BIOAEROSOLS IN ENT HOSPITALS: A THREAT FOR NOSOCOMIAL INFECTION

Pranita A. Gulhane
Department of Microbiology,
S.S.E.S.A's Science College, Congress Nagar, Nagpur.

Abstract

Bioaerosol analysis of 6 ENT hospitals in Amravati was carried out. Thirty six air samples were analyzed, from which 15 air samples were found to be contaminated with bacterial bioaerosols. It showed 5 different types of bacterial pathogens i.e. *Pseudomonas aeruginosa* (44.44%) followed by *Staphylococcus aureus* and *Staphylococcus epidermidis* (22.22% each), *Micrococcus luteus* and *Proteus mirabilis* (5.55% each). Bioaerosols contamination in different sections of ENT hospitals showed that OPD (38.88%) was most contaminated followed by General Ward (27.77%), Reception Area and Operation Theatre (16.66% each). Seasonal distribution showed that in Winter (61.11%) followed by Summer (27.77%) and Monsoon (11.11%) bacterial bioaerosol contamination was found in ENT hospitals. Area wise analysis reported that hospitals near Roadside area were 66.66% contaminated while that near Residential area were 33.33% contaminated with bacterial bioaerosols. Bacterial bioaerosols from ENT hospitals were resistant to Ciprofloxacin, Fusidic Acid, Gentamicin (94.44% each) followed by Augmentin, Erythromycin, Penicillin (88.88% each), Ceftriaxone, Chloramphenicol, Lincomycin (83.33% each), Amikacin, Ceftazidime, Cephotaxime, Netilmicin, Ofloxacin (77.77% each) and Vancomycin (72.22%).
Keywords: Bacterial Bioaerosols, ENT Hospitals

Introduction

Bioaerosols are aerosols containing microorganisms (bacteria, fungi, viruses) or isolated compounds from microorganisms (Mandal and Brandl, 2011). The particles having 0.3 to 20 microns size are pathogenic (Mortazavie et al., 2009). Exposures to bio aerosols are linked with a broad spectrum of health effects. Bioaerosols consist of approximately 5 to 34 percent of air pollution (Choobineh et al., 2008).

Healthcare associated infections (HAI) are also known as nosocomial infections or hospital-acquired infections. They can transmit by a different vectors, including airborne mode of transmission. The most dangerous HAI pathogens are those that have the potential to spread by the airborne route *(Kowalski, 2006;* Yadav et al., 2017). Many of these pathogens, are now called "superbugs" due to their resistance to antibiotics. Bacterial counts in hospitals depends on number of individual present, ventilation and air flow methods. The environments in the hospitals are dynamic and subject to continuous change (Sandle, 2006).

Airbore bacteria found in hospital environment are Gram-negative bacilli, *Neisseria meningitidis, Serratia marcescens, Staphylococcus aureus, Streptococcus pyogenes, Streptococcus pneumoniae* and *Tubercle bacilli* (Denning, 1996; Wald et al., 1997; Manning

et al., 2001; Prasad et al., 2001). They are derived from skin, hair and clothes of patients and contaminated indoor environment of ward (Haddad et al., 2004).

According to Gröschel (1980) the purpose of air sampling in hospitals may be epidemiologic, research, safety or quality control etc. Humidity also plays an important role in concentration of airborne bacteria in hospitals. Infection control practices are very important in hospital settings (Montz and Edward, 2000). It can be minimized by various infection control practices (Abussaud, 1991). There is a demand to reduce airborne microorganisms. Hospital aerosols must be regularly investigated. Therefore the present investigation was carried out to study the presence of bacterial pathogens containing bioaerosols from air samples of ENT hospitals and its antibiotic resistance profile.

Materials and Methods

Sample Collection Site: Bioaerosol survey of 6 ENT hospitals in Amravati was carried out.

Bioaerosol Analysis: Thirty six air samples were analyzed from ENT hospital environment by using sedimentation method (Mathias et al., 2000; Tambekar et al., 2007). The Mannitol salt agar, MacConkey agar and cetrimide agar plates were exposed for 5 min in air to sample particles at 1 cubic foot height. The plates were incubated at 37°C for 48 h and observed for the presence of bacteria. The bacterial isolates were identified using standard procedure (Bergey's Manual of Determinative Bacteriology, 1974; Collee and Marr 1996.).

