

Recall of Prior Knowledge in Medical Microbiology Among Medical Interns: A Multicenter Cross-Sectional Assessment in Saudi Arabia

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Background: Retention of basic biomedical sciences knowledge is of great importance in medical practice. This study aimed to provide some insights into medical interns' ability to recall theoretical knowledge of medical microbiology and to explore factors that affect its retention.

Methods: In this cross-sectional study conducted between January and March 2019, an anonymized questionnaire with 10 validated multiple-choice questions about medical microbiology was distributed as hard copies to test the ability to recall knowledge of Saudi medical interns in three tertiary training hospitals in Riyadh, Saudi Arabia.

Results: A total of 300 medical interns [164 females (54.7%) and 136 males (45.3%)], in three major tertiary medical care centers in Riyadh, Saudi Arabia, voluntarily participated in the study. Almost a third of participants, 107 (36.4%), graduated from medical schools adopting a traditional curriculum, whereas 184 (63.6%) graduated from medical schools adopting problem-based learning (PBL) instructional approach. The overall mean score out of 10 marks was 3.9 ± 1.8 with almost 82% failures scoring less than six marks. Both total and pass/fail grades were significantly associated with interns who graduated from private colleges. Scores were not significantly associated with any of the investigated parameters except type of college (governmental vs private) with a *p*-value of 0.049.

Conclusion: The current study revealed an overall poor recall of knowledge in microbiology among interns. Our findings suggest a need for a careful revision of curriculum to correct deficiencies, particularly in teaching medical microbiology. Integration of basic sciences is required as well as aligning teaching of basic medical sciences with clinical skills.

Keywords: prior knowledge, microbiology curriculum, medical intern, Saudi Arabia

Background

Retention of basic biomedical sciences knowledge is essential in medical practice as it tends to decrease significantly and is often quickly forgotten as medical students progress in their studies and after graduation.^{1,2} Recall of previously taught subjects has been a long-standing concern for medical educators.³ For instance, AlMohanna, and co-authors 2018 reported significant loss of prior immunology and physiology knowledge among medical graduates during their internship training.⁴ Retention of basic sciences knowledge is significantly associated with performance in certifying and licensing examinations.⁵ Lower scores have been observed in the basic medical sciences (step 1) of the United States Medical Licensing Exam (USMLE) as compared to clinical subjects (step 2), since perceived relevance appears to facilitate knowledge retention⁶ suggesting that nonuse or nonpractice of previously taught knowledge and skills seems to be the primary determinant of the degree of this loss.⁷ Medical students in their senior clinical phases do not recall much from their basic sciences courses^{8,9} and in fact forget a large portion of what was taught in the early years of medical college.⁸ This trend in poor recall of basic knowledge in biomedical sciences is also observed in other scientific domains.¹⁰

Microbiology is one of the basic medical sciences, which significantly overlaps other disciplines such as internal medicine, immunology and genetics. Moreover, knowledge of microbiology can be affecting impact on public health, the economy, and the environment.^{1,2} Worldwide, infectious diseases represent approximately 10% of the total burden of disease and remain the third leading cause of death historically.^{11,12} Emerging and reemerging infectious diseases are a continuous challenge for public health officials. HIV/AIDS, tuberculosis, Marburg virus, malaria, West Nile virus, SARS, and influenza are examples of microorganisms that continue to pose a significant warning of potentially newly emerging endemic diseases.¹¹

Currently, microbiology learning activities at universities are mostly based on passive memorization of concepts and definitions.^{1,2} It is a big challenge to assess the retention of basic medical sciences knowledge following using traditional or innovative educational strategies. It is well documented that good knowledge retention acquired by students during the undergraduate years are essential for professional medical practice. Medical graduates are expected to enhance their clinical experience based on proper comprehension of such basic sciences courses. Previous studies have already addressed the recall of knowledge in basic sciences such as biochemistry, pharmacology, and physiology,^{4,13–15} To the best of our knowledge, no study regarding microbiology recall by medical interns was undertaken in the Middle East, more so in the Kingdom of Saudi Arabia (KSA). Therefore, the present study aims to fill this gap and investigate the recall of prior microbiology knowledge among senior medical interns trained in multiple medical institutions in Riyadh, KSA.

Methods

Design and Participants

In this cross-sectional study, medical graduates on internship rotation in three main hospitals in Riyadh city were recruited during the study period of January–March, 2019. The study sites were King Fahad Medical City (KFMC; N=170), King Khalid University Hospital (KKUH; N=70), and National Guard Health Authority (NGHA; N=56) in Riyadh City. The study was approved by the Institution Review Board (IRB) of King Fahad Medical City, (IRB Log Number: 18–641). Informed consent of all subjects was obtained. Participants were assured of the confidentiality of data, and that it would be used only for the stated purpose.

