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Original Article

Medical students carry more virulent microorganisms at their throat than that of patients' accompaniers

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Abstract

Background: Transition of medical students from a non-clinical to a clinical situation carries a considerable risk that needs further investigation. This study aims to detect and compare the throat bacterial colonization between medical students and patients' accompaniers in a tertiary hospital.

Methods: Across-sectional descriptive study was conducted at the outpatient clinics of the Baquba Teaching Hospital at the Faculty of Medicine, Diyala University, Iraq. A total of 120 throat swabs collected from a sample of 70 medical students (fifth stage) and 50 volunteers as a control group who were selected conveniently during their outpatient visits over September 2018. Aerobic and anaerobic culture methods were recruited to investigate the samples following the standard microbiological procedures.

Results: Finding of this study indicate a high rate of bacterial throat colonization among medical students compared to the control group. Male gender showed high susceptibility for infection than females. The most common bacteria isolated among medical students were Staphylococcus aureus, and Escherichia coli 26 (37.1%), followed by Streptococcus pneumonia appeared in 23 samples (32.8%), Viridians streptococci 19 (27.1%), Acinetobacter spp.14 (20%), Enterobacter spp. 4 (5.7%), Candida spp. 3 (4.2%), Pseudomonas aeruginosa 2 (2.8%) respectively.

Conclusion: Our findings suggest that medical students may contribute significantly to the transmission and dissemination of nosocomial pathogens among patients and vice versa.

Keywords: Medical students, patients' accompaniers, throat, normal flora, Baquba, Diyala, Iraq

Background

Normal flora (normal resident flora) or sometimes called commensals defined as a group of different microorganisms such as bacteria, fungi, protozoa, and viruses that continuously inhabited the human body. Normal flora has been detected at six important human body openings-related sites that usually exposed to the external environment, including the skin, eyes and ears, respiratory tract, oral cavity (mouth), gastrointestinal tract, and urogenital tract. Bacteria are the most commonly seen normal flora, compared to fungi and other commensals [1,2]. Normal flora plays an active role in the prevention of diseases and maintaining health. It helps in the prevention of colonization by pathogens via bacterial intervention mechanisms [2,3]. As usual, the fetus and the internal body organs such as the spleen, liver, pancreas, bladder, lymph, blood and cerebrospinal fluids (CSF) are free of normal flora; however, the opportunistic microbes can easily attack the fetus or body organs and cause infection when the number of normal flora significantly reduced. The number and variety of normal flora depend on multiple factors which might be physiological (such as the change in body temperature), the geographical habitat (such as hospital attendance), diet (presence of particular nutrient in mouth), age (neglected kids and old age), gender, the immune system status (immune deficiency diseases) and chronic disease [3,4]. Frandah et al. (2013) found that "patients with diabetes and a history of recent proton pump inhibitors (PPIs) use are more likely to have abnormal oral flora on admission to the medical intensive care unit (MICU)" [5].

Unfortunately, visitors of the hospital, whether they had been admitted or in an outpatient clinic and even their accompaniers, are most likely to have a risk of the transmission of pathogens from health workers and hospital instruments. Microorganisms have been isolated from the white coat of medical doctors and students [6,7], medical uniforms [8], the nasal cavity of medical students [9-11] and other health workers

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[11], hands of medical doctors and students [12-15], stethoscopes, medical students' cell phone [16], medical charts [17], ward fomites [18,19], and the frequently touched objects in hospital [20]. The objectives of this study were (1) to determine the normal flora or the bacterial growth in the throat of medical students who are undergoing training education in the hospital and being in direct contact with patients, (2) to determine the bacterial growth or the normal flora in the throat of the control group of the patient's accompaniers, (3) to compare the results of isolated bacterial growth between medical students and the control group.

Methods

Study design and subjects

A cross-sectional descriptive-analytical study was performed among medical students, faculty of medicine, Diyala University, Iraq. Data were collected from 1st to 30th September 2018. To investigate the normal flora in the throat, all the fifth stage medical students (the academic year of 2018-2019) who were undergoing clinical training and being in direct contact with patients at the Baquba Teaching Hospital of Diyala University were included. Because of inclusion and exclusion criteria (Table 1), swabs were collected from the throat of 70 medical students compare to 50 volunteers in the control group, who were accompanying patients during their outpatient visits. At the time of the study, both the sample and control groups clinically examined. Table 1 presents the main inclusion and exclusion criteria.