Antibiotic sensitivity test: The total eighteen bacterial pathogens from bioaerosols were tested for antimicrobial susceptibility tests against the following antibiotics: Amikacin (30 mcg), Augmentin (30 mcg), Ceftazidime (30 mcg), Ceftriaxone (30 mcg), Cephotaxime (30 mcg), Chloramphenicol (30 mcg), Ciprofloxacin (5 mcg), Erythromycin (10 mcg), Fusidic acid (10 mcg), Gentamycin (10 mcg), Lincomycin (2 mcg), Netilmicin (30 mcg), Ofloxacin (2 mcg), Penicillin (10 units) and Vancomycin (30 mcg). Antibiotic disks were purchased from Hi-media Laboratories Pvt. Ltd, Mumbai. Antibiotic sensitivity test was performed by Kirby Bauer Disc Diffusion method (Bauer et al., 1966). Bacterial pathogens from bioaerosols were grown on nutrient agar at 37^0C for 24 hours and the bacterial colonies were suspended in sterile saline water equivalent to a 0.5McFarland standard (1.5X108CFU/ml). Hi-sensitivity agar plate was uniformly seeded by adding 100µl inoculated broth and was spread by means of spreader. The discs were placed on each inoculated Hi-sensitivity agar plate. The plates were incubated at 37^0C for 18 hours. The diameter of the zone of inhibition was observed in mm and the isolates were classified as "resistant" or "sensitive" based on the standard interpretative chart according to Clinical and Laboratory Standards Institute (CLSI) guidelines (CLSI, 2007).

Results nd Discussion

The present bioaerosol survey was conducted to analyse the presence of bacterial pathogens in total 6 ENT hospitals environment. Thirty six air samples were analyzed, from which 15 air samples were found to be contaminated with bacterial bioaerosols. It showed 5 different types of bacterial pathogens i.e. *Pseudomonas aeruginosa* (44.44%) followed by *Staphylococcus aureus* and *Staphylococcus epidermidis* (22.22% each), *Micrococcus luteus* and *Proteus mirabilis* (5.55% each) (Table 1). Airborne nosocomial pathogens of hospital get

increased due to dirtiness of hospital equipments and poor ventilation (Anderson et al., 1996), food, flower and fruits brought by visitors (Schabrun and Chipchase, 2006).

Bioaerosols contamination in different sections of ENT hospitals showed that Out Patient Department (OPD) (38.88%) was most contaminated followed by General Ward (27.77%), Reception Area and Operation Theatre (OT) (16.66% each) (Table 2). Possible explanation for that is concentration of airborne bacteria was the highest in OPD compared to other different types of hospital area would be frequent comings and goings of many people based on the report by Jaffal et al., (1997) that bioaerosol level in hospital is determined mainly by human activity. On the other hand, the reason that the operation theatre had the less airborne bacteria because it is a clean room applied with high ventilation rate. In addition, source of airborne microorganisms in operation theatre would be derived from activity of doctors and nurses because visiting of external people was not allowed severely in case of operation theatre (Sacchal, 1991).

Seasonal distribution showed that in Winter (61.11%) followed by Summer (27.77%) and Monsoon (11.11%) bacterial bioaerosol contamination was found in ENT hospitals (Table 3). Area wise analysis reported that hospitals near Roadside area were 66.66% contaminated while that near Residential area were 33.33% contaminated with bacterial bioaerosols (Table 4). Bacterial bioaerosols from ENT hospitals were resistant to Ciprofloxacin, Fusidic Acid, Gentamicin (94.44% each) followed by Augmentin, Erythromycin, Penicillin (88.88% each), Ceftriaxone, Chloramphenicol, Lincomycin (83.33% each), Amikacin, Ceftazidime, Cephotaxime, Netilmicin, Ofloxacin (77.77% each) and Vancomycin (72.22%) (Table 5). The main reason for airborne bacterial contamination might not be the cleanliness of hospital but the movement of people, organic materials derived from the outdoors and lack of proper ventilation (Jaffal, 1997; Li and Hou, 2003).

Conclusion

The present study reveals the presence of different types of bacterial pathogens such as the most dominant *Pseudomonas aeruginosa* followed by *Staphylococcus aureus, Staphylococcus epidermidis, Micrococcus luteus* and *Proteus mirabilis*. Bioaerosols contamination in different sections of ENT hospitals showed that OPD was most contaminated followed by General Ward, Reception Area and Operation Theatre. Seasonal distribution showed that bacterial bioaerosol contamination was highest in Winter followed by Summer and Monsoon. Area wise analysis reported that hospitals near Roadside area were most contaminated as compared to Residential area. Bacterial bioaerosols from ENT hospitals were mostly resistant to the tested antibiotics. More studies need to be done to establish a surveillance base on the healthcare facilities.

