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AIRBORNE MICROFLORA IN AN HOSPITAL ENVIRONMENT OF UNIVERSITY OF BENIN TEACHING HOSPITAL (UBTH), BENIN CITY, NIGERIA

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ABSTRACT

A study was undertaken to determine typical concentrations of airborne bacteria and fungi (microflora) in Teaching Hospital environment in Benin City in the tropical rainforest environment of Nigeria. Aerial sampling was conducted at various hospital wards each day. The air samples were collected thrice daily, that is, in the morning, between 8am and 10am, in the afternoon, between 12noon and 2pm and in the evening between 4pm and 6pm. Concentrations of airborne microflora exceeded available local guidelines for indoor quality in the accident and emergency ward, female ward, male ward, pediatric ward and the maternity ward, but not in the restricted wards like the theatre, intensive care unit and bacteriological laboratory. Results showed that the occupant density was the key factor influencing the levels of airborne microflora, while humidity was also observed as a factor, depending on the particular location with the hospital.

The concentration of airborne bacteria and fungi in the nine different hospital units varied from wards to wards. The bacterial population ranges from 3.0cf/m3 to 76.0cf/m3, with the highest bacterial population recorded in the accident and emergency ward. The fungal population ranges from 6.0cf/m3 to 44.7cf/m3, while the highest fungal population was recorded in the accident and emergency ward. The microflora characterized and identified, were representative of the normal microflora of the human body (skin, gastrointestinal tracts, respiratory tract) and the opportunistic pathogens. The microbial isolates included six bacterial genera, among which are, Staphylococcus aureus, Staphylococcus epidermis, Escherichia coli, Bacillus sp. and Proteus mirabilis, the fugal isolates included, Aspergillus sp, Penicillium sp., Mucor sp., Candida sp and Verticillium sp. The variations in hospital units in concentrations of total airborne microorganisms (bacteria and fungi) in the air of hospital environments were statistically significant ($p<0.001$). The concentrations of airborne microflora recorded in the hospital environment, specifically in the accident and emergency ward was significantly different from other wards ($p<0.001$), with the mean value of 40.0 and 72.2 for fungal and bacterial population respectively.

KEYWORDS: Airborne, microflora, hospital environment, time, UBTH, Benin City, Nigeria.

INTRODUCTION

Microorganisms abound in the earth's atmosphere as particle or bacteria, fungi, lichen and algal cell. The composition and concentration of these particles are generally related to man's activities (Lacey, 1981). Atmospheric pollution is one of the most pressing problems of our age. This pollution has now reached an advance level that possesses threat to the health and wellbeing of the people (Ekhaise, Ighosewe and Ajakpovi, 2008). The quality of the indoor environment, however, is not easily defined or controlled, and can potentially place human occupants at risk (Jaffal, Nsanze, Bener, Ameen, Banat and El Mogheth, 1997a).

Microorganisms are the primary sources of indoor air contamination. The indoor air environment can potentially place patients at greater risk than the outside environment, because enclosed spaces can confine aerosols and allow them to build up to infectious levels (Jaffal, Banat El Mogheth, Nsanze, Bener, and Ameen, 1997b). Indoor biological pollution has only recently begun to receive the afforded attention. The apparent lack of interest is tied to the difficulties in sampling biological aerosols as well as the evaluation of their variable health effect (Yungiger, Jones and Gleich, 1976). The indoor environment can potentially place human occupants at greater health risk than the outdoor, because enclosed spaces can confine aerosols and allow to build to infection levels.

