American Journal of Infection Control 47 (2019) 268–270

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major Article

Single-institution experience of medical students' bacterial colonization during training

Gebrael Saliba MD [a,*], Nadim El Kary MD [b], Ziad Bakouny MD [b], Lilas Dagher MD [b], May Mallah Hamdan MSc [c], Wassim Abdallah MD [d]

[a] Department of Infectious Diseases, Saint Joseph University, Beirut, Lebanon
[b] Infectious Diseases department, Hôtel-Dieu de France University Hospital, Faculty of medicine - Saint-Joseph university, Beirut, Lebanon
[c] Microbiology Laboratory, Saint Joseph University, Beirut, Lebanon
[d] Indiana University School of Medicine, Indianapolis, IN, USA

Key Words:
Medical students
Screening
Resistant bacteria
Colonization
Infection control

Background: Medical students are often potential vectors for resistant bacteria to their entourage. We therefore conducted this study to evaluate the variation of medical students' multiple drug resistant bacterial flora throughout their medical training.
Methods: We performed a cross-sectional study enrolling medical students of the 2016 academic year from the Saint-Joseph University - Faculty of Medicine, Lebanon.
Results: The multivariate analysis identified the medical year as the sole factor contributing to the extended spectrum beta-lactamase producing Enterobacteriaceae colonization (OR = 2.33 [1.14-4.77], P = 0.021).
Discussion: Lack of hygiene knowledge among medical trainees is not uncommon. Hence, the degree of clinical exposure predicts their risk of contamination from critically ill patients.
Conclusions: Implementing regular and practical training in line with a behavioral modification program would limit the colonization of medical students with resistant germs.

Infection due to pathogenic resistant bacteria is a serious issue, especially in the nosocomial setting.[1,2] These bacteria can be pathogenic with consequent increased morbidity and mortality, especially in frail patients, and may significantly increase economic and health care costs.[3] Medical students are often underappreciated as potential vectors of such bacteria for their entourage, as well as their patients. They are colonized, along with their medical tools, with resistant germs.[4-6] The direct link between these contaminations and infection transmissions has not been well established. The role of intrafamilial spread of resistant germs has been recently reported through asymptomatic carriers, namely, medical students and other health care personnel.[7] When indicated, the optimal empiric treatment of medical students remains controversial, and the approach to controlling their role in germ transmission is challenging. We conducted this study to evaluate the variations in medical students' multidrug-resistant (MDR) bacterial flora during medical training.

METHODS

This cross-sectional study enrolled medical students from Saint Joseph University's Faculty of Medicine. The study was approved by the university's ethics committee, and each participant provided informed consent before enrollment. Eligible participants were all medical students enlisted for the academic year 2016-2017. We excluded medical students with previous hospitalization or with positive culture for the following resistant germs: methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci, extended-spectrum beta-lactamase–producing Enterobacteriaceae (EPE), and carbapenem-resistant Enterobacteriaceae. These exclusion criteria were applied within the previous 6 months before study enrollment. All participants completed a questionnaire eliciting information on epidemiologic data and clinical rotations. We identified high-risk clinical rotations as those in the following departments: infectious diseases, urology, intensive care unit, gynecology/obstetrics, emergency, and gastroenterology. We further defined the naive group as medical students enrolled in the first and second university years, who had not yet been exposed to patients. Students in the third, fourth, and fifth years are progressively more exposed to

* Address correspondence to Gebrael Saliba, MD, Department of Infectious Diseases, Saint Joseph University, Damascus Road, Beirut, Lebanon.
E-mail address: gebraelsaliba@gmail.com (G. Saliba).
Conflicts of interest: None to report.

https://doi.org/10.1016/j.ajic.2018.08.025

Table 1
Characteristics of the participants eligible for multidrug-resistant bacterial flora evaluation