References

- Abussaud, M.J. (1991), "Prevalence of nosocomial infections in Saudi Arabian teaching hospital", J. Hosp. Infect., Vol.17, pp.235-238.
- Anderson, K., Morris, G., Kennedy, H., Croall, J., Michie, J., Richardson, M.D. and Gibson, B. (1996), "Aspergillosis in immunocompromised pediatric patients: association with building hygiene, design, and indoor air", Thorax, Vol. 51, pp. 256–261.
- Bauer, A.W., Kirby, W.M., Sherris, J.C. and Turck, M. (1966), "Antibiotic Susceptibility testing by a standardized disk method", Am. J. Clin. Pathol., Vol. 45 No. 4, pp. 493-496.
- Bergey's Manual of Determinative Bacteriology, (1974), 8th Edn The Williams and Wilkins Company, Baltimore.
- Choobineh, A., Rostami, R. and Tabatabaei, S.H. (2008), "Assessment of Bioaerosols Types and Concentration in Ambient Air of Shiraz University of Medical Sciences Educational Hospitals", J Iran Occup Health., Vol. 6 No. 2, pp. 69-76.
- CLSI. (2007), "Performance standards for antimicrobial susceptibility testing: 17th Informational supplement, Approved standard M100-S17, Wayne, USA", Clinical and Laboratory Standards Institute.
- Collee, J.G. and Marr, W. (1996), "Tests for identification of bacteria and laboratory control of antimicrobial therapy", Chapter 7 and chapter 8. In In: Mackie & McCartney Practical Medical Microbiology, by Fraser A.G., Marmion B.P. and Simmons (Eds.) 14th ed. Collee J.G., pp. 131-151. New York: Churchill Livingstone: New York.
- Denning, D.W. (1996), "Therapeutic outocme in invasive aspergillosis", Clin Infect Dis., Vol. 23, pp. 608–615.
- Gröschel, D.H.M. (1980), "Air sampling in hospitals", Ann. N. Y. Acad. Sci., Vol. 353, pp. 230-240.
- Haddad, S.H., Arabi, Y.M., Memish, Z.A. and Al-Shimemeri, A.A. (2004), "Nosocomial infective endocarditis in critically ill patients: a report of three cases and review of the literature', Int J Infect Dis., Vol. 8, pp. 210–216.
- Jaffal, A.A., Nsanze, H., Bener, A., Ameen, A.S., Banat, I.M. and Mogheth, A.A. (1997), "Hosptial airborne microbial pollution in a desert country", Environ Int., Vol. 23, pp. 167–172.
- Kowalski, W.J. (2006), "Aerobiological engineering handbook', McGraw-Hill, New York.
- Li, C.S. and Hou, P.A. (2003), "Bioaerosol characteristics in hospital clean rooms", Sci Total Environ., Vol. 305, pp. 169–176.
- Mandal, J. and Brandl, H. (2011), "Bioaerosols in Indoor Environment-a Review with Special Reference to Residential and Occupational locations", J Open Environ Biol Monit., Vol. 4, pp. 83-96.

- Manning, M.L., Archibald, L.K., Bell, L.B., Banerjee, A.N. and Jarvis, W.R. (2001), "Serratia marcescens transmission in a pediatric intensive care unit: a multifactional occurrence", Am J Infect Control., Vol. 29, pp. 115–119.
- Mathias, A.J., Somashekar, R.K., Sumatra, S. and Subramanya, S. (2000), "An assessment of reservoirs of multi-resistant nosocomial pathogens in a secondary cares hospital", Ind. J. Microbiol., Vol. 40, pp. 183-190.
- Montz, J.R. and Edward, W. (2000), "Contamination control in hospitals. Engineered Systems", Vol. 17 No. 6, pp. 68-71.
- Mortazavie, S.B., Dadashpour, Ahangar A., Rezaie, A., Mirzaie, R., Khavanin, A. and Beygi, B. (2009), "Quantitative Analysis of Bioaerosols in Operating Room and Efficiency of Controls Systems", J Mil Med., Vol. 11 No. 3, 171-174.
- Prasad, G.A., Jones, P.G., Michaels, J., Garland, J.S. and Shivpuri, C.R. (2001), "Outbreak of Serratia marcescens infection in a neonatal intensive care unit', Infect Control Hosp Epidemiol., Vol. 5, pp. 303–305.
- Sandle, T. (2006), "Environmental monitoring risk assessment. Journal GXP Compliance", Vol. 10 No. 2, pp. 54-74.
- Schaal, K.P. (1991), "Medical and microbiological problems arising from airborne infection in hospitals", J Hosp Infect., Vol. 18, pp. 451–459.
- Schabrun, S. and Chipchase, L. (2006), "Healthcare equipment as a source of nosocomial infection: a systematic review", J Hosp Infect., Vol. 63, pp. 239–245.
- Tambekar, D.H., Gulhane, P.B. and Bhokare, D.D. (2007), "Studies on Environmental Monitoring of Microbial Air Flora in the Hospitals", Journal of Medical Sciences, Vol. 7, pp. 67-73.
- Wald, A., Leisenring, W., Van Burik, J. and Bowden, R.A. (1997), "Epidemiology of Aspergillus infections in a large cohort of patients undergoing bone marrow transplantation", J Infect Dis., Vol. 175, pp. 1459–1466.
- Yadav, Monika, Pal, Rohan, Sharma, Somorjit, H. and Khumanthem, Sulochana, D. (2017), "Microbiological surveillance of operation theatre in a tertiary care hospital in North East India", International Journal of Research in Medical Sciences, Vol. 5 No. 8, pp. 3448-3453.