Study Questionnaires

A total of 10 questions ([Supplementary Table S1](#)) were developed following the USMLE questions in the Immunology and Microbiology Lecture Notes Book by.¹⁶ These multiple-choice questions (MCQs) covered basic medical microbiology domains (parasitology, bacteriology, virology, mycology and genetics/drug resistance) as taught in undergraduate medical schools ([Table 1](#)). In addition, an additional questionnaire was provided which included demographic characteristics and information concerning universities, colleges, national or international, government or private, traditional or problem-based curriculum, training hospitals, and current rotation specialty.

Data Analysis

Statistical analysis was performed using the SPSS, version 17. Each correct answer was given one point. The total marks of the MCQs were recoded into two categories: Pass for 6 marks and above and fail for marks less than 6 out of 10 marks, as well as the total score. Descriptive statistics such as frequency and percentages (%) were used to describe qualitative variables while mean and standard deviation (SD) was used for quantitative variables. Differences between means for quantitative variables were compared using *t*-test or Mann–Whitney test as appropriate after checking for normality. The ANOVA or Kruskal–Wallis tests, as necessary, were used for differences for more than two means. The Chi-square test was used to find any association between scores and some categorical variables. Significance was set at <0.05.

Results

The study subjects included 300 interns who completed the questionnaires and answered ten MCQs covering recall of basic medical microbiology knowledge. The mean score of the 10 MCQs was 3.9 ± 1.8 , and only 55 (18.3%) interns

Table 1 Overall Scores Attained by the Participants and Their Demographic Parameters

Parameters	Variables	N (%)	Overall Score	Passed N (%)
Sex	Male	136 (45.3)	3.9 ± 2.0	29 (21.3)
	Female	164 (54.7)	3.9 ± 1.6	26 (15.9)
	p-value		0.93	0.14
Age (years)	<23	77 (25.7)	3.9 ± 1.9	17 (22.1)
	24	129 (43.0)	4.0 ± 1.7	26 (20.2)
	25	59 (19.7)	3.6 ± 1.6	6 (10.2)
	<26	35 (11.7)	3.7 ± 2.0	6 (17.1)
	p-value		0.34	0.30
Curriculum	Traditional	107 (36.4)	3.9 ± 1.7	17 (15.9)
	Problem-based	184 (63.6)	3.8 ± 1.8	36 (19.3)
	p-value		0.89	0.29
Type of College	Private	77 (25.4)	4.2 ± 1.8	22(28.9)
	Government	233 (74.6)	3.8 ± 1.8	33(14.8)
	p-value		0.049	0.006
Place of College	National	289 (96.3)	3.8 ± 1.8	53 (18.6)
	International	11(3.7)	4.4 ± 1.3	2 (18.2)
	p-value		0.35	0.67
Exam	SMLE	102 (34.0)	4.1 ± 1.6	20 (19.6)
	USMLE	12 (4.0)	4.5 ± 1.6	2(16.7)
	Others	186 (62.0)	3.7 ± 1.9	33(17.7)
	p-value		0.14	0.92
Graduation Year	2016	4 (1.3)	3.0 ± 1.6	0 (0)
	2017	13 (4.3)	3.3 ± 1.5	0 (0)
	2018	214 (71.3)	3.9 ± 1.8	41 (19.2)
	2019	69 (23.0)	4.0 ± 1.6	14 (20.3)
	p-value		0.47	0.25

Note: Data presented as mean ± SD; p-value significant at <0.05.

passed. Table 1 shows the general characteristics of the study subjects and the overall scores. The majority of interns were females, aged 24 years, who studied in local government colleges, graduated in the year 2018 from a problem-based curriculum and preparing for SMLE. Private colleges' graduates scored significantly higher than government colleges in both overall score and pass rate. No significant association was found according to all other parameters studied (Table 1). The mean score of the individual ten questions out of a maximum of 5 points is shown in a descending order (Figure 1). The highest score was for question 6 (4.34/5) and the lowest was for question 7 (2.67/5). Five questions had a mean score of less than 3.

In Table 2, males scored significantly higher scores for questions 1 and 3. Graduates from government colleges scored significantly higher scores for questions 9 and 10 compared to graduates of private colleges. Interns of colleges inside Saudi Arabia scored significantly higher in question 5, while the reverse is true for question 8. Interns coming from the traditional curriculum scored significantly higher scores for questions 2 and 10 while those from problem-based learning (PBL) scored significantly higher scores for questions 6 and 8. No other significant differences were observed in other stratified parameters.

