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Airborne Antibiotic Resistant Bacteria: Hospital Indoor Air Pollution and the Challenge of Nosocomial Infection

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Hospitals have a unique and complex environment in comparison with other commercial and residential buildings. In hospital environments, a greater risk exists for health problems such as headache, dizziness, eye irritation, coughing, asthma, respiratory, and cardiovascular disorders [1].

The transmission modes of microbial infection in hospitals are often in the form of airborne, contact, and droplet [2]. Indoor air quality (IAQ) is an important factor in hospital-acquired infection (HAI). Low air quality of hospitals can lead to HAI or nosocomial infection and sick building syndrome (SBS) [3, 4].

About 8.7% of the hospitalized patients around the world are infected with nosocomial infections [5]. *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Escherichi coli*, *Enterococci*, *Acinetobacter spp.*, and *Coagulase-negative Staphylococci* are the main pathogenic bacteria that are the common causes of nosocomial infections with high survival capability in the environment, which can easily become resistant to antibiotics [6,7]. More than 0.7 million people die each year from antibiotic-resistant infections; it is estimated that this type of death rate will reach to 10 million by 2050 [6].

The airborne form of these bacteria can cause nosocomial infections for patients and hospital staff. People in the operating room, delivery room, and intensive care unit (ICU) are at greater risk than others [6,7]. Therefore, controlling airborne infectious agents should be considered as an important factor in the hospitals' design, preparation, and maintenance [8].

One of the factors that make the pathogenic bacteria more viable and effective in hospital environments is their resistance to antibiotics. The most common and widely used antibiotics are in hospitals. Due to the high exposure of pathogens to antibiotics, antibiotic resistance is also high in hospitals. Increased development of the antibiotic-resistant bacteria threatens effective treatment of infectious diseases and poses many health risks. Studies also showed that a significant proportion of deaths was due to antibiotic-resistant pathogens. Furthermore, major concerns exist about their release into the environment [9-12]. Antibiotic-resistant bacteria (ARB) cause serious problems in the treatment of infectious diseases. These bacteria and antibiotic-resistant genes (ARGs) enter the environment through various sources [13].

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Currently, antibiotics make up about 13% of the total expenditure of the pharmaceutical market in Iran. In Iran, the cost of antibiotics is about three trillion Rials a year, which is a high value [9]. The most important cause of increased bacterial antibiotic resistance in Iran is prescription and overuse of antibiotics. Previous studies (such as in Dutch for β-lactam ARG genes) revealed that the amounts of ARGs in agricultural soils significantly increased between the 1940s and 2010 [14]. Microbial resistance reduces or eliminates susceptibility of the germs to antibiotics. Increased percentage of the antibiotic-resistant bacterial strains in different environments can make problems in the selective treatment of the bacterial infections [15].

In order to control the microbial quality of the air protective barriers should be considered to prevent the infections caused by airborne microorganisms. Airborne biological materials can be measured and counted by active and passive air sampling including the Anderson (active) and the 1/1/1 methods (passive) [16,17].

Frequent epidemics of infections with several disease-resistant organisms have appeared in hospitals since 1950 with *Staphylococcus* resistance to penicillin. Despite the advancement of science in factors controlling the development of bacterial resistance over the past 60 years, this problem has now become one of the world's most severe threats to treat infectious diseases [18]. Increased incidence of microbial resistance to antibiotics is especially evident in hospital ICUs. Moreover, the incidence rates of methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci (VRE), and ICU-resistant gram-negative bacilli are on the rise [19].

Multidrug-resistant genes, probably cells of methicillin-resistant *Staphylococcus aureus*, and other staphylococci are occasionally present in hospital atmosphere [20]. Some studies showed that the air inside the hospital was a possible way for transmission of β-lactam–resistant bacteria, like *Staphylococcus* and *Acinetobacter*. Furthermore, these bacteria were the principal cause of nosocomial infection [21].

Airborne microbial contamination in the inpatient facilities was higher compared to the public and restricted zones of the hospital [22]. Stand-alone air cleaning devices can diminish the amount of airborne bacteria. Atmospheric dust may act as a source of genetic components capable of attributing drug resistance [20]. The hospitals with enhanced mechanical ventilation systems had the lowest airborne microbial contamination [22]. Therefore, use of advanced air purification and ventilation equipment, their constant monitoring, as well as continuous microbial sampling of the hospital air are strongly recommended for preventing nosocomial infection.