Table 1: Bacteriological Analysis of Bioaerosols in ENT Hospitals

Total Bioaerosols Samples Analysed	Total Contaminated Samples	Total Bacterial Pathogens Isolated	DifferentTypes of Bacterial Pathogents Isolated	Number (Percentage)
36	15	18	*Pseudomonas aeruginosa*	8 (44.44%)
			Staphylococcus aureus	4 (22.22%)
			Staphylococcus epidermidis	4 (22.22%)
			Micrococcus luteus	1 (5.55%)
			Proteus mirabilis	1 (5.55%)

Table 2: Sectionwise Bacteriological Analysis of Bioaerosols in ENT Hospitals

Section	Total Bacterial Contamination
Out Patient Department (OPD)	7 (38.88%)
General Ward	5 (27.77%)
Reception Area	3 (16.66%)
Operation Theatre (OT)	3 (16.66%)

Table 3: Seasonal Distribution of Bacterial Pathogens in Bioaerosols of ENT Hospitals

Season	Total Bacterial Contamination
Winter	11 (61.11%)
Summer	5 (27.77%)
Monsoon	2 (11.11%)

Table 4: Areawise Distribution of Bacterial Pathogens in Bioaerosols of ENT Hospitals

Area	Total Bacterial Contamination
Roadside Area	12 (66.66%)
Residential Area	6 (33.33%)

Table 5:Antibiotic Resistance Profile of Bacterial Pathogens Isolated from ENT Hospitals

Bacterial Pathogen-->	*Pseudomonas aeruginosa* (n=8)		*Staphylococcus aureus* (n=4)		*Staphylococcus epidermidis* (n=4)		*Micrococcus luteus* (n=1)		*Proteus mirabilis* (n=1)		Total Resistance	
Antibiotics	R	S	R	S	R	S	R	S	R	S	R	S
Amikacin	7	1	2	2	4	0	1	0	0	1	14 (77.77%)	4
Augmentin	8	0	3	1	3	1	1	0	1	0	16 (88.88%)	2
Ceftazidime	7	1	2	2	3	1	1	0	1	0	14 (77.77%)	4
Ceftriaxone	7	1	2	2	4	0	1	0	1	0	15 (83.33%)	3
Cephotaxime	6	2	4	0	2	2	1	0	1	0	14 (77.77%)	4
Chloramphenicol	6	2	4	0	4	0	1	0	0	1	15 (83.33%)	3
Ciprofloxacin	8	0	3	1	4	0	1	0	1	0	17 (94.44%)	1
Erythromycin	8	0	4	0	3	1	1	0	0	1	16 (88.88%)	2
Fusidic Acid	8	0	4	0	3	1	1	0	1	0	17 (94.44%)	1
Gentamicin	8	0	3	1	4	0	1	0	1	0	17 (94.44%)	1
Lincomycin	8	0	2	2	3	1	1	0	1	0	15 (83.33%)	3
Netilmicin	8	0	1	3	3	1	1	0	1	0	14 (77.77%)	4
Ofloxacin	7	1	1	3	4	0	1	0	1	0	14(77.77 %)	4
Penicillin	7	1	3	1	4	0	1	0	1	0	16 (88.88%)	2
Vancomycin	7	1	1	3	3	1	1	0	1	0	13 (72.22%)	5

Where, R= Resistant, S= Sensitive