Nosocomial infections also known as hospital acquired infection are infections acquired from healthcare services (hospitals) during treatment, which are secondary to the patient's original condition. The source and spread of organisms inside the hospital are important issues, human related organisms or the body flora, also found in clothing are spread through shedding during human activities (Ekhaise et al. 2008). Organisms frequently involved in hospital infections include, Staphylococcus aureus, Micrococcus spp. Pseudomonas spp. alpha - hemohytic Streptococci, Cladosprium spp. Aspergillus spp. and viruses (Ekhaise et al. 2008). Adebolu and Vhriterhire (2002) reported that, people that go to hospitals are prone to nosocomial infections, whose magnitude is dependent upon the level of hygienic conditions of the hospital environment, the number and type of visitors. Other factors include the quality of the hospital systems and mechanical

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movement within the enclosed space (Dutkiewicz and Augustowska, 2006).

This study was aimed at investigating the concentrations and type of airborne microorganisms in University of Benin Teaching Hospital, Benin City environment. The Teaching Hospital was chosen for the study due to its high patronage by patients from Edo, Delta, Ekiti and Ondo States, in order to ascertain the nature of the air quality in the hospital environment.

MATERIALS AND METHODS

Study Area: University of Benin Teaching Hospital (UBTH) Benin City was used for the study. The samples for the study were collected from nine different units in the hospital, these includes the male ward, female ward, children ward (pediatric), theater, accident and emergence ward (A and E), microbiology laboratory, maternity ward, labour ward and intensive care unit.

Air Sampling and Microbiological Examination: The microbiological samples were collected from nine (9) units in the Teaching Hospital using the exposed prepared plate techniques (Dutkiewicz and Augustowska, 2006). The samples were collected three times a day that is, in the morning, between the hour of 8.00am and 10.00am, in the afternoon 12noon – 2.00pm and in the evening, 4.00 – 6.00pm. The exposed plates containing the growth medium (nutrient agar and potato dextrose agar media) were allowed to stay for about 10-20minutes of exposure. Upon exposure, the plates were transported in a clean container to the laboratory for microbiological examination. The bacterial culture plates were incubated at 37oC for 24-48hours while the fungal culture plates were incubated at (28oC) room temperature for 3-4days. The total number of colony forming unit (cfu) was enumerated and converted to organisms per cubic meter air. Bacterial isolates were characterized and identified according to the methods of Buchanan and Gibbons, (1974); Gerherdt, Murray, Wood, and Krieg (1994). The fungal isolated were characterized and identified according to the manual of Barnett and Hunter (1972).

Statistical analysis. The data were analyzed by Kuskal – Wallis one - way analysis of variance for distribution, chi2 Test and Tukey Pairwise comparison for correlation (Dutkiewicz and Augustowska, 2006).

RESULTS

Microbial Load in Study Areas:

The total airborne microbial population of the nine different units studied in University of Benin Teaching Hospital varied from units to units (Tables 1 and 2). The concentrations of the total airborne microorganisms (bacteria and fungi) varied with time of investigations. The concentration of airborne bacterial from the different unit was recorded high in the evening compared to morning and afternoon time of studies. The population ranges between 3.7 and 76.0cfu/m-3 (Table 1). The concentration of the airborne fungal organisms was recorded high in the evening, though while compared to the population recorded in the morning. The population ranges between 9.0 and 44.7cfu/m-3, 14.0 and 35.3cf/um-3 for evening and morning respectively (Table 2). In the study among the different units in the three different times, the male, female, maternity, accident and emergency, and children wards were observed to record high bacterial and fungal counts.

Table 1: Concentration of airborne bacterial population in air of nine units in UBTH, Benin City (cfu/m3)

Study area	Sampling Time		
	Morning 8:00-10:00am	Afternoon 12:00-2:00pm	Evening 4:00-6:00pm
Female ward	23.30	35.7	29
Male ward	52.0	40.3	60.3
Microbiology Laboratory	03.7	05.3	05.3
Paediatric ward	36.3	14.3	55.0
Maternity ward	42.3	18.0	63.0
Theatre	55.7	21.3	35.7
Accident and Emergency ward	73.0	67.7	76.0
Intensive care unit	14	6.0	14.3
Labour ward	30	18.7	09

Table 2: Concentration of airborne fungal population in air of nine units in UBTH, Benin City (cfu/m3)

