Journal of Air Pollution and Health (Summer 2016); 1(3): 215-218

Original Article

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BACTERIAL BIOAEROSOLS IN THE OPERATING ROOMS: A CASE STUDY IN TEHRAN SHARIATI HOSPITAL

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ARTICLE INFORMATION

Article Chronology:

Received 16 June 2016
Revised 9 July 2016
Accepted 21 August 2016
Published 31 August 2016

Keywords:

HIAQ; bacterial bioaerosols; active sampling; ORs

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ABSTRACT:

Introduction: Maintenance of adequate hospital indoor air quality (HIAQ) in operating rooms (ORs) is critical to the Surgical Site Infection (SSI) in hospitalized patients. This study assessed the concentration of bacterial bioaerosols in various ORs in a hospital.

Materials and methods: The concentration of bacterial bioaerosols was measured in the 8 ORs and 2 nurse stations. Active sampling method was used to monitor bacterial bioaerosols.

Results: The mean concentrations of the total bacteria were 211-386 and 208-443 CFU/ m^3 in the first and second floor, respectively. Gram-positive bacteria (e.g., Micrococcus spp., Staphylococcus spp. and streptococcus spp.) were frequently observed in the assessed ORs and nurse stations.

Conclusions: Bacterial bioaerosol monitoring is a useful tool for evaluation of the bio-contamination of ORs in order to improve indoor air quality of them.

INTRODUCTION

Hospital indoor air quality (HIAQ) is an important parameter in preventing infections in occupants of hospital environments [1]. HIAQ is affected by factors including air conditioning systems, type and rate of ventilation, building materials and human factors such as overcrowding in constrained spaces [2, 3]. Poor HIAQ may cause to surgical site infection (SSI), sick hospital syndrome (SHS), and other occupational hazards [1, 2, 4]. Components that cause infections in hospital environments include bioaerosols [5]. Bioaerosols are a class of particulate matter of biological origin [6-8]. This includes bacteria and fungi products such as endotoxins, mycotoxins, peptidoglycans, β (1, 3)-glucans, bacterial and fungal spores, viruses, pollen grains and other biological components [6, 9]. The most important bioaerosol particles are bacterial and fungal spores [8]. Bioaerosol contamination in operating rooms (ORs) remarkably affect the risk of SSI [1]. Because of the fact that occupants of hospital environments spend majority of their time, more than 80-90%, in hospital environments. A safe bacterial bioaerosols concentration in ORs is considered to be 180 and

Please cite this article as: Azimi F, Nabizadeh R, Alimohammadi M, Naddafi K. Bacterial bioaerosols in the operating rooms: a case study in Tehran Shariati hospital. Journal of Air Pollution and Health. 2016; 1(3): 215-218.

10 CFU/m^3 during general surgery and during prosthetic replacement/arthroplasty procedures, respectively. Hence, it is important to understand the concentration of bioaerosols in operating rooms. The main objectives of our study were the following: 1) to identify the dominant bacterial genera in OR 2) to evaluate the concentration of bacterial genera in OR, and 3) to determine the contribution of the bacterial genera in OR.

MATERIALS AND METHODS

ORs

Indoor air quality was measured in 8 ORs (General Operating Room 1 (GOR1), Orthopedics Operating Room (OOR), Nerves Operating Room (NOR), General Operating Room 2 (GOR2), Urology Operating Room (UOR), Women Operating Room (WOR), Emergency Operating Room (EOR) and Maxillofacial Operating Room (MOR)) and 2 nurse stations at Shariati hospital in center of Tehran. In the present study, the air in the ORs was conditioned in a no-heating mode. During the sampling periods, an airflow of 16 air change hour (ACH) was provided to all ORs. During surgical procedures, the doors of the ORs were always kept closed.

Sampling methods

We used active sampling to collect OR bacterial. In the active method, air sampling was performed for 2 min using QuickTake 30 sample pump equipped with the bio stage single-stage cascade impactor (SKC, USA). The pump was set at flow rate of 28.3 L/min, and the height of sampling was located 1.5 m [10, 11]. The flow rate of pump was calibrated by a manometer.

Bacterial incubation and identification

To identify bacterial bioaerosols, the plates were located in an incubator at 35±0.5 °C for 24–48 h. The bacterial bioaerosols were assessed according to Bergey's manual and biochemical tests. Then, the following formula was used to calculate bacterial bioaerosols' colony-forming unit per cubic meter (CFU/m^3) [12-14]:

$$CFU/m^3 = (1000 \times T)/ (28.3 \times t)$$

Where, 1000 is the conversion factor of liter to cubic meter [15], T is the number of bacterial bioaerosols, 28.3 is the pump flow rate, and t is the duration of sampling (min).

RESULTS AND DISCUSSION

Concentrations of the bacterial bioaerosols

Tables 1 presents the concentrations of bacterial in the hospital rooms during the study period. The results showed that the mean concentrations of the total bacteria were in the range of 211-386 and 208-443 CFU/m^3 in the first and second floor, respectively. As presented in Table 1, the mean concentrations of the total detected bacteria were 256, 303, 211, 305, 258, 386, 208, 443, 317 and 309 CFU/m^3 in the GOR1, OOR, NOR, GOR2, UOR, NS1, WOR, EOR, MOR and NS2, respectively. Results also indicated that the mean bacterial concentrations in the EOR, in the second floor, were higher in the other rooms, which could be due to the denser population and the many number of surgery. According to the level suggested in the UK guideline (180 CFU/m^3) during surgery, all of the mean samples exceeded the recommended concentrations. In addition, according to the Italian institute for Occupational Safety and Prevention (ISPESL) the mean samples exceeded the recommended concentrations in operational (≤ 180 CFU/m^3).