Medical school year	Number of students enrolled	Sex ratio, males/females	Average age, y	Clinical rotations						
				ID	Urology	ICU	GE	ER	OB-GYN	Two or more high-risk clinical rotations
1	23	13/10	18	NA	NA	NA	NA	NA	NA	NA
2	24	20/4	19	NA	NA	NA	NA	NA	NA	NA
3	6	4/2	21	3	0	2	1	0	0	0
4	19	13/6	21	1	1	0	1	1	3	1
5	39	20/19	22.1	15	15	8	14	12	15	22
6	52	29/23	23.2	8	6	21	10	41	7	35
7	21	11/10	24.1	7	5	22	6	20	13	19
Overall	184	110/74	21.2							

ER, emergency room; *GE*, gastroenterology; *ICU*, intensive care unit; *ID*, infectious disease; *NA*, not applicable; *OB-GYN*, obstetrics and gynecology.

patients, and sixth- and seventh-year students are permanently involved in patient care.

All participants underwent 1 nasal swab for MRSA screening and 1 rectal swab for EPE screening. The nasal swabs were screened for MRSA using an oxacillin-impregnated petri dish. The anal swabs were screened for EPE using 2 distinct petri dishes: one impregnated with cefotaxime and the other impregnated with ceftazidime. The identification of EPE organisms required an initial first grow on the latter antibiotic-impregnated media and subsequent positive testing on synergy challenge with a beta-lactamase inhibitor.

Statistical analysis was performed using SPSS version 20.0 (IBM, Armonk, NY) and Xlstat version 2017.1 (Addinsoft, Paris, France). For all statistical tests, the statistical significance threshold was specified at $\alpha = 0.05$. Responses to the qualitative variables were recorded as percentages. Age was recorded as mean and standard deviation. Univariate logistic regression analyses were performed between the dependent variables presence of extended-spectrum beta-lactamase/presence of MRSA and the qualitative variables of the demographic questionnaire. Significant relationships were described as odds ratios (ORs) and their 95% confidence intervals (CIs). Stepwise multivariate logistic regression was then performed using the qualitative variables of the demographic questionnaire that were significantly correlated with the dependent variables in the previous statistical step. Significant relationships were described by adjusted OR (aOR) and 95% CI.

RESULTS

The characteristics of the 184 participants eligible for this study are reported in Table 1. None of the cultures taken from nasal swabs grew in MRSA. The prevalence of EPE collected from rectal swabs was 28%, with *Escherichia coli* being the most prevalent Enterobacteriaceae isolated. EPE were identified in 17% of the first 2-year students and in 32% of later-year students (Table 2). The univariate analysis showed that compared with medical students in the first 4 years of study, students in the fifth year and beyond were more frequently colonized by EPE (OR, 2.33; 95% CI, 1.14-4.77; $P = .021$). Moreover, students who had completed at least 2 high-risk clinical rotations were more prone to harbor EPE (OR, 2.56; 95% CI, 1.18-5.56; $P = .017$). Intensive care unit training and gynecology training were identified as risk factors for EPE colonization (OR, 2.50, 95% CI, 1.10-5.67, $P = .028$ and OR, 2.19, 95% CI, 1.04-4.60, $P = .039$, respectively). In the multivariate analysis, the year of medical training emerged as the sole factor contributing to the difference in EPE colonization between medical students in the fifth year and beyond and those in the first 4 years (aOR, 2.33; 95% CI, 1.14-4.77; $P = .021$).

DISCUSSION

One-third of Saint Joseph University's Faculty of Medicine students were enrolled in this study, providing a fairly representative sample of the study population. Overall, EPE seemed to be the predominant MDR bacterial flora in the medical students, and MRSA was not encountered. This finding may be subject to the local epidemiologic data of Lebanon.[8] We analyzed the variations in the MDR bacterial flora of the medical students as a surrogate for contamination during medical training. The literature reports on the prevalence of MRSA and EPE colonization among medical students without analyzing the preponderant risk factors for their acquisition. We found that the major factor involved in medical students' MDR bacterial contamination seems to be their degree of clinical exposure, represented here by their year of study.