Study area	Sampling Time		
	Morning 8:00-10:00am	Afternoon 12:00-2:00pm	Evening 4:00-6:00pm
Female ward	18.3	18.0	17.0
Male ward	9.0	16.7	10.3
Microbiology Laboratory	17.0	10.0	9.0
Paediatric ward	21.0	13.0	33.7
Maternity ward	19.0	21.6	26.0
Theatre	24.3	21.3	15.0
Accident and Emergency ward	35.3	39.7	44.7
Intensive care unit	13.3	6.0	17.7
Labour ward	16.7	18.7	25

Composition and Frequency of Airborne Microflora

The composition of microflora isolated from the air of the different hospital units is presented in Table 3. Six bacterial and five fungal genera isolates were isolated from the different units, among which are, Staphylococcus aureus, Escherichia coli, Bacillus spp, and Protein mirabilis were observed to be the most prevalent. Aspergillus sp. and Penicilluim sp. were the fungal isolates most commonly isolated in the units studied. The degree of frequently of microbial distribution was recorded high in the order presented below, accident and emergency, female, male, bacteriology laboratory, children theatre wards and Intensive Care Unit (ICU).

Statistical Analysis: Correlation between concentration of airborne microorganisms (airborne microbial load) and hospital wards: The data were analysed using Kruskal – Wallis one way anlaysis of variance. The result shows significant chi-square 0.001. The data were subjected to pairwise comparison test using Turkey at 95% confidence interval, it was showed that, the fungi load were significantly not different for the wards studied, except for the accident and Emergency Ward (AEW) which has a mean estimate of 40.0 and was significantly different from all other wards. The same test was used to analyze the correlation between the bacterial loads and the various wards. The bacterial load in bacteriological laboratory (BL), intensive care unit (ICU) and labour ward (LW) were significantly not different, except the female ward (FW) which was, significantly different from BL, ICU and LW.

The bacterial load in the pediatric ward (PW) was significantly different from the bacterial load in the female (FW) and labour wards (LW), the bacterial load in male ward was (MW) significantly different, from the bacterial load in the Theatre Ward (TW) and Pediatric Wards (PW), while the bacterial load present in Accident and Emergency Ward (AEW) with a mean value of 72.22 was significantly different from the bacterial load present in male ward (MW), Theatre Ware (TW), and Pediatric Ward (PW) (Table. 5)

Table 3: Frequency of Occurrence of hospital airborne Microorganisms isolated in nine units in UBTH, Benin City.

Microbial isolates	Male ward	Female ward	Children's ward (paediatric)	Theatre	Bacteriology Laboratory	A & E	Intensive care Unit	Labour ward	Maternity war 2
Staphylococcus aureus	+++	+++	+++	+ - -	+++	+++	+++	+++	+++
Staphylococcus epidermidis	- - -	- - -	- - -	- + -	+ - -	+++			
Escherichia coli	++-	+- -	- - -	- - -	- - -	++-	- - -	+ - +	++ -
Bacillus spp	+++	+++	- - -	+ + +	+++	+++	- - -	- - -	- ++
Proteus mirabilis	+++	+++	+ - +	- - +	+++	+++	- - -	- - -	- ++
Streptooccus spp	+ - -	++ -	+ - -	+ - -	+ - -	+++	- - -	- - -	- ++
Aspergillus spp	+++	++ -	+++	- + -	+++	+ - +	+++	+++	+++
Penicillim spp	+++	+++	+ - -	- - -	- - -	+++	- - +	+++	- ++
Mucor spp	- - +	++ -	- - -	- - -	- - -	- - -	++ -	- - -	+ - -
Candida spp	- - -	- - -	+ - +	- - -	- - -	- - -	- - +	- - -	+ - -
Verticillium spp.			- - -				- - -	+ - -	