Table 1 Inclusion and exclusion criteria

Inclusion and exclusion criteria	Medical Student	Control Group
Fifth stage medical students.	+	-
Patient's accompaniers who have visited the hospital	-	+
Willing to participate.	+	+
Acute or chronic rhinitis.	-	-
Pharyngitis, cryptic tonsillitis, sinusitis, and otitis media	-	-
Sino bronchial syndrome.	-	-
Disorders related to airways or nasopharyngeal way.	-	-
Smoking and alcohol drinking. Diabetes or hypertensive.	-	-
Current antibiotic therapy (oral or systemic) use or used in the preceding two weeks.	-	-
Recent tonsil or throat surgeries.	-	-
Dental surgery in the preceding two weeks	-	-

+: referred to inclusion criteria; -: referred to exclusion criteria

Collection of the sample

Researchers followed the standard clinical methods to collect throat swab samples. All samples were extracted in a well-lit room, considering the comfortable sitting of participants and facing a light source. Precautions were taken to avoid swab contamination before and after the swab collecting procedure. A sterile tongue blade or spoon was used to depress the tongue. Attention was given not to touch all sides or top of the mouth, including the tongue, while moving the swab. A firm and quick rubbing of the swab on the back of the throat and the tonsils has performed. Swabs have soon placed in the provided culture medium.

Transport of sample

In order to ensure the viability of pathogens, samples were sent directly to the Baquba teaching hospital's microbiology department in a sterile transport medium. Moreover, each sample was provided with individual participant data such as name, date, age, and gender to facilitate data collection for analysis.

Stain and culture process

Blood, Chocolate, and MacConkey agars were separately used to culture the organisms. According to the standard microbiological methods, "Five percent sheep blood agar and MacConkey agar plates were incubated aerobically, while chocolate agar was incubated under 5% CO2 atmosphere at 37°C for 24–48 h". The isolates then stained with Gram stain to identify the shape and color of the colonies under the microscope. The isolates were cultured on the differential and diagnostic medium and then diagnosed with a VITEK-2 compact system.

Statistical analysis

Data was collected and analyzed using Microsoft Excel Spreadsheet. Descriptive analysis performed concerning the most common pathogen isolated in both medical student and control groups and the gender differences.

Results

Descriptive analyses

More than half (55.7%, 39) of the 70 throat swab samples collected from fifth class medical school students were females compared to 44.3%, 31 males. In the control group, the 50 throat swab samples equally distributed between the male and female participants (Figure 1). Each participant of medical students and the control group was in the average age of 22 years old.

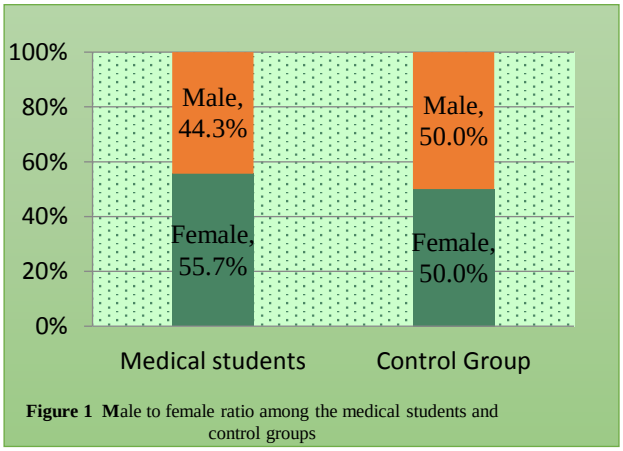

Figure 1 Male to female ratio among the medical students and control groups

Table 2 presents the bacterial growth in medical students and control groups. The most common bacterial growth in the

samples of medical students was Staphylococcus aureus, Escherichia coli, Streptococcus pneumoniae, Viridians streptococci, Acinetobacter spp.