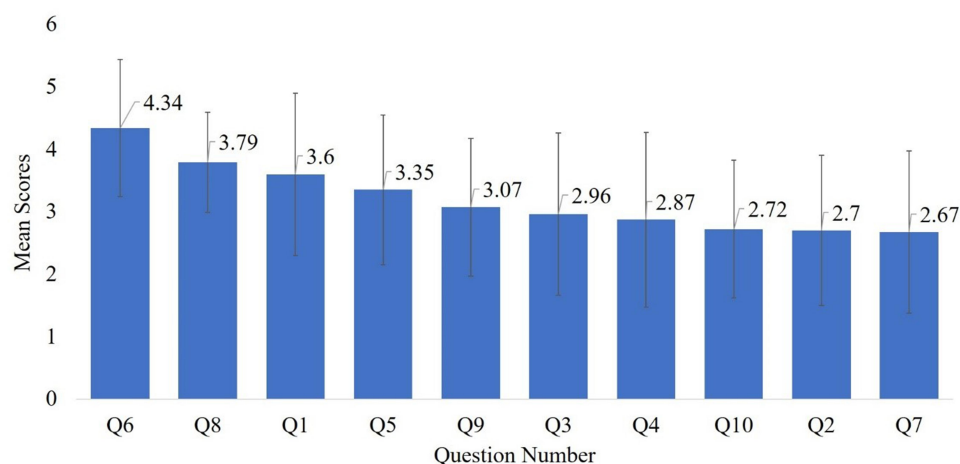


Figure 1 Mean scores for each question (10 questions) in descending order. The figure shows the mean scores of the individual ten questions out of a maximum of 5 points. The highest score was for question 6 (4.34/5) and the lowest was for question 7 (2.67/5). Five questions had a mean score of less than 3.

Discussion

The retention and use of basic medical science knowledge in clinical settings have been of interest and concern for medical educators.³ We found something (in those that passed and retained knowledge) that could help in the recall of prior

Table 2 Mean Scores of Microbiology Knowledge Attained by the Participants According to Their Sex, Type and Location of College, and Instructional Approach

Parameters	Questions									
	1	2	3	4	5	6	7	8	9	10
Sex										
Male	3.8 ± 1.2	2.8 ± 1.2	3.1 ± 1.3	2.8 ± 1.5	3.4 ± 1.3	4.2 ± 1.2	2.6 ± 1.3	3.8 ± 0.8	3.0 ± 1.2	2.8 ± 1.2
Female	3.4 ± 1.4	2.6 ± 1.2	2.8 ± 1.3	2.9 ± 1.4	3.3 ± 1.2	4.4 ± 1.0	2.7 ± 1.3	3.8 ± 0.8	3.1 ± 1.0	2.7 ± 1.0
p-value	0.014	0.44	0.037	0.50	0.74	0.19	0.47	0.66	0.59	0.49
Type of College										
Private	3.8 ± 1.4	2.6 ± 1.2	2.7 ± 1.2	3.0 ± 1.6	3.2 ± 1.2	4.4 ± 1.0	2.8 ± 1.4	3.7 ± 0.9	2.8 ± 1.0	2.5 ± 1.0
Government	3.5 ± 1.3	2.7 ± 1.2	3.0 ± 1.3	2.8 ± 1.4	3.4 ± 1.3	4.3 ± 1.1	2.6 ± 1.3	3.8 ± 0.8	3.2 ± 1.1	2.8 ± 1.2
p-value	0.18	0.41	0.08	0.59	0.44	0.5	0.38	0.18	0.006	0.04
Place of College										
National	3.6 ± 1.3	2.7 ± 1.2	3.0 ± 1.3	2.9 ± 1.4	3.4 ± 1.2	4.3 ± 1.1	2.7 ± 1.3	3.8 ± 0.8	3.6 ± 1.3	2.7 ± 1.2
International	3.6 ± 1.1	2.3 ± 1.3	3.1 ± 1.2	3.2 ± 1.2	2.6 ± 1.8	4.8 ± 0.4	2.6 ± 1.5	4.3 ± 0.6	3.6 ± 1.1	2.3 ± 1.3
p-value	0.90	0.23	0.74	0.47	0.03	0.14	0.93	0.048	0.35	0.99
Curriculum										
Traditional	3.5 ± 1.3	2.9 ± 1.2	2.9 ± 1.3	3.0 ± 1.4	3.2 ± 1.4	4.2 ± 1.2	2.9 ± 1.3	3.6 ± 1.0	3.0 ± 0.9	2.9 ± 1.2
PBL	3.6 ± 1.3	2.6 ± 1.2	3.0 ± 1.3	2.8 ± 1.4	3.5 ± 1.1	4.4 ± 1.0	2.6 ± 1.3	3.9 ± 0.7	3.1 ± 1.2	2.6 ± 1.0
p-value	0.46	0.048	0.36	0.45	0.08	0.03	0.05	0.007	0.80	0.002

