------|---------------|-------------|
|                                  | 8:00-10:00am  | 4:00-6:00pm |
| <b>Faithdome medical center.</b> |               |             |
| Male ward                        |               |             |
| Female ward                      |               |             |
| Children ward                    | 176           | 216         |
| Theater                          | 164           | 224         |
| Waiting room                     | 120           | 272         |
|                                  | 53            | 18          |
|                                  | 212           | 288         |
| <b>Eromosele medical center.</b> |               |             |
| Male ward                        |               |             |
| Female ward                      |               |             |
| Children ward                    | 184           | 344         |
| Theater                          | 216           | 376         |
| Waiting room                     | 184           | 392         |
|                                  | 8             | 23          |
|                                  | 404           | 492         |

**TABLE 2: CONCENTRATION OF FUNGI POPULATION IN AIR OF FIVE WARDS IN FAITHDOME HOSPITAL AND EROMOSELE HOSPITAL IN EKPOMA (cfu/m<sup>3</sup>)**

| STUDY AREA                      | SAMPLING TIME |             |
|---------------------------------|---------------|-------------|
|                                 | 8:00-10:00am  | 4:00-6:00pm |
| <b>Faithdome medical center</b> |               |             |
| Male ward                       | 17            | 26          |
| Female ward                     | 10            | 21          |
| Children ward                   | 17            | 23          |
| Theater                         | 10            | 15          |
| Waiting room                    | 9             | 19          |
| <b>Eromosele medical center</b> |               |             |
| Male ward                       | 13            | 45          |
| Female ward                     | 9             | 15          |
| Children ward                   | 7             | 81          |
| Theater                         | 3             | 7           |
| Waiting room                    | 15            | 21          |

**TABLE 3: FREQUENCY OF OCCURRENCE OF HOSPITAL AIR MICROORGANISMS ISOLATED FROM FIVE WARDS IN FAITHDOME AND EROMOSELE HOSPITAL IN EKPOMA.**

| MICROBIAL ISOLATES           | MW  | FW  | CW  | OT | WR  |
|------------------------------|-----|-----|-----|----|-----|
| <i>Escherichia coli</i>      | +++ | +++ | ++  | ++ | ++  |
| <i>Streptococcus spp</i>     | ++  | ++  | +   | +  | +++ |
| <i>Staphylococcus aureus</i> | +++ | ++  | ++  | ++ | +++ |
| <i>Klebsiella spp</i>        | ++  | ++  | +   | +  | ++  |
| <i>Staphylococcus aureus</i> | +   | ++  | ++  | +  | ++  |
| <i>Bacillus spp</i>          | +   | +   | +   | +  | +   |
| <i>Pseudomonas spp</i>       | ++  | +   | -   | +  | +   |
| <i>Candida albican</i>       | +++ | +   | +   | +  | +   |
| <i>Aspergillus spp</i>       | +++ | ++  | +++ | -  | +   |
| <i>Penicillium spp</i>       | ++  | ++  | +++ | +  | +++ |
| <i>Rhizopus spp</i>          | +   | +   | ++  | -  | +++ |
| <i>Microsporium spp</i>      | +   | +   | +   | -  | +   |
| <i>Trichophyton spp</i>      | +   | +   | +   | -  | ++  |

**Key**

|                    |                          |
|--------------------|--------------------------|
| +++.... Numerous   | MW-----Male ward.        |
| ++.... Scanty      | FW-----Female ward       |
| +.... Very scanty. | CW-----Children ward     |
| -.....negative     | OT-----Operating theatre |
|                    | WR-----Waiting room.     |

**DISCUSSION**

This study revealed that the waiting room of Faithdome and Eromosele hospital had a bacterial load of 288cfu/m<sup>3</sup> and 492cfu/m<sup>3</sup> respectively and it is inline with the results obtained by Awosika, *et al.*, (2012) in Sagamu, Ogun state, Nigeria. This can be attributed to the physical activities carried out by patients, doctors, nurses and the exchange between indoor and outdoor air which raises the microbial load. This results agrees with the work of (Hyvarien *et al.*, 2001), which reported the role of outdoor microbial concentration through opened windows and doors in raising the microbial load of indoor air in buildings.

The theatre in both hospitals recorded the least microbial concentration. In Faithdome hospital, bacteria count in the theatre ranged from 18 to 53cfu/m<sup>3</sup>, while fungal count ranged from 10 to 15cfu/m<sup>3</sup>. Eromosele hospital recorded a bacterial count that ranged from 8 to 23cfu/m<sup>3</sup> and a fungal count that ranged from 3 to 7cfu/m<sup>3</sup> in the theatre. This is due to the restriction of movement in and out of the theatre, high sanitary standards and their locations. These findings corresponds with results obtained by Ekhaise *et al.*, (2008) when he assessed the air quality of two hospitals in Benin City. The least microbial count was also obtained in the theatre. The microbial floral isolated included six bacterial and six fungal genera. *Staphylococcus aureus*, *Klebsiella spp*, *Escherichia coli* and *Aspergillus spp* were isolated from all the wards sampled in both hospitals. This agrees with the finding of Jaffal *et al.*, 1997; Awosika *et al.*, 2012).

The statistical analysis to compare the microbial count as it relates to the ward, time of sampling and hospital type showed no significant difference except for between the sampling times for fungal count in Faithdome hospital.

Results from this study shows that the indoor air in of both hospitals sampled had a high microbial load. *Staphylococcus aureus* is known to be easily carried in the nasopharynx, throat, skin, cuts, boils, nails and as such can easily contribute to the microbial flora in the hospital environment causing post-operative infections, respiratory tract infections, bed sore and food poisoning under favorable conditions.

*Klebsiella spp* and *Escherichia coli* are associated with urinary tract infections among catheterized patients. *Bacillus spp* are spore forming bacteria that can survive for long periods in the environment causing serious medical problems. *Aspergillus* has also been associated with incidence of nosocomial infection in immunocompromised patients. Apart from these infections, allergic reactions have been reported following inhalation of fungal spores, making it important to pay attention to their presence in hospital air.

**CONCLUSION**

The acquisition of potentially pathogenic microorganisms from hospitals which can cause life threatening nosocomial infections necessitates the recommendation that improved hygiene procedures such as regular cleaning, sweeping and disinfection of surfaces be put in place in all health care settings. Restriction of patient's relatives may also be necessary in order to reduce the microbial load of indoor air in all wards within the hospitals. Overcrowding should be avoided in all units within the hospitals this is because crowded places increases the chances of contracting an infection and these infections may subsequently spread and antibiotics resistant strains of the pathogens may emerge leading to more severe and untreatable infections. Better and well constructed

ventilation systems should be provided in hospitals as this would go a long way in reducing the microbial load in hospitals.

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