Medical students lack knowledge of hygiene in infection control, as their personal belongings commonly come close to patients and are rarely cleaned appropriately.[5,6] Moreover, they are unaware of the correct indications for hand hygiene and the use of alcohol-based hand rubs, universal gloves, and protective gowns.[9,10] Throughout training, medical students are exposed to increasing numbers of patients with resistant germs. As these students progress in their training, they are at greater risk of contamination from critically ill patients.[9] The inherent community behavior, attitudes, and peer

Table 2
Distribution of multidrug-resistant bacterial rectal flora in medical students by academic year

Medical school year	*Escherichia coli* ESBL, n	*Citrobacter freundii* ESBL, n	*Escherichia fergusonii* ESBL, n	*Klebsiella pneumoniae* ESBL, n	*Proteus mirabilis* ESBL, n	Total EPE per year, n
1	3	0	0	0	0	3
2	5	0	0	0	0	5
3	0	0	0	0	0	0
4	5	0	0	0	0	5
5	13	1	1	0	1	16
6	16	0	0	1	0	17
7	6	0	0	0	0	6
All students	48	1	1	1	1	52

ESBL, extended-spectrum beta-lactamase; *EPE*, ESBL-producing Enterobacteriaceae colonization.

behavior of medical students have been identified as the core factors in the adherence to infection control strategies.[11]

CONCLUSIONS

Covering the gaps in performance, knowledge, and education would improve infection control.[12] As such, implementing regular and practical training in line with a behavioral modification program is required in the early years of the medical curriculum to build in proper unconscious hygiene behavior.[12] This strategy of infection control would limit the colonization of medical students with MDR bacterial flora and their vectoring in the nosocomial and community settings.

References

1. Uhlemann AC, Otto M, Lowy FD, DeLeo FR. Evolution of community- and healthcare-associated methicillin-resistant *Staphylococcus aureus*. Infect Genet Evol 2014;21:563-74.
2. Pitout JD. Extraintestinal pathogenic *Escherichia coli*: a combination of virulence with antibiotic resistance. Front Microbiol 2012;3:9.
3. Johnson JR, Tchesnokova V, Johnston B, Clabots C, Roberts PL, Billig M, et al. Abrupt emergence of a single dominant multidrug-resistant strain of *Escherichia coli*. J Infect Dis 2013;207:919-28.
4. Li B, Zhong Y, Fu XC, Qiu YH, Wang SY, Yang AJ, et al. Duration of stool colonization in healthy medical students with extended-spectrum-β-lactamase-producing *Escherichia coli*. Antimicrob Agents Chemother 2012;56:4558-9.
5. Kotris I, Drenjančević D, Talapko J, Bukovski S. Identification of microorganisms on mobile phones of intensive care unit health care workers and medical students in the tertiary hospital. Med Glas (Zenica) 2017;14:85-90.
6. Uneke CJ, Ogbonna A, Oyibo PG, Ekuma U. Bacteriological assessment of stethoscopes used by medical students in Nigeria: implications for nosocomial infection control. World Health Popul 2008;10:53-61.
7. Adler A, Baraniak A, Izdebski R, Fiett J, Salvia A, Samso JV, et al. A multinational study of colonization with extended spectrum β-lactamase-producing Enterobacteriaceae in healthcare personnel and family members of carrier patients hospitalized in rehabilitation centres. Clin Microbiol Infect 2014;20:O516-23.
8. Matta R, Hallit S, Hallit R, Bawab W, Rogues AM, Salameh P. Epidemiology and microbiological profile comparison between community and hospital acquired infections: a multicenter retrospective study in Lebanon. J Infect Public Health 2018;11:405-11.
9. Morgan DJ, Rogawski E, Thom KA, Johnson JK, Perencevich EN, Shardell M, et al. Transfer of multidrug-resistant bacteria to healthcare workers' gloves and gowns after patient contact increases with environmental contamination. Crit Care Med 2012;40:1045-51.
10. Weinstein RA. Controlling antimicrobial resistance in hospitals: infection control and use of antibiotics. Emerg Infect Dis 2001;7:188-92.
11. Whitby M, McLaws ML, Ross MW. Why healthcare workers don't wash their hands: a behavioral explanation. Infect Control Hosp Epidemiol 2006;27:484-92.
12. Scheithauer S, Haefner H, Schwanz T, Lopez-Gonzalez L, Bank C, Schulze-Röbbecke R, et al. Hand hygiene in medical students: performance, education and knowledge. Int J Hyg Environ Health 2012;215:536-9.