Note: Data presented as mean ± SD; p-value significant at <0.05.

microbiology knowledge among medical interns. Interestingly, this study suggests that retention of basic microbiology knowledge is significantly affected by the type of college. Graduates from private colleges attained higher scores than their peers from governmental medical schools. This finding was not observed when testing for other basic fields.^{4,14,15} The only probable reason to explain the better performance of interns from private colleges is that is that their entrance qualification for medical schools was foreign secondary schools' certificates (eg, General Certificate of Education Advanced level and Scholastic Assessment Test). This means that they are more familiar with English as a language of instruction than interns from governmental universities prior to enrolling in the medical schools. All other parameters studied such as the sex, age, type of curriculum taught, year of graduation, place of college, or exam preparation did not significantly correlate with the recall of microbiology knowledge.

The type of adopted curriculum in colleges was not associated with the prior recall of microbiology knowledge. However, graduates of traditional curricula attained significantly higher recall scores as compared to students from schools adopting problem-based curricula.¹⁷ The overall goals of medical education include the attainment of knowledge, skills, attitudes, and values required to perform professional medical tasks competently and safely. Thus, it is necessary to adequately integrate clinical experiences with basic sciences to achieve these goals. The basic medical sciences curricula of traditional medical schools have been a place of sharp criticism by regulatory bodies of clinical practice.¹⁸ They blame the medical schools on the substantial factual overload of basic medical sciences in their curricula.¹⁸

The scientific knowledge necessary for learning and practicing medicine has changed dramatically, while the implementation of science education in the premedical and medical curricula has mostly remained unchanged.²

In the present study, sex and age were not associated with retention of prior microbiology knowledge. This is in disagreement with other studies that reported that retention and academic performance are influenced by the age and the sex of students,^{1,19} but not all.¹⁰ Since basic knowledge is included in initial graduate examinations, it is conceivable that fresh interns preparing for graduate studies, attain high scores. However, neither exam preparation (SMLE, USMLE, or others) nor year of graduation in our study revealed any significant predictor.

The fact that most interns have difficulty in recalling basic sciences knowledge is supported by local and international studies.^{2,13–15,20} This may be related to non-practice of basic sciences knowledge and skills learned and probably to methods of teaching.^{2,3,5,6,9} Medical students and interns may regard the basic medical subjects as peripheral and irrelevant to the medical profession and thus tend to forget them.²¹ Although remembering basic science concepts during the clinical years do not directly affect clinical knowledge, there is a positive correlation between retained basic concepts and efficient clinical practice.²¹ To improve recall of basic sciences knowledge in clinical years, implementation of programs like early clinical exposure and integration of the subjects can make learning basic science subjects more exciting and can affect the student's attitude towards patients' care.^{22,23}

The authors of this study acknowledge some limitations. The study was cross-sectional, which is not a robust design for assessing association and causation. Though the study was a multicenter, it may not reflect similar populations in other Arabian Gulf and Middle Eastern countries and as such, findings may only apply to the curriculum adopted by the Saudi medical schools. The findings nevertheless offer insights in the need to revise curriculum of medical microbiology to medical students and training interns in KSA.

Conclusions

The current study revealed an overall deficiency of recall of prior knowledge in microbiology among interns in KSA, which is not related to curriculum type or demographic characteristics but rather ownership of teaching college. Integration of basic sciences as well as aligning teaching of basic medical sciences with clinical skills are recommended.

Abbreviations

PBL, problem-based learning; MCQs, multiple-choice questions; IRB, Institutional Review Board; SML, Saudi Medical Licensure Examination; USMLE, United States Medical Licensing Examination; KFMC, King Fahad Medical City; KKHU, King Khalid University Hospital; NGHA, National Guard Health Authority.

Data Sharing Statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics

This study sought approval from the IRB committee of King Fahad Medical City (IRB Log number IRB: 18-641).

Consent

Participation in this study was voluntary and all the study subjects gave their consent by signing on the first page of the questionnaire.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no conflicts of interest in relation to this work.

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