Contribution of the bacterial genera

As shown in Fig.1, the identified bacterial genera in our study were gram-positive such as Pseudomonas aeruginosa, and negative including Staphylococcus spp, Micrococcus spp., Streptococcus spp. and Bacillus spp., which more were gram-positive. In Numerous studies have shown that gram-positive bacteria are present in the soil, aqueous environments, and vegetation and that some of them are the normal flora of the mucosa and skin of humans and animals [16]. The

Table 1. Concentrations of bacterial in Hospital Rooms (CFU/m^3)

		No. of samples = 120		Environment conditions (Mean)	
Floor	Hospital rooms	Min – Max	Mean±SD	T (°C)	RH (%)
First	GOR1[1]	88-495	256±117	22	31
	OOR[2]	124-919	303±228	22	30
	NOR[3]	53-459	211±127	23	27
	GOR2[4]	71-573	305±186	23	27
	UOR[5]	53-495	258±119	22	29
	NS1[6]	212-760	386±152	23	26
Second	WOR[7]	53-442	208±143	23	25
	EOR[8]	71-954	443±254	23	26
	MOR[9]	159-618	317±138	24	28
	NS2[10]	124-459	309±121	26	26

1 GOR: General Operating Room, 2 OOR: Orthopedics Operating Room, 3 NOR: Nerves Operating Room, 4 GOR2: General Operating Room 2
5 UOR: Urology Operating Room, 6 NS 1: Nursing Stations1, 7 WOR: Women Operating Room, 8 EOR: Emergency Operating Room, 9 MOR: Maxillofacial Operating Room, 10 NS 2: Nursing Stations 2

resistance of gram-negative bacteria is much less than their gram-positive counterparts, so gram-positive can survive even under unfavorable environmental conditions such as dryness, intense solar radiation, and chemical pollutants [16, 17]. Therefore, it is not surprising that these bacterial genera are dominant in this study. The results showed that the dominant bacterial genera in the Shariati hospital was Staphylococcus spp., Micrococcus spp., and Streptococcus spp., which is consistent with the findings of genus in OOR the previous study [18]. The dominant bacterial, NS 1, WOR, EOR and NS 2 of the Shariati hospital was Staphylococcus spp. (32, 38, 31, 32 and 32 % of the total detected bacteria, respectively), but in GOR 1, GOR2, UOR and MOR was Streptococcus spp. (32, 39, 33 and 28 % of the total detected bacteria ,respectively). In NOR, the dominant bacterial genus was Micrococcus spp. (34 % of the total detected bacteria). On the other hand, Bacillus comprised only 6 and 15 % of the total detected bacterial in ORs and nursing stations.

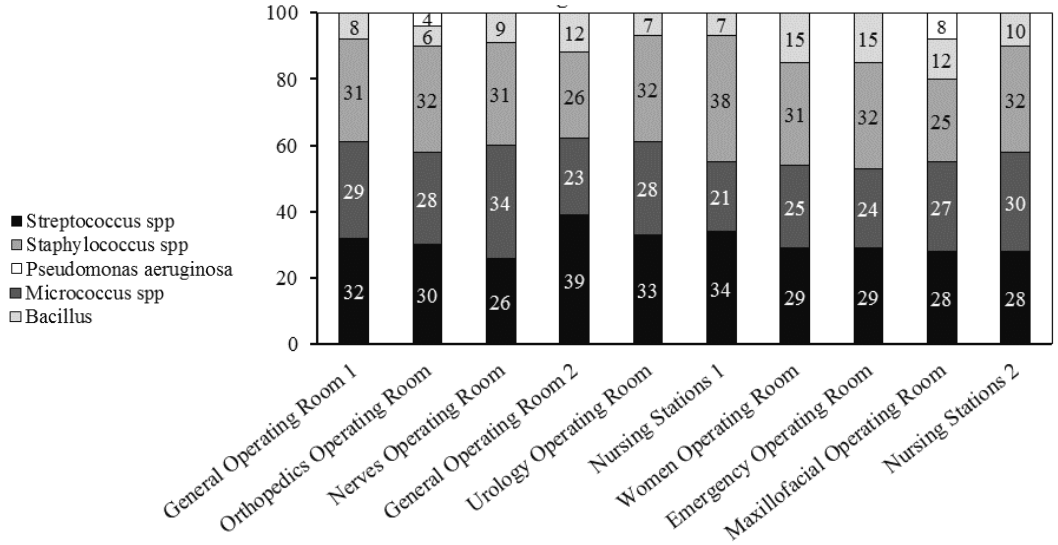

Fig.1. Contributions of bacterial genera in the ORs

CONCLUSIONS

We assessed the ORs bioaerosols in Tehran Shariati hospital. Based on the results obtained, bacterial bioaerosols were isolated from all samples collected from both ORs and nurse station, indicating that bioaerosols are present in most of the enclosed environments and are an inseparable part of the human life. Based on ISPESL, air quality of ORs was poor.

FINANCIAL SUPPORTS

The work has been financially self-supported by the authors.

COMPETING INTERESTS

Herby the authors declare no conflict of interests.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the financial and technical support provided by the Tehran University of Medical Sciences, Tehran, Iran.

ETHICAL CONSIDERATIONS

Authors have completely considered all ethical issues.

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