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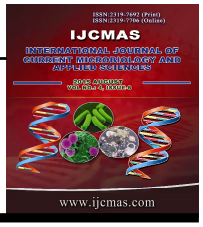

Original Research Article

Microbial Profile and Antibiogram of Air Contamination in Hospital Wards of a Tertiary Care Hospital, Western Rajasthan, India

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A B S T R A C T

The aim of this work was to study the prevalence and antibiogram of microbes isolated from air in tertiary care hospital in Rajasthan. Settle plate's method was used for collection of air samples. High bacteriological contamination of air was detected. It was concluded that microbiological surveillance of hospital wards can play an important role in reducing bacterial contamination consequently preoperative infectious episodes can be reduced considerably.

Keywords

Antibiogram, Microbial profile, Hospital ward, Air contamination

Introduction

Nosocomial infections represent an important cause of morbidity and mortality in population (Sana and Amani, 2010). It is associated with a considerable increase in morbidity and mortality of patients at a hospital as well as to significant increases in costs. Approximately 10% of the nosocomial infections in both immune-compromised and healthy people are caused by airborne bacteria (Gioffre *et al.*, 2007).

It has been suggested that many pathogens can survive as bio-aerosols, spread Considerable distances and result in infection (Moletta-Denat *et al.*, 2010). Thus, recognition and control of microbial contamination of hospital air wards has great importance especially for those infections that an airborne transmission is postulated (Perdelli *et al.*, 2006). Indoor air quality of hospitals and medical centres has become a critical part of hospital management protocols.

The quality of microclimatic conditions in indoor environment belongs to the most important effects on human health and also represents ethical problems in environmental epidemiology (Bencko, 1995). Hospitalized patients, especially those requiring extended treatments and intensive care, are at increased risk to exposure under bio aerosol contamination.

Bacterial pathogens that can able to survive in the hospital environment for long period

of time and resist disinfection are particularly more important for nosocomial infections. Bacterial pathogens isolated from hospital environments are also known to develop resistance to multiple antimicrobial agents.

Thus, in this study, the basic aim was to investigate bacterial contamination of the hospital air in tertiary care hospital western Rajasthan & their resistance to commonly used antimicrobial agents.

Materials and Methods

This study was carried out in the Department of Microbiology, Dr. S.N. Medical College, Jodhpur to detect prevalence and anti-biogram of Microorganism in various air sample collected from Mahatma Gandhi Hospital. Samples were collected from different wards such as Intensive care unit (ICU), Critical care unit (CCU), surgical ward, Post Surgical ward, Orthopaedic ward etc.

Sample collection

Settle plate method (Sana and Amani, 2010; Kaur, 2007) was adopted using standard sized MacConkey agar and Blood agar plates. Plates used are pre incubated overnight under the conditions that matched incubation of air samples to be taken. Then plates are distributed at various distance in the wards and left opened to the air for one hour.

After exposure of one hour that allows sufficient time for settling of particles in natural and efficient manner, samples are transported to the microbiology laboratory.

Processing of sample

The air plates are incubated at 37°C for 24–48 hours. The representative colonies from each plate are picked up and confirmed by colony morphology, Gram's staining and biochemical reactions (Sana and Amani, 2010; Kaur, 2007).

Antibiotic sensitivity test (CLSI, 2005; Bauer *et al.*, 1966)

Antibiotic sensitivity test method used was Kirby Bauer method (CLSI, 2007) Muller Hinton agar medium was used for Antibiotic sensitivity. It is a type of disc diffusion method. For antibiotic sensitivity test Amikacin, Cefoperazone, Cefotaxime, Ceftriaxone, Ciprofloxacin, Gentamicin, Imipenam and Tobramycin used for gram negative bacteria & Azithromycin, Amoxyclav, Ampicillin, Cefotaxime, Ceftazidime, Ceftriaxon, Levofloxacin and Vancomycin used for gram positive bacteria.

Results and Discussion

All samples collected are processed for initial cultivation of microorganism then their identification and antimicrobial sensitivity by conventional methods (CLSI, 2007; Collee *et al.*, 1996; Pasquarella *et al.*, 2010).

