

Three global adaptations of the American medical education model

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ABSTRACT

Following the movement toward globalization by patients, providers, and healthcare institutions, the era of borderless medical education programs has finally arrived. Some well-known United States medical schools recently have established medical education programs overseas, while several others are currently being planned. This article describes three adaptations of the standard American medical education model outside the United States. The reports from these institutions demonstrate that such adaptation into diverse cultures has been successful and that they are currently graduating medical doctors meeting highest international standards. While methodology and innovations of these institutions differ, they share common objectives of producing high quality graduates comparable to United States medical graduates based on standardized assessments.

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INTRODUCTION

Three medical schools (American University of Beirut, Weill Cornell Medical College in Qatar, and Duke/National University Singapore) are leading the movement toward globalization of the American medical education model. In this article each of these institutions describes the context in which it was established, its special philosophy, specific missions, and indicators of its current success. They review their current curricula, the outcomes of their endeavors, and typical pathways taken by their graduates. They conclude by summarizing the critical success factors for their particular institution's mission.

AMERICAN UNIVERSITY OF BEIRUT

(Kamal F. Badr)

Background: Timeline and history of program

American Presbyterian missionaries founded the American University of Beirut (AUB) in 1866. Chartered by the State of New York, it was originally named the "Syrian Protestant College," and in 1920, it received its current name. Today, AUB [Figure 1] is a secular, teaching-centered research university, with approximately 700 instructional faculty and 8,000 students. The University was granted institutional accreditation in June 2004 by the Commission on Higher Education of the Middle States Association of Colleges and Schools in the United States, which was reaffirmed in June 2009.¹



Figure 1. Aerial view of the AUB campus today.

AUB currently includes six faculties: Agricultural and Food Sciences, Arts and Sciences, Engineering and Architecture, Health Sciences, Medicine (which includes the Rafik Hariri School of Nursing), and the Suliman S. Olayan School of Business. AUB offers more than 120 programs leading to the Bachelor, Master, MD, and PhD degrees.

From the beginning of AUB, the founders realized that a medical school was critical to fulfilling their objectives of responding to the healthcare and educational needs of the region. It was the first American medical school following Harvard to adopt a four-year program of study for the MD degree. In 1902, the hospital (currently the American University of Beirut Medical Center) opened, and in 1905, a school of nursing – now the Rafik Hariri School of Nursing – launched its programs.

Since 1867, the Faculty of Medicine (FM) has been a leader in the provision of medical education and research in the Middle East. Currently over 4000 AUB medical alumni are practicing at leading institutions in the United States. Over 70 per cent of our 328 current faculty possess American Board certification. The FM enrolls approximately 95–100 students per class; Medical College Admission Test (MCAT) scores of students accepted at AUB rank among the top 20 of those admitted to United States medical schools.

The American University of Beirut Medical Center (AUBMC), which serves as the teaching hospital for the Faculty of Medicine at AUB, has provided the highest standards of care to patients across Lebanon

and the region for over a century. AUBMC's superior standards in patient-centered care, nursing, and pathology/laboratory services are evidenced by currently being the only medical institution in the entire Middle East region with international accreditations by the Joint Commission International (JCI), College of American Pathologists (CAP), and Magnet designation by the American Nurses Credentialing Center (ANCC) [Figure 2]. AUBMC is a 350-bed institution that annually serves over 300,000 local and regional patient visits.

AUBMC and American Accreditation

- **Joint Commission International (JCI) since 2008**
- **Commission on laboratory accreditation of the College of American Pathologists (CAP) since 2004**
- **The Nursing Service is Magnet designated by the American Nurses Credentialing Center (ANCC) since 2009 (one of two outside US)**

Figure 2. AUBMC's accreditations by international and American bodies.

Philosophy and mission: AUBMC 2020 Vision

In what has become known as the "AUBMC 2020 Vision," the American University of Beirut embarked on a major campaign aimed at modernizing and expanding its medical education, research, and clinical facilities. Under this plan, by the year 2020, AUB's Medical Center will have increased its bed capacity from the current 350 to 600 beds and will have expanded outpatient services through construction of new facilities [Figure 3]. It will increase the size of its medical class to 120 students, and markedly expand its research programs through the creation of Centers of Excellence in cancer, heart