The highest percentage of 26 (37.1%) was reported at an equal rate among Staphylococcus aureus and Escherichia coli. While Streptococcus pneumoniae appeared in 23 samples (32.8%), Viridians streptococci 19 (27.1%), Acinetobacter spp. 14 (20%), Enterobacter spp. 4(5.7%), Candida spp. 3(4.2%), Pseudomonas aeruginosa 2(2.8%). However, the lowest percentage was at an equal percentage of 1.4% (1 sample) for each of Proteus spp., Streptococcus pyogenes, Staphylococcus Albicans. Regarding the control group, the bacterial growth limited to five spp.; Haemophilus spp., Viridians streptococci, Streptococcus pneumoniae, Staphylococcus aureus and Streptococcus pyogenes at a percent of 21(42%), 18(36%), 9(18%), 4(8%) and 1(2%) respectively.

Table 3 presents the bacterial growth according to gender. There is a difference between males and females within the students and control groups in this study. In the student samples, almost all isolated bacterial spp. (Staphylococcus aureus, Escherichia coli, Streptococcus pneumoniae, Viridians streptococci, Acinetobacter spp.) recorded high bacterial growth among the male gender compared to the female gender. However, the opposite was reported in the control group, where the isolated bacterial growth, such as Haemophilus spp., appeared more among female gender than the male gender.

Table 2 Bacterial growth in the healthy students and Control group

Medical students			**Control group**		
Bacteria	**N**	**%**	**Bacteria**	**N**	**%**
Staphylococcus aureus	26	37.1	Haemophilus spp.	21	42
Escherichia coli	26	37.1	Viridians streptococci	18	36
Streptococcus pneumoniae	23	32.8	Streptococcus pneumoniae	9	18
Viridians streptococci	19	27.1	Staphylococcus aureus	4	8
Acinetobacter spp.	14	20	Streptococcus pyogenes	1	2
Enterobacter spp.	4	5.7			
Candida spp.	3	4.2			
Pseudomonas aeruginosa	2	2.8			
Proteus spp.	1	1.4			
Streptococcus pyogenes	1	1.4			

Table 3 Bacterial growth in the healthy students and Control group according to sex

Medical students			**Control group**		
Bacteria	**Male**	**Female**	**Bacteria**	**Male**	**Female**
Staphylococcus aureus	15	11	Haemophilus spp.	9	12
Escherichia coli	17	9	Viridians streptococci	9	9
Streptococcus pneumoniae	15	8	Streptococcus pneumoniae	4	5
Viridians streptococci	10	9	Staphylococcus aureus	2	2
Acinetobacter spp.	8	6	Streptococcus pyogenes	0	1
Enterobacter spp.	3	1			
Candida spp.	2	1			
Pseudomonas aeruginosa	2	0			
Proteus spp	0	1			
Streptococcus pyogenes	0	1			

Discussion

In this study, different numbers and types of bacterial growths have been detected in the throats of both medical students and control groups. Twelve different bacterial spp. (Table 2) have been isolated from the throats of the medical student group compare to five bacterial spp. (Table 3) from the control group. The results of the study confirmed the existence of two different environments [11] with marked changes that happened like the normal resident flora in the throats of students. Most normal flora components are harmless in healthy individuals; however, normal flora could be changed to an inflammatory agent when stimulated by other organisms [1, 4]. The upper respiratory tract (URT) is often the main colonization place by pathogens compare to the lower respiratory tract (LRT), which usually stays sterile, due to the difficulty of bacteria to reach it [1,21,22]. Collins (2008) identified three essential elements for the transmission of disease within health institutions: “a source of infecting microorganisms, a susceptible host, and a means of transmission for the microorganism to the host” [23]. Health

care personnel, including medical students, are vulnerable to patient or any of his or her contaminated discharges [23], which may explain partly the possibility of medical students in our study might have been exposed to microorganisms from patients during their training education in the hospital. Furthermore, although the undergraduate medical students are out of the normal medical staff in health institutions, they contribute seriously to be a source and means of transmitting nosocomial infections because health training requires frequent contact with patients. [10,24-27]. This study's findings showed that the prevalence rate of S. aureus and Escherichia coli throat colonization was 37.1% among the sample of medical students compared to 8.0% among the control group sample.

