ABSTRACT: A recent academic paradigm shift in the United Arab Emirates (UAE) introduced US-style medical education to meet the nation’s growing need for medical practitioners. This newly established Doctor of Medicine (MD) program at Khalifa University of Science and Technology (KU) left gaps in student preparedness. To address this problem, KU simultaneously developed a post-bachelor’s premedical program, commonly known as a pre-medicine post-baccalaureate (PMPB) program, that prepared students for entry into the UAE’s first MD program. The authors adapted US-style post-baccalaureate approaches to create KU’s PMPB program that gave students unique opportunities to take coursework that filled gaps in previous knowledge and prepare for the Medical College Admission Test (MCAT) exam. The 1-year bridging program harnessed academic strengths from the Association of American Medical Colleges (AAMC) post-baccalaureate premedical programs network and Kaplan, Inc. Overall, 19 (12 Emirati and 7 international) students achieved admissible MCAT scores (group’s minimum score = 485, average score = 492, and maximum score = 509) and gained research experiences that supported their entry into KU’s medical school. The PMPB program supplied two-thirds of the medical schools’ fall 2019 inaugural class, increased local awareness and interest in medicine and created a novel platform to help students pursue a career in medicine in the UAE.

KEYWORDS: premedical, pre-medicine, post-baccalaureate, MCAT, US-style, post-bachelor’s medical education, United Arab Emirates

Introduction

The healthcare sector in the United Arab Emirates (UAE) is rapidly expanding to meet the nation’s growing demand for medical services and to find effective solutions to overcome the severe shortage of Emirati physicians.1,2 By setting up the College of Medicine and Health Sciences (CMHS) in 2019, Khalifa University of Science and Technology (KU) became the first institution to introduce US-style medical education in the UAE. In doing so, the university implemented a unique way to support the UAE’s expanding needs for medical services by strengthening its ability to attract, retain, and train medical professionals.2

This plan is part of KU’s vision to become a major player in meeting Abu Dhabi Vision 2030,3 by developing a highly-skilled, highly-productive workforce that can be future world leaders. Among its other missions, KU strives to transform the institution, and thus Abu Dhabi and UAE into a world-known education destination of choice. This mission necessitated a paradigm shift in education, such as introducing US-style medical education along with the present UK-style educational systems.

Traditionally, medical education in the UAE, and by extension, the Gulf Cooperative Council (GCC) countries, has relied on the model from the United Kingdom (UK), which accepts students with only high school level training.4 In comparison, the US model of medical education requires students to have completed traditional premedical training, and possess an undergraduate degree and an admissible MCAT score.5 Thus, the introduction of KU’s US-style program left a gap in
student preparedness, particularly in obtaining admissible MCAT scores, since universities in UAE did not generally include the needed curricular elements of premedical education in undergraduate programs. Nevertheless, to ensure the success of the US-style program, local candidates entering KU’s MD program had to meet these new entry requirements. To address this issue, the authors looked to create ways to help prospective students meet the requirements for KU’s MD program by understanding how educational pipelines in the US help students pursue various careers.

Since the 1970s, education pipeline programs across the US have enhanced student entry into various scientific and technical fields. Pipeline programs traditionally start with K-12 students and end with trained professionals, are vital components of workforce development and workplace diversity, and ensure that sufficient qualified candidates are available to fill needed positions. Moreover, pipelines programs are useful tools to promote equity and inclusion in education.

Pipeline programs have become popular in the field of medical education, as they provide exposure to various medical career paths while enhancing the skills that prepare students for success in professional school. Within recent times, colleges and universities have added a component to the medical education pipeline: Pre-Medicine Post-Baccalaureate (PMPB) training, as shown in Figure 1. Such training typically begins after a student has completed their undergraduate degree, to enhance an applicant’s competitiveness, and support the transition to medical school. Thus, the authors envisioned that a PMPB program would help fill gaps in student preparedness generated by the recent introduction of US-style medical education in the UAE. This paper primarily reports the development of new PMPB program at KU and the promising results of our first 3 cohorts in 2018-2019.

**PMPB Programs: Structure and Criteria**

According to the Association of American Medical Colleges (AAMC), there are currently over 200 PMPB programs in the US. Academic institutions design these programs to support the transition to professional school. Generally, PMPB programs achieve this goal by helping students enhance their academic records, pursue a career change, and prepare for the MCAT exam.

The structures of PMPB programs vary by target demographic, duration, enrollment requirements, curricula, financial support, and credentials awarded upon successful completion. Typically, these programs can be expensive and span from 1 to 3 years, depending on full-time or part-time enrollment. Students often take premedical coursework and participate in research projects that depend on whether the program is non-degree- or degree-granting.

**KU’s PMPB Program**

Using the above mentioned criteria, the authors developed an academic bridging program at KU, officially called the Pre-Medicine Bridge Program, to support the transition of potential candidates to the CMHS. To the authors’ knowledge, KU’s PMPB program is the first of its kind in the GCC countries. The program was developed as follows.