References

1. Chamseddine A, Alameddine I, Hatzopoulou M, et al. Seasonal variation of air quality in hospitals with indoor–outdoor correlations. Build Environ. 2019;148:689-700.
2. Siegel JD, Rhinehart E, Jackson M, et al. Guideline for isolation precautions preventing transmission of infectious agents in healthcare settings. Centers for Disease Control and Prevention. Available from: https://wwwcdcgov /infectioncontrol/guidelines/isolation/ [cited July 30, 2019].
3. Wan GH ,Chung FF, Tang CS. Long-term surveillance of air quality in medical center operating rooms. Am J Infect Control. 2011;39(4): 302-8.
4. Fouladi Fard R, Hosseini M, Faraji M, et al. Building characteristics and sick building syndrome among primary school students. Sri Lanka J Child Health. 2018;47(4):332-7.
5. Heydarpour F, Rahmani Y, Heydarpour B, et al. Nosocomial infections and antibiotic resistance pattern in open-heart surgery patients at Imam Ali Hospital in Kermanshah, Iran. GMS Hyg Infect Control. 2017;12:1-8.

[DOR: 20.1001.1.24766267.2019.4.4.1.5]
[DOI: 10.18502/jehsd.v4i4.2017]

6. Hwang W, Yoon SS. Virulence characteristics and an action mode of antibiotic resistance in multidrug-resistant pseudomonas aeruginosa. Sci Rep.2019;9(1):487.
7. Solomon FB, Wadilo FW, Arota AA, et al. Antibiotic resistant airborne bacteria and their multidrug resistance pattern at University teaching referral Hospital in South Ethiopia. Ann Clin Microbiol Antimicrob. 2017; 16: 29.
8. Morawska L, Jamriska M, Francis P. Particulate matter in the hospital environment. Indoor Air. 1998;8(4):285-94.
9. Abdollahiasl A, Kebriaeezadeh A, Nikfar S, et al. Patterns of antibiotic consumption in Iran during 2000-2009. Int J Antimicrob Agents. 2011;37(5): 489-90.
10. Wright GD. Antibiotic resistance in the environment: a link to the clinic?. Curr Opin Microbiol. 2010;13(5):589-94.
11. Ben Y, Fu C, Hu M, et al. Human health risk assessment of antibiotic resistance associated with antibiotic residues in the environment: A review. Environ Res. 2019;169:483-93.
12. Aali R, Baragh S, Asgari E, et al. Tracking of chloramphenicol, erythromycin, and sulfamethoxazole antibiotic-resistant bacteria from untreated wastewater effluents to receiving river. Environmental Health Engineering and Management Journal. 2019;6(2):89-96.
13. Aali R, Nikaeen M, Khanahmad H, et al. Monitoring and comparison of antibiotic resistant bacteria and their resistance genes in municipal and hospital wastewaters. Int J Prev Med. 2014; 5(7): 887–894.
14. Graham, D.W., Knapp, C.W., Christensen, B.T., et al. Appearance of β-lactam Resistance Genes in Agricultural Soils and Clinical Isolates over the 20 th Century. Scientific reports, 2016; 6:21550.
15. Martinez JL. Environmental pollution by antibiotics and by antibiotic resistance determinants. Environ Pollut. 2009;157(11): 2893-902.
16. Ortiz G, Yagüe G, Segovia M, et al. A study of air microbe levels in different areas of a hospital. Curr Microbiol. 2009;59(1):53.
17. Pasquarella C, Pitzurra O, Savino A. The index of microbial air contamination. J Hosp Infect. 2000; 46(4):241-56.
18. Perez HR, Johnson R, Gurian PL, et al. Isolation of airborne oxacillin-resistant Staphylococcus aureus from culturable air samples of urban residences. J Occup Environ Hyg. 2011;8(2):80-5.
19. Mirhoseini SH, Nikaeen M, Shamsizadeh Z, et al. Prevalence and molecular identification of antibiotic resistant airborne bacteria at intensive care units. Koomesh. 2018;20(4):772-8.
20. Drudge CN, Krajden S, Summerbell RC et al. Detection of antibiotic resistance genes associated with methicillin-resistant Staphylococcus aureus (MRSA) and coagulase-negative staphylococci in hospital air filter dust by PCR. Aerobiologia. 2012;28(2):285-9.
21. Mirhoseini SH, Nikaeen M ,Shamsizadeh Z, et al. Hospital air: A potential route for transmission of infections caused by β-lactam–resistant bacteria. Am J Infect Control. 2016;44(8):898-904.
22. Stockwell RE, Ballard EL, O'Rourke P, et al. Indoor hospital air and the impact of ventilation on bioaerosols: a systematic review. J Hosp Infect. 2019;103(2):175-84.