

## Original Research Article

# Indoor Airborne Bacterial Load in Neonatal, Perinatal Intensive Care Units and Pediatric Wards at Tertiary Care Hospital Bagalkot, India

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## ABSTRACT

Hospital indoor air contains a diverse range of microbial population. Micro-organisms are the primary source of indoor air contamination. The indoor air environment can place patients at greater risk than the outside environment. Objective of the study is to investigate the quantity and quality of airborne microorganisms in the Neonatal, paediatric intensive care units and paediatric wards. The samples were collected from neonatal, paediatric intensive care units and paediatric wards. Samples were collected by exposing nutrient agar plates for 30 min and were collected between 10am and 11 am and between 4pm and 5pm. Plates were incubated at 37°C for 24 to 48 hrs. The total number of colony forming units (CFU) was calculated. Bacterial colonies were identified by conventional methods. Maximum bacterial loads were obtained during peak activity in the morning hours. Colonies of Gram positive cocci were higher than colonies of Gram negative bacilli. Coagulase negative *Staphylococci*, *Micrococci*, *Bacillus species*, *Klebsiella species*, *E. coli*, *C. freundii* and *P. aeruginosa* were isolated. Factors such as levels of activity, ventilation, humidity and overcrowding increase the airborne microbial loads in different units of the hospital. This emphasizes the need for proper designing for closed systems with appropriate ventilation and segregation of patients is necessary to prevent microbial air contamination.

## Keywords

Indoor air,  
CFU,  
Neonatal and  
paediatric  
intensive care  
units,  
Paediatric  
wards

## Introduction

Hospital indoor air contains a diverse range of microbial population. Micro-organisms are the primary source of indoor air contamination. The indoor air environment can place patients at greater risk than the outside environment because enclosed spaces can confine aerosols and allow them to build up to infectious levels (Ekhaise *et al.*, 2008; Jaffal *et al.*, 1997; Lewis, 1994). Microorganisms such as bacterial and fungal

spores are almost always present in the air. The quality of indoor environment, however, is not easily defined or readily controlled, and can potentially place human occupants at risk (Ekhaise *et al.*, 2008).

Atmospheric pollution is one of the most pressing problems of our age. This pollution has now reached an advance level those posses a potential threat to the health and

well being of the population. The atmosphere consists of different component, which enhance or promote the survival of microorganisms in the air. It is composed of 75% nitrogen, 21% oxygen, 0.9% argon, 0.03% carbon dioxide and 0.076% other trace gases, very low concentration of organic and inorganic nutrients and free waters as an irregular internals (Ekhaise *et al.*, 2008).

The biological quality of air in hospital environments is of particular concern as patients may serve as a source of pathogenic microorganisms to staff and hospital visitors, in addition to fellow patients. Although hospitalization and medical procedures are designed to cure diseases, they can sometimes inadvertently introduce pathogenic microorganisms into the body and initiate a nosocomial infection. The most important source of airborne pathogens inside the hospital is the infected patient. Airborne transmission occurs when pathogenic microorganisms are transferred from an infected to a susceptible individual via the air. The predominant mechanism that makes the pathogens airborne is the production of aerosol droplets by sneezing or coughing, and their subsequent loss of water which allows them to float in the air over considerable distances and for a long time. Biological aerosols contain bacteria, viruses, yeasts, molds and fungal spores. Under special clinical circumstances, skin lesions may also be a source of airborne particles (Quadiset *et al.*, 2009).

Healthcare facilities are complex settings, especially in developing countries, where factors such as overcrowding, improper design and ventilation can impact the growth and / or survival of microorganisms. Climatic conditions such as excessive humidity and moisture of walls and ceilings may facilitate fungal colonisation. Physical parameters such as temperature and

humidity are known to influence the ability of microorganisms to survive and be airborne (Lewis, 1994). In a tropical setting where hot and humid climatic conditions prevail, it is necessary to monitor airborne microbial concentrations and determine if there are variations in the microbial concentrations and their types with changing climatic conditions (Sudarshanam *et al.*, 2012).

The study was undertaken to investigate the 1) quality and quantity of airborne bacterial load in Pediatric wards, Neonatal and Pediatric intensive care units 2) To ascertain their contribution in causing hospital infections 3) Initiate corrective measures to minimize air borne related infections.

## **Materials and Methods**

### **Study area**

The study was carried out in Department of Microbiology, B. V. V. Sangha's S. Nijalingappa Medical College and Hanagal shri Kumareshwar Hospital and Research Centre Navanagar, Bagalkot. The samples were collected from neonatal, paediatric intensive care units and paediatric wards using settle plate technique.

### **Sample collection and processing**

Walk through was conducted prior to every sampling to gather details on the existing local environmental conditions and the extent of activity. Depending on the nature of activity, the extent of activity was graded as minimum (talking), moderate (talking, movement of patients and delivering healthcare to patients) and maximum (talking, movement of patients, delivering healthcare to patients, and cleaning which includes change of bed linens and mopping of floors).

Settle plate technique using Petri dishes containing nutrient agar media was used. Three plates of nutrient agar media were distributed at different parts of NICU, PICU and paediatric wards examined. The sampling was done at morning hours (10am and 11am) and evening (4pm–5pm). The plates containing nutrient agar medium were exposed and allowed to stay for 20 min, after which the plates were covered and transferred to the hospital’s Microbiology laboratory Unit. The nutrient agar plates were incubated at 37°C for 24–48 hrs. The total number of colony forming units (CFU) was enumerated. The identification of the isolates was done according to standard procedures.

**Identification of Microorganisms:**

Bacterial colonies were initially characterised by cultural, morphological and microscopic examinations and further identified by biochemical examination as per standard procedures.

**Results and Discussion**

A total number of six wards were studied. Air borne bacterial load of the selected six wards were varied from units to units. The bacterial load was higher in morning samples than the evening samples.

Among NICU, PICU and Paediatric wards, bacterial count was more in Paediatric wards and low in PICU and NICU

**Frequency of isolation**

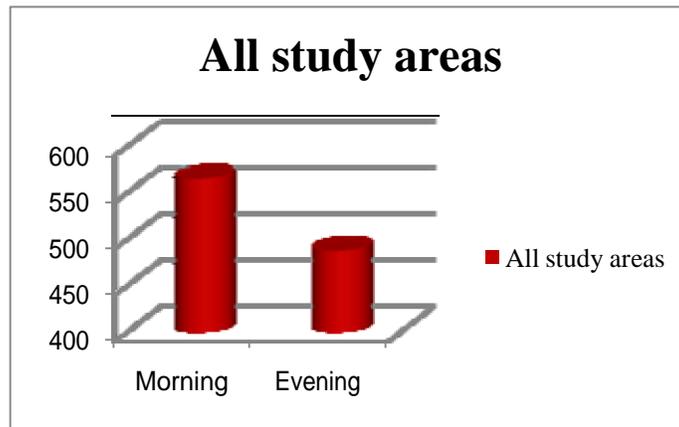
Colonies of Gram positive cocci were higher than colonies of Gram negative bacilli. *Coagulase negative Staphylococci* were frequently isolated from selected units followed by *Micrococci*, *Bacillus spp*, *Klebsiella spp*, *E. coli*, *C. freundii* & *P. aeruginosa*

Hospital associated infections have been linked with many factors among which is the microbial quality of the indoor air of different wards and units of each hospital (Awasika *et al.*, 2012; Ekhaise *et al.*, 2010). Reports have previously documented the existence of microorganisms in hospital environments, including air and possibility of air as a source for nosocomial infections (Beggs, 2003; Sudharsanam *et al.*, 2008). Infections in hospital environment are as result of the following factors: Microorganisms in the hospital, the compromised immune status of patients and the chain of transmission in the hospital (Oyetayo and Ilori, 2007).

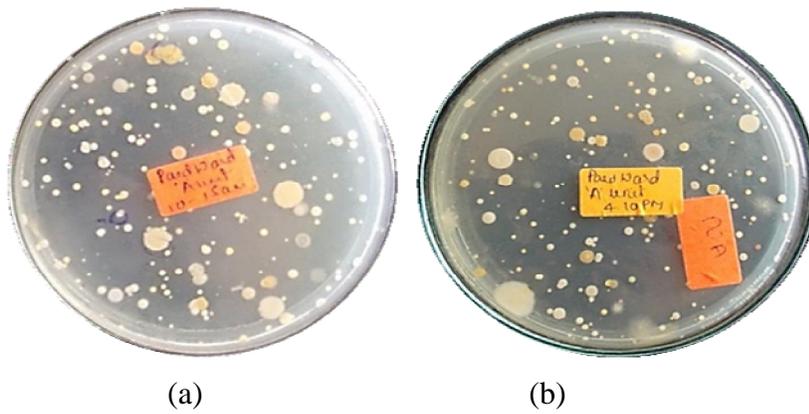
**Table.1** Bacterial load in selected wards at two different times

Study area	Morning (10 – 11am) (no of colonies)	Percentage of colonies	Evening (4 – 5pm) (no of colonies)	Percentage of colonies 5%	Total colonies
Ped ward - ‘A’ unit	160	54.05%	136	45.95%	296
Ped ward - ‘B’ unit	108	57.14%	81	42.85%	189
Ped ward - ‘C’ unit	127	51.83%	118	48.16%	245
NICU - 1	36	55.38%	29	44.61%	65
NICU - 2	12	52.17%	11	47.82%	23
PICU	122	52.13%	112	47.86%	234

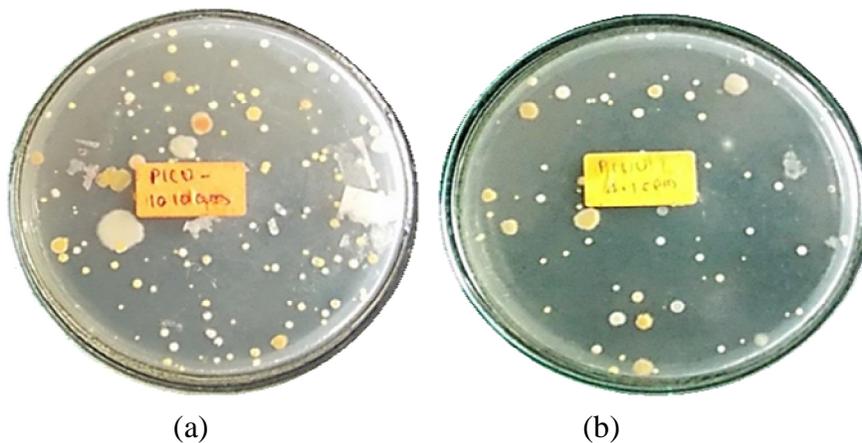
**Fig.1** Bacterial load in morning and evening samples



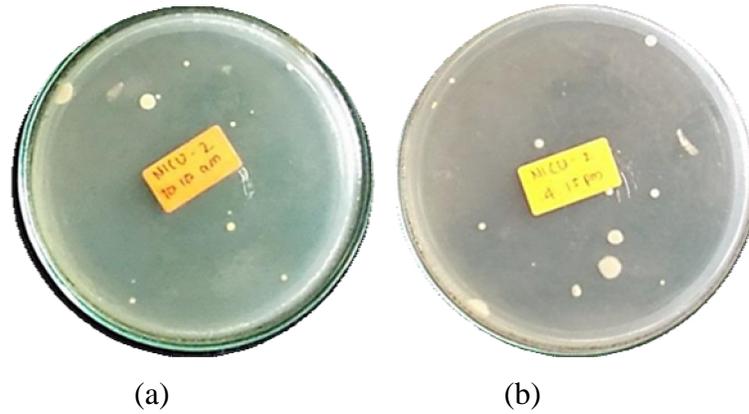
**Fig.2** Bacterial count obtained from Paediatric ward unit A during a) morning and b) evening hours