**Recruitment and Target Candidates**

Considering target candidates, our PMPB program currently focuses on recruiting students with backgrounds in science, technology, engineering, and mathematics (STEM) disciplines. The program also focuses on attracting senior students from KU’s Biomedical Engineering program and its recent graduates, as these students have relevant biomedical academic backgrounds, within the KU system, which makes them strong candidates for medical degrees. The choice of students from STEM or biomedical backgrounds, as a first stage, was to facilitate launching a completely new program/academic track for medical degrees in UAE by avoiding further challenges of students with less relevant backgrounds. The authors consider evaluating the program in future years after establishing a solid foundation for STEM candidates to consider students with other academic backgrounds. KU’s administration also recruits highly qualified international students who meet the outlined requirements are willing to relocate to the UAE.

**Enrollment, Program Adaptations, and Cofounding Factors**

KU’s PMPB program was planned to span the entire academic year with recruitment on rolling basis. The curricular and research components of the program was adapted accordingly to welcome cohorts that spend different lengths of study in order to maximize the number of students that could transition to the MD program.
For instance, in the 2018-2019 academic year, we enrolled students at the beginning of the 2018 fall, 2019 spring, and 2019 summer semesters. Despite that this represents a significant confounding factor for MCAT performance, this adaptation is currently a strength in our PMPB that allows us to prepare more students for US-style medical degrees and meet the nation’s need to increase its physician pool. Data from different cohorts are being collected regularly to compare the performance of cohorts with similar length of studies. They will be used and reported in subsequent evaluation and adaptation of the program.

Program duration, level of English proficiency, undergraduate GPA, and degree major may be other extraneous variables that could support confounding. Again, based on the high demand to increase student enrollment into KU’s MD program and the currently limited pool of potential candidates qualified for this program in the region, these limitations will be accounted for in the future.

The semesters were designed as follows. Students that enter the fall semester remain in the program for the full academic year, complete their class-based training across that semester, take the MCAT exam at the beginning of their spring semester, and then conduct research until the end of the summer semester. Students that enrol in the program in the spring follow a similar plan in terms of classes over 1 semester (spring), but have a much shorter period to conduct research (summer). Lastly, students that start the program in the summer semester, have significantly less time to prepare for the MCAT exam and do not complete a research project. Despite the length of study, the program instructors aim to ensure that students cover the academic objectives (Table 1, vide infra) to meet the primary outcome of the program, that is, prepare to sit for the MCAT exam.

**Financial Support**

KU also gives all PMPB students generous scholarships that cover tuition and fees, board, books, computing supplies, medical insurance, MCAT preparation, registration fees, and sponsored travel to sit the MCAT exam at an international testing site. Such support aims to help students focus on completing this rigorous non-degree-granting program and on showing their full potentials without financial burdens to be well prepared to pursue an MD degree.

**PMPB Curriculum**

All students take an MCAT diagnostic exam before the start of the classes listed in Table 1, to help measure baseline content knowledge and track student progress. The authors used the AAMC’s course-mapping tool designed for the MCAT exam to structure the PMPB curriculum, presented in Table 1. This tool assists pre-health advisors in identifying existing courses or creating new courses that teach the knowledge and skills needed for the new MCAT exam.

Since the PMPB students do not generally possess typical premedical backgrounds, these courses focus on fundamental biological and physical science concepts. The curriculum also provides relevant experiences in the humanities and social sciences, which most of these students do not receive from their previous education.

**Coaching Sessions**

The curriculum also included 1 week of live on-site MCAT coaching sessions to train students on ways to complete standardized exams. Kaplan instructors traveled to the UAE to deliver 36 hours of in-person sessions on various test-taking and time management strategies or provided these sessions remotely.
Students received several opportunities to practice these strategies, as the curriculum included a rigorous schedule of full-length MCAT practice exams. This schedule ensured that PMBP students took several practice tests (at least 5 Kaplan-based and 2 AAMC-based exams) in computer-labs to simulate the MCAT exam testing conditions before they took the actual exam.

This testing regimen supports current best practices recommended by our test preparation partner Kaplan, Inc., and other leaders in medical education, Next Step, Princeton Review, and the AAMC. These organizations highlight practice exams as a critical component for success on this standardized exam. Moreover, these organizations recommend that typical pre-medical students take a minimum of 3 practice exams and up to 7 exams before their actual MCAT test. Since our students do not fall into this category, the curriculum ensured that KU’s PMBP program students completed the maximum prescribed number of practice exams.

Program Evaluation
The primary outcome of evaluation was the MCAT scores. A detailed example of primary evaluation is discussed based on the cohorts of 2018–2019. Other secondary outcomes were also evaluated to some extent such as performance of students in research projects. The program offered students supervised research opportunities at KU, and the Abu Dhabi Healthcare Company (SEHA), the largest and most comprehensive healthcare network in the UAE. Students also had opportunities to develop projects at world-renowned US-based research centers (The Cleveland Clinical Abu Dhabi and New York University Abu Dhabi).