Key: +++ = very good, ++- = good, +-- = Positive, - - - = negative

Table 4: Bacterial Load – Turkey Pairwise comparison

Identifier	Mean
BL	4.67
ICU	11.44
LW	19.22
FW	28.67
PW	35.22
TW	40.56
MW	45.94
AEW	72.22

Keys: BL = Bacteriological laboratory
ICU = Intensive care unit
LW = Labour ward
FW = Female ward
PW = Paediatric ward
TW = Theatre ward
MW = Male ward
AEW = Accident and Emergency ward

Table 5: Fungal load: Turkey Pairwise comparison

Identifier	Mean
BL	11.89
ICU	12.33
MW	17.06
FW	17.78
LW	20.11
TW	20.22
PW	22.44
AEW	39.89

Keys: BL = Bacteriological laboratory
ICU = Intensive care unit
MW = Male ward
FW = Female ward
LW = Labour ward
TW = Theatre ward
PW = Paediatric ward
AEW = Accident and Emergency ward

DISCUSSION

The concentration of airborne microflora in air hospital environment of University of Benin Teaching Hospital (UBTH), Benin City, Nigeria (a Federal Government owned Teaching Hospital) studied, showed that, the hospital claim to be a place of high hygienic conditions, is believed to be a source and reservoir of infections microorganisms. The discharge of these infectious microorganisms into the environment are through sneezing, coughing, talking, contact with hospital materials and the uncontrolled movement of in and out of the hospital environment. These infectious microorganisms are known to be common source of nosocomial infection in the hospital environment. Putsept (1981) reported that, approximately one of every five thousand patients attending an American hospital dies of an infection contracted in the hospital. It is believed that, the environment where patients are treated therefore has an important influence on the likelihood of such recovering or acquiring infection that may complicate their conditions.

The quantitative study of the different hospital units showed that, the accident and emergency ward recorded the highest airborne bacterial and fungal population, while the least airborne bacterial and fungal population was recorded with the Bacteriological laboratory. The microbial isolates characterized and identified included six bacterial and five fungal isolates, they include, Staphylococcus aureus, Staphylococcus epidermis, Escherichia coli, Bacillus sp., Proteus mirabilis and Streptococcus sp. for the bacterial isolates, while the fungal isolates includes Aspergillus sp. Penicillium sp., Mucor sp., Candida sp. and Verticillium sp. Jaffal et al. (1997a and b) and Ekhaise et al. (2008) isolated the same microbial isolates. Among the microbial isolate, Staphylococcus aureus, was reported to be the most prevalent bacterial isolate followed by Proteus mirabilis, while Aspergillus sp. and Penicilium sp. where observed to be the most prevalent fungal isolates. Jaffal et al. (1997b) reported that, the fungal isolates, Aspergillus, Chaetomium and Alternanria were found to be most frequently isolated indoor microorganisms.

The prevalence of Staphylococcus aureus, in the indoor environment, especially in the hospital environment, could be attributed to its easy way of transmission through the agents such as throat, skin, cuts, boils, nails and nasopharynx (Ekhaise et al. 2008), and other hospital activities. In the study, the different hospital units played significant role in the distribution of

microorganisms, the accident and emergency ward showed a highly significant variation which was distinctly compared to other units (Table 4 and Table 5). The bacterial load present in the accident and emergency ward was significantly different from other hospital wards (units) studied. The same result was recorded for the fungal load. The result could be attributed to the high rate of in and out movement of people, because the accident and emergency ward serves as the first entering point to the hospital, before patients are referred to the assigned unit.

It could be inferred that, hospital plays significant role in the spread of common nosocomial infection, the magnitude of which depends on the level of hygienic conditions of the hospital environment. It is advisable that strict measures should be put in place to check the increasing microbial load in the hospital environment. This is necessary, because a place where people go to get well and promote life now serves as an avenue to contact diseases and diminish human health. The indoor environment can potentially place human occupant at higher risk than the outside spaces (Adeeb, 2003), because enclosed spaces help to confined aerosols, which allows them to buildup to potentially infectious levels.

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