Although it is a normal inhabitant of the oral cavity, throat, and nose [28], S. aureus considered among the most common pathogens responsible for many infectious diseases in both community and health institutions [29]. Bhatta et al. (2018), in his study among Nepalese medical students, found that "the prevalence of s. aureus was significantly higher among clinical sciences students compared to preclinical sciences students" [30]. Al-Tamimi et al. (2018) reported that the prevalence rate of S. aureus nasal colonization among medical students as an international trend was 14 to 45%, which is close to our findings of 37.1% throat colonization among medical students [10]. Results showed that medical students throat colonization with another group of infectious pathogens (Escherichia coli, Streptococcus pneumoniae, Viridians streptococci, Acinetobacter spp.) no less dangerous than S. aureus. International research indicated that most of these organisms act as resistant bacteria in oral cavities [31-34]. Results of this study might be explained based on either the medical students have exposed to nosocomial infections from the direct contact with patients as it was discussed earlier in this research, or the behavior of medical students agreed with the nature of the community of excessive and unjustified use of antibiotics, which results in bacterial resistance, and this is beyond the current research.

Although "females were generally more interested in training improvement and higher education than males" [35], which generally required them to attend more training and clinical sessions in hospital, however finding of this study showed that most of the bacterial growing were among the males' group compared to females (Table 3). Two main factors (genetic differences and endocrine, immune reactions) were reported to determine the immunological differences between the sexes [36]. Differences in gene expression and sex steroid hormones help to obtain a difference in immune responses between males and females [37,38]. Females showed a robust immune response to antigenic challenges such as infection and vaccination and subsequently more resistant to infection thane males [36,39]. Females give more frequent and severe reactions to viral and bacterial vaccines than men [36,40]; however, they are more susceptible to autoimmune disorders and diseases than their counterparts [41]. Predicting the transmission of severe pathogens from patients to medical students or the reverse can be reached by regular screening of clinical medical students.

The clinical medical students are more likely responsible for transmitting and disseminating the pathogens within the health care institution than other health care providers because the medical students are undergoing to a rotational training bacterial infection when they have direct contact with the program in different wards/units of the hospital, while doctors and nurses are usually working in predetermined wards/units depending on their specialty.

In light of our results and similar studies, the availability of data will significantly reduce the transmission of diseases among hospital departments, especially among high-risk patients such as ICU, burn, postoperative, and neonates. Policy about the standard medical practice, including awareness/orientation program should be strictly implemented in the level of health care personnel and medical students to avoid the transmission of nosocomial pathogens.

The strength of this study lies in comparing medical students with patient's accompaniers belonging to two different environments. However, this study had a complaint from some limitations. First: we collected our data during the autumn/summer season (September); however, the seasonal variation in the colonization rate was ignored in this study. Second: antibiotic sensitivity of the isolated pathogens was not done. Third, the transmission of isolated pathogens from the sample of medical students to the control group, patients, or the other healthcare personnel, and vice versa, was not included in the current study. Fourth: The study results cannot be generalized to other medical students because the sample was from one medical college of Diyala University, Iraq.

Conclusion

This study compared a sample of undergraduate medical students (fifth class) with patients' accompaniers attending outpatient clinics. The student is usually visiting different departments within the hospital following their clinical teaching curriculum. The results of this study found that the medical students complained from a high rate of bacterial throat colonization compared to the control group. Such evidence may increase the possibility that medical students play a role in transmitting and disseminating the infection among patients and health care personnel. Efforts should be adequate to raise knowledge and awareness among medical students and steadfast adherence to infection control protocols to minimize the transmission of nosocomial diseases in healthcare institutions.

Declarations

Abbreviations

CSF: Cerebro Spinal Fluids PPIs: Proton Pump Inhibitors; MICU: Medical Intensive Care Unit; URT: Upper Respiratory Tract; URTI: Upper Respiratory Tract Infection; LRT: Lower Respiratory Tract

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Availability of data and materials

Data will be available by emailing hanan6319@gmail.com.

Authors' contributions

HRH is the principal investigator of the study who designed the study and coordinated all aspects of the research, including all steps of the manuscript preparation. She is responsible for the study concept, design, writing, reviewing, editing, and approving the manuscript in its final form. AAF, HMJ, and AHA contributed to the study design, analysis, and reviewed and approved the manuscript. All authors read and approved the final manuscript.

Ethics approval and consent to participate

We conducted the research following the Declaration of Helsinki, and the Center of Training and Human Resource Development, Diyala Province Health Directorate, Ministry of Health, Iraq approved the protocol (Ref: official letter No. 303 issued on 21st January 2018). Confidentiality was assured with signed informed consent.

Consent for publication

Not applicable

Competing interest

The authors declare that they have no competing interests.

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