Projects were designed to help students identify a research problem, perform a literature review, write a theoretical/conceptual framework, research the design or approach to the problem, collect and analyze data, and draw conclusions, provide recommendations. Each student in the program completed these tasks and presented their findings at a KU-sponsored research symposium.

Primary Evaluation of the Program: 2018–2019
KU used the acceptance rates at different MCAT and GPA levels for applicants accepted into U.S. medical schools from 2017–2018 through 2019–2020. The frequencies are combined totals of both years. This data in Table 2 provided insight on

| GPA Range | Acceptance Rate (%) |
|-----------|---------------------|
| 2.20-2.19 | 7.7                 |
| 2.40-2.59 | 1.4                 |
| 2.20-2.39 | 5.0                 |
| 2.60-2.79 | 33.3                |
| 2.40-2.59 | 6.9                 |
| 2.80-2.99 | 10.3                |
| 3.00-3.19 | 21.6                |
| 3.20-3.39 | 4.2                 |
| 3.40-3.59 | 12.0                |
| Greater than 3.79 | 87.8                |

This table was re-created from data provided by the AAMC. The data outlines various combinations of MCAT scores and GPAs for students admitted to medical school. Additionally, the 19 black stars highlight the data obtained from the 19 KU PMBP program students that entered KU’s MD program in the Fall of 2019. The PMBP program students had a minimum MCAT score of 485, an average MCAT score of 492, and a maximum MCAT score of 509, and a minimum GPA of 2.56, an average GPA of 3.32, and a maximum GPA of 3.96. Specifically, the data also highlights how the acceptance criteria at KU’s newly established medical school matched those of US-based medical schools.
how established medical institutions determine the likelihood of a student advancing from their first year to the second year of medical school. In so doing, we used these criteria to gauge how our inaugural class matched the current standard provided by the AAMC. We also plan to use such data to investigate student advancement to the second year of our program.

In particular, 26 students entered KU’s PMPB program in 2018-2019, and approximately 90% of these students were non-native English speakers. However, only 73% of these students, 12Emirati and 7 international students (from Canada, Egypt, Lebanon, Sudan, Syrian Arab Republic, United States of America, and Yemen) obtained MCAT scores that helped them enter KU’s MD program in the fall of 2019. The number of students that transitioned from the fall, spring, and summer PMPB programs were 10, 3, and 6, respectively. Following the acceptance criteria set by US-based medical schools, the 19 PMPB students were accepted in KU’s MD program in the Fall of 2019. Had MCAT and grade point average (GPA) combinations that matched those of students accepted into US medical schools during the same period, as shown in Table 2. Overall, the PMPB program supplied roughly 63% (19 of the 30 students) of the inaugural MD class, and thus significantly supported the immediate recruitment needs of the CMHS.

## Conclusion

The CMHS at KU adapted US-style post-baccalaureate approaches to develop a PMPB program, which helped students prepare for entry into the UAE’s first Doctor of Medicine (MD) program. KU’s PMPB program took into account the criteria of recruitment, target candidates, curricular and research factors, enrollment, financial support, and evaluation of MD entry requirements in launching this new medicine career track in UAE. The program aims to allow students to fill gaps in knowledge and to prepare for the Medical College Admission Test (MCAT) exam.

The results obtained from the first iteration of the PMPB program demonstrate the feasibility of creating a dedicated system to help students meet the requirements for admission into KU’s MD-granting school. Initial results confirm that our non-native English-speaking students, who have limited pre-medical backgrounds, can overcome gaps in their earlier knowledge in short periods. The distribution of MCAT exam scores, and the above-mentioned medical school acceptance rates, highlight a few keys problems, which the authors can address in the second iteration of the PMPB program.

Most students obtained scores in the lower third of the MCAT score scale, which is understandable given the student demographic in question. To achieve a shift in scores to the middle third of the MCAT score scale, the program can become more selective in choosing target candidates and the authors can revise the curriculum by increasing the number of total teaching and coaching hours, adding more MCAT practice exams, and adding sessions to review the contents of each mock exam.

Altogether, the PMPB program and these efforts can potentially help KU develop a sustainable education pipeline that supports a paradigm shift to US-style medical education in the UAE. On a long-term basis, this program can increase awareness and serve as an advertising platform to help enhance Emirati students’ interest in pursuing a career in medicine, as there is a severe shortage of Emirati physicians in the UAE.

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## Author Contributions

HAS and GT conceived the idea and developed the initial methodology. PC devised the project and the main conceptual ideas, and JS, SV, AH, ASM, HAS, and GT further supported the development of the project’s theoretical framework. PRC led the manuscript’s construction with JS. All authors contributed to the final version of the manuscript.

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