Staphylococcus aureus, Coagulase Negative *Staphylococcus*, *Micrococcus spp.* & Gram positive bacilli grown in all wards. Whereas *Klebsiella* spp. was isolated from ICU B, CCU II & Postoperative Ward (Male)and *E. coli* was isolated from IICU, postoperative ward (Male) & surgical ward only.

Maximum number of microorganisms isolated from ICU A was Coagulase Negative *Staphylococcus* (33.85%) & minimum number of microorganism was *Micrococcus* (12.25%). While in ICU B Coagulase Negative *Staphylococcus* (48.87%) was found maximally & minimum isolates are *Klebsiella* (3.03%) and in IICU *Staphylococcus aureus* (27.18%) was found

maximally & minimum isolates are *E. coli* (0.97%). CCU (I) *Staphylococcus aureus* 30.09% was found maximally & minimum isolates are Coagulase Negative *Staphylococcus* (20.5%). While in CCU (II) GPB (30.08%) was found maximally & minimum isolates are *Klebsiella* (1.09%). Postsurgical (M) *Micrococcus* (44.76 %) was found maximally & minimum isolates were *Klebsiella* & *E. coli* (1.75%). While in Postoperative (F) GPB (34.43 %) was found maximally & minimum isolates were Coagulase Negative *Staphylococcus* (19.81%). Orthopaedic (M) *Staphylococcus aureus* (32.19 %) was found maximally & minimum isolates were Coagulase Negative *Staphylococcus* (11.36%). While in Orthopaedic (F), *Staphylococcus aureus* (31.13%) was found maximally & minimum isolates are coagulase negative *Staphylococcus* (1.1%). Surgical GPB (25.55 %) was found maximally & minimum isolates were *E. coli* (3.33%) (Table 1).

Antimicrobial sensitivity testing was done by commonly used antimicrobial agents. *Staphylococci* are mostly sensitive to most of the commonly used antibiotics like Azithromycin, Amoxyclave, Ampicillin, Cefotaxime, Ceftazidime, Ceftriaxone, Levofloxacin, Vancomycin. On other hand multidrug resistance was higher in ICU and CCU in compare to other ward. Coagulase negative *Staphylococcus* and *Micrococcus* were also sensitive for mostly used antibiotics. *Klebsiella* sensitivity pattern varied from 100% for Gentamicin, Imipenem, Tobramycin to 33.33% for Ciprofloxacin & Ceftriaxone. For *E. coli* 100% for Imipenam, Tobramycin to 33.33% Gentamicin (Tables 2–6).

The aim of this work was to study the prevalence and antibiogram of microbes isolated from air in tertiary care hospital in Rajasthan.

According to *Pasquarella et al.* (2010) microbiological quality of air may be considered as mirror of the hygienic condition of the Hospital. The quality of indoor air depends on external and internal sources, such as ventilation, cleaning procedures, the surgical team and their activity.No attempt is made to record the number of people entering the rooms. The greatest effect on number is movement and presence of the patient and theatre staff in the theatre. The care for immune compromised patients is very demanding and consists of a complex of medical procedures. An integral part of this care is prevention of infection. The submitted study deals with microbial air load in the patient's breathing zone as a source of exogenous infection.

This study indicates that the Gram positive bacteria, Coagulase negative *Staphylococci, Staph aureus, Micrococcus* and *Bacillus spp*. are isolated from all the air samples. Whereas gram negative bacteria (*E. coli, Klebsiella*) found in air of some wards. Gram positive bacteria could be detected significantly and frequently as compared to Gram negative bacteria which are less often isolated from the environment. It is in accordance to the study conducted by Qudiesat *et al.* (2009). A study conducted in Chennai, India by Sudharsanam *et al.* (2012) also revealed that Microbial loads were found to vary with the sampling method.

The prevalence of bacteria varies from ward to ward in our study. On average frequency of *Staph. aureus* (15.15% to 32.19%), Coagulase negative *Staphylococci* (1.1%to 33.85%), *Micrococcus* (12.25% to 44.76 %), *E. coli* (0.97% to 3.33%), *Klebsiella spp*. (1.09% to 3.33%), *Aspergillus* spp. (2.07% to 5.83%), *Rizopus* (3.41% to 10.52%) in different wards (Table 1).