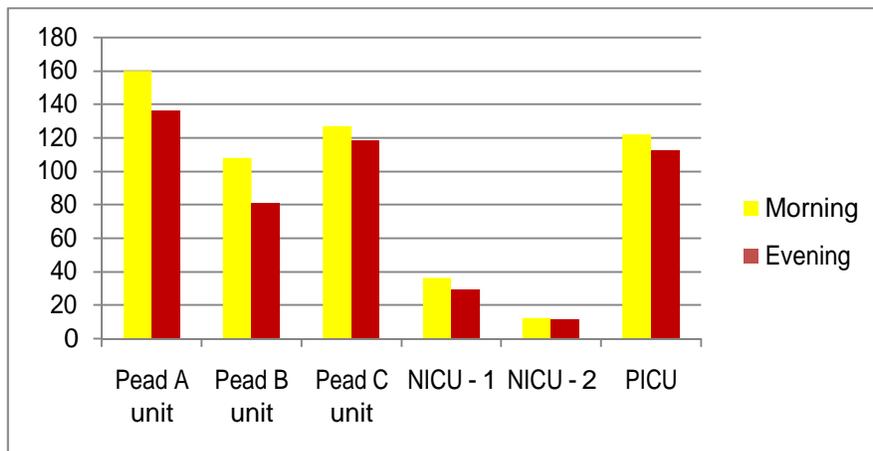
**Fig.3** Bacterial count obtained from Paediatric intensive care unit during morning (a) and evening (b) hours



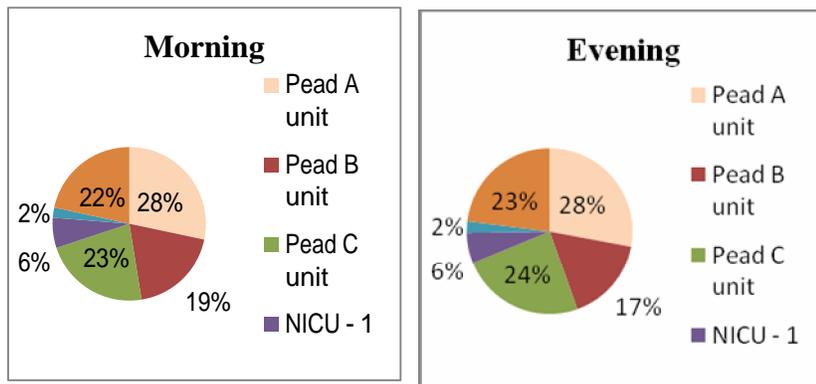
**Fig.4** Bacterial count obtained from Neonatal intensive care unit during morning (a) and evening (b) hours



**Fig.5** Bacterial load in selected wards at two times (morning & evening)



**Fig.6** Percentage of bacterial load in different selected study areas



In this study, the microbial load obtained from different sections of paediatric ward varies. The total colony forming unit obtained in paediatric ward was higher than PICU and NICU. The most frequently isolated bacteria from the selected wards sampled are - Coagulase negative *Staphylococci* followed by *Micrococci*, *Bacillus spp*, *Klebsiella spp*, *E. coli*, *C. freundii* and *P. aeruginosa* and the results were similar to a study conducted by Ekhaise *et al.* (2008). Similar study was conducted by Awasika *et al.* (2012) and isolated *S. aureus*, *Bacillus spp*, *Klebsiella spp*, *Serratia marcescens*, *Streptococcus pyogenes*. Previous reports had implicated most of the bacterial isolates listed above as common pathogens isolated from hospital environment.

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 environment. Periodic monitoring of these sections should be carried out to reduce the hospital infections.

The concentration of air borne bacterial load from selected units under study was recorded high in the morning compared to evening time of studies. Factors such as level of activity, ventilation, humidity and overcrowding, increase the air borne bacterial load in different units of the hospital. This emphasizes the need for proper designing for closed systems with appropriate ventilation & segregation of patients is necessary to prevent microbial air contamination.

Regularly, monitoring of hospital aero flora is particularly recommended. Thorough hand washing and use of alcohol rubs by medical personnel before and after each patient contact are known effective methods

to combating nosocomial infections; regular mopping, restricting the patient attenders visit could also limit microbial dispersals within the hospital.

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