Table.1 Frequency of microorganism found in air of different wards

Organisam / Ward	Total no. of sample	*Staph. aureus (F%)*	*Micro coccus (F%)*	Coagulase Negetive Staph.(F%)	*Klebsiella (F%)*	*E.coli (F%)*	GPB (F%)
ICUA	10	29	12.25	33.85	-	-	24.9
ICUB	10	15.15	18.18	48.47	3.03	-	15.16
IICU	10	27.18	24.27	16.5	-	0.97	25.26
CCU(I)	10	30.09	23.16	20.5	-	-	23.99
CCU(II)	10	22.02	24.5	22.11	1.09	-	30.08
Postoperative(Male)	10	24.14	44.76	13.35	1.75	1.75	10.83
Postoperative(Female)	10	22.12	22.12	19.81	-	-	30.43
Orthopaedic(Male)	10	32.19	30.3	11.36	-	-	22.36
Orthopaedic(Female)	10	31.13	24.06	1.1	-	-	18.05
Surgical	10	22.22	22.22	22.51	-	3.33	25.55

Table.2 Sensitivity to different drugs to *Staphylococcus aureus* isolated from air

Ward / Drugs	ICU (F%)			CCU (F%)		POST SURGICAL (F%)		ORTHOPAEDIC (F%)		SURGICAL (F%)
	A	B	IICU	(I)	(II)	(M)	(F)	(M)	(F)	
AMC	69.2	40	37.5	50	50	100	100	100	80	-
AMP	100	40	75	50	50	100	100	100	80	-
AZM	76.92	40	100	50	-	100	100	-	80	66.66
CAZ	53.84	40	12.5	50	-	33.33	66.66	87.5	80	100
CTR	100	60	100	50	50	100	66.66	87.5	60	66.66
CTX	100	80	87.5	50	50	100	66.66	87.5	60	100
LE	100	100	87.5	50	100	100	100	87.5	100	100
VA	100	100	100	100	100	66.66	100	87.5	80	-

Table.3 Sensitivity to different drugs to coagulase negative *Staphylococcus* isolated from air

Ward / Drugs	ICU (F%)			CCU (F%)		POST SURGICAL (F%)		ORTHOPAEDIC (F%)		SURGICAL (F%)
	A	B	IICU	(I)	(II)	(M)	(F)	(M)	(F)	
AMC	25	66.66	75	100	-	100	100	100	100	100
AMP	25	100	50	100	-	100	100	100	100	-
AZM	25	66.66	50	87.5	-	100	100	100	100	100
CAZ	50	100	25	100	100	50	66.66	100	75	-
CTR	75	33.33	25	100	100	100	100	100	75	100
CTX	75	100	75	100	100	100	66.66	100	100	66.66
LE	100	100	75	100	100	100	100	100	100	100
VA	100	100	100	100	100	100	100	100	100	100

Table.4 Sensitivity to different drugs to *Micrococcus* isolated from air

Ward / Drugs	ICU (F%)			CCU (F%)		POST SURGICAL (F%)		ORTHOPAEDIC (F%)		SURGICAL (F%)
	A	B	IICU	(I)	(II)	(M)	(F)	(M)	(F)	
AMC	50	100	75	100	100	87.5	50	50	100	100
AMP	100	100	100	100	100	87.5	100	100	100	100
AZM	100	100	100	100	100	100	50	75	87.5	100
CAZ	100	100	75	100	100	50	50	-	87.5	100
CTR	75	100	87.5	100	100	100	100	50	87.5	66.66
CTX	75	100	87.5	100	100	100	100	50	87.5	66.66
LE	100	100	100	100	100	100	100	100	100	100
VA	100	100	100	100	100	100	100	100	100	100

Table.5 Sensitivity to different drugs to *Klebsiella* spp. isolated from air

Ward / Drugs	ICU (F%)			CCU (F%)		POST SURGICAL (F%)		ORTHOPAEDIC (F%)		SURGICAL (F%)
	A	B	IICU	(I)	(II)	(M)	(F)	(M)	(F)	
AK	-	87.5	-	-	66.66	66.66	-	-	87.5	-
CIP	-	87.5	-	-	33.33	66.66	-	-	87.5	-
CPZ	-	75	-	-	66.66	66.66	-	-	75	-
CTR	-	87.5	-	-	33.33	66.66	-	-	75	-
CTX	-	75	-	-	66.66	66.66	-	-	75	-
GEN	-	100	-	-	66.66	66.66	-	-	75	-
IMP	-	100	-	-	100	100	-	-	87.5	-
TOB	-	100	-	-	66.66	100	-	-	87.5	-

Table.6 Sensitivity to different drugs to *E. coli* isolated from air

Ward / Drugs	ICU (F%)			CCU (F%)		POST SURGICAL (F%)		ORTHOPAEDIC (F%)		SURGICAL (F%)
	A	B	IICU	(I)	(II)	(M)	(F)	(M)	(F)	
AK	-	-	87.5	-	-	100	-	-	-	50
CIP	-	-	87.5	-	-	66.66	-	-	-	37.5
CPZ	-	-	75	-	-	66.66	-	-	-	62.5
CTR	-	-	75	-	-	66.66	-	-	-	62.5
CTX	-	-	75	-	-	66.66	-	-	-	50
GEN	-	-	100	-	-	33.33	-	-	-	50
IMP	-	-	100	-	-	100	-	-	-	65.5
TOB	-	-	100	-	-	100	-	-	-	75

Alireza Abdollahi *et al.* (2012) reported numbers of colonies (%) for various microorganisms in the air of different wards (ICU, surgery etc**.**) which varies, i.e. coagulase negative *Staphylococci* (15% to 33.33), *Micrococcus* (15% to 43.47), *Aspergillus* spp (3.03% to 8.33). which was quite similar to our results.

Similar observation was also found in study of *Javed et al.,* (2008) High bacteriological contamination of air and total bacteriological counts in air samples was high.

Generally we can say that Gram positive bacteria survive longer in the form of aerosol than Gram-negative bacteria. This is mainly due to the composition of their wall which contains peptidoglycan resistant to desiccation.

Antimicrobial susceptibility tests for the isolates of air in our study revealed that *Staphylococci* are mostly sensitive to most of the commonly used antibiotics like Azithromycin, Amoxyclave, Ampicillin, Cefotaxime, Ceftazidime, Ceftriaxone, Levofloxacin, Vancomycin. On other hand

multidrug resistance is higher in ICU and CCU in compare to other ward. Surgical ward shows 100 % resistance towards Ampicillin in our study is comparable with the study conducted by Chalachew *et al* (2011) in a surgical ward, the drug susceptibility pattern of *S. aureus* which is 100% resistance to Methicilin, 82.8% to Ampcillin and 77.1% to Penicillin. They didn't use those antibiotics which are used in our study except Ampcillin.

Coagulase negative *Staphylococci* and *Micrococcus* are also sensitive for mostly used antibiotics. For gram negative bacteria Amikacin, Cefoperazone, Cefotaxime, Ceftriaxone, Ciprofloxacin, Gentamicin, Imipenam, Tobramycin was used. For *Klebsiella* sensitivity pattern varied from 100% for Gentamicin, Imipenem, Tobramycin to 33.33% for Ciprofloxacin& Ceftriaxone. For *E. coli* 100% for Imipenam, Tobramycin to 33.33% Gentamicin.

In overall, Levofloxacin and Vancomycin were quite sensitive antimicrobial to gram positive bacteria isolated from air. Imipenem, Tobramycin were quite sensitive to gram negative isolated from air by settle plate method.

As conclusion our findings demonstrate that the microbiological quality of air in wards may be considered a mirror image of the hygienic conditions of a Hospital. Settle plate's method for air proved to be more valuable in detecting the contamination level in our set up with limited resources.

In conclusion almost all indoor air samples showed higher aerobic bacterial load and the isolates are showing multidrug resistance which may cause serious nosocomial infection that will increase the duration of hospital stay and treatment cost. The range of microbial air load at a ward depended on disinfection activities in the wards. The strict aseptic regimen during the patient`s hospitalization and the properly working filter ventilation system can represent very efficient preventive measures to reduce the risk of airborne infections. The microbiological quality of the air in the wards is a significant parameter to control healthcare associated respiratory infections, and regular microbial monitoring can represent useful tool to assess environmental quality and to identify critical situations which require corrective intervention.

Our findings emphasize the role of regular monitoring of the biological risk for both patient and healthcare workers. The results would be useful in planning for employing appropriate strategies to reduce air burden in this hospital and other hospitals with similar situation.

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References

Alireza Abdollahi, Sanam Mahmoudzadeh, 2012. Microbial profile of air contamination in hospital wards. *Iran. J. Pathol.,* 7(3): 177–182.

Bauer, A.W., Kirby, W.M., Sherris, J.C., Turck, M. 1966. Antibiotic scseptibility testing by a standard single disc diffusion method. *Am. J. Clin. Pathol.,* 45: 493–6.

Bencko, V. 1995. Contemporary ethical problems in environmental

epidemiology (in Czech). *Epidemiol. Microbiol. Immunol.,* 44(4): 180–183.

Chalachew Genet, Gebre Kibru, Wondewosen Tsegaye. 2011. Indoor air bacterial load and antibiotic susceptibility pattern of isolates in operating rooms and surgical wards at Jimma University Specialized Hospital, Southwest Ethiopia. *Ethiop. J. Health Sci.,* 21(1): 9–17.

Clinical and Laboratory Standards Institute (CLSI), 2005. Performance standard for antimicrobial disc susceptibility test, CLSI, Jan. 2005; 25 No (1).

Clinical and Laboratory Standards Institute (CLSI), 2007. Performance standards for antimicrobial susceptibility testing. 17th information supplement. Pp. M100–S17.

Collee, J.G., Duguid, J.P., Fraser, A.G., Marmion, B.P. (Eds.), 1996. Mackie and McCartney, practical medical microbiology, Chapt. 7, 14th edn., Churchill Livingstone, New York. Pp. 361–384.

Collee, J.G., Duguid, J.P., Fraser, A.G., Marmion, B.P. (Eds.), 1996. Mackie and McCartney, practical medical microbiology, Chapt. 41, 14th edn., Churchill Livingstone, New York. Pp. 699, 796–797.

Gioffre, A., Dragone, M., Ammoscato, I., Iannò, A., Marramao, A., Samele, P., *et al.* 2007. The importance of the airborne microorganisms evaluation in the operating rooms: the biological risk for health care workers. *G. Ital. Med. Lav. Ergon.,* 29: 743–5.

Javed, I., Hafeez, R., Zubair, M., Anwar, M.S., Tayyib, M., Husnain, S. 2008. Microbiological surveillance of operation theatres and ICUs of a tertiary care hospital, Lahore. *Biomedica,* 24(Jul. - Dec. 2008).

Kaur, N. *et al.* 2007. Air bacterial isolates from operation theatres. *J. Clin. Diagn. Res.,* 1(2): 87–89.

Moletta-Denat, M., Bru-Adan, V., Delgenes, J.P., Hamelin, J., Wery, N., Godon, J.J. 2010. Selective microbial aerosolization in biogas demonstrated by quantitative PCR. *Bioresour. Technol.,* 101: 7252–7.

Pasquarella, C., Veronesi, L., Castiglia, P., Liguori, G., Montagna, M.T., Napoli, C., Rizzetto, R., Torre, I., Masia, M.D., Di Onofrio, V., Colucci, M.E., Tinteri, C., Tanzi, M. 2010. Italian multicentre study on microbial environmental contamination in dental clinics: a pilot study. *Sci. Total Environ.,* 408: 4045–4051.

Perdelli, F., Cristina, M.L., Sartini, M., Spagnolo, A.M., Dallera, M., Ottria, G., *et al.* 2006. Fungal contamination in hospital environments. *Infect. Control Hosp. Epidemiol.,* 27: 44–47.

Qudiesat, K., Abu-Elteen, K., Elkarmi, A., Hamad, M., Abussaud, M. 2009. Assessment of airborne pathogens in healthcare settings. *Afr. J. Microbiol. Res.,* 3: 66–76.

Sana, O.Y., Amani, E.A. 2010. Isolation of potential pathogenic bacteria from the air of hospitaldelivery and nursing rooms. *J. Appl. Sci.,* 10(11): 1011–1014.

Sudharsanam, S., Swaminathan, S., Ramalingam, A., Thangavel, Annamalai, R., Steinberg, R., Balakrishnan, K., Srikanth, P. 2012. Characterization of indoor bioaerosols from a hospital ward in a tropical setting. *Afr. Health Sci.,* 12(2): 217–225. http://dx.doi.org/10.4314/ahs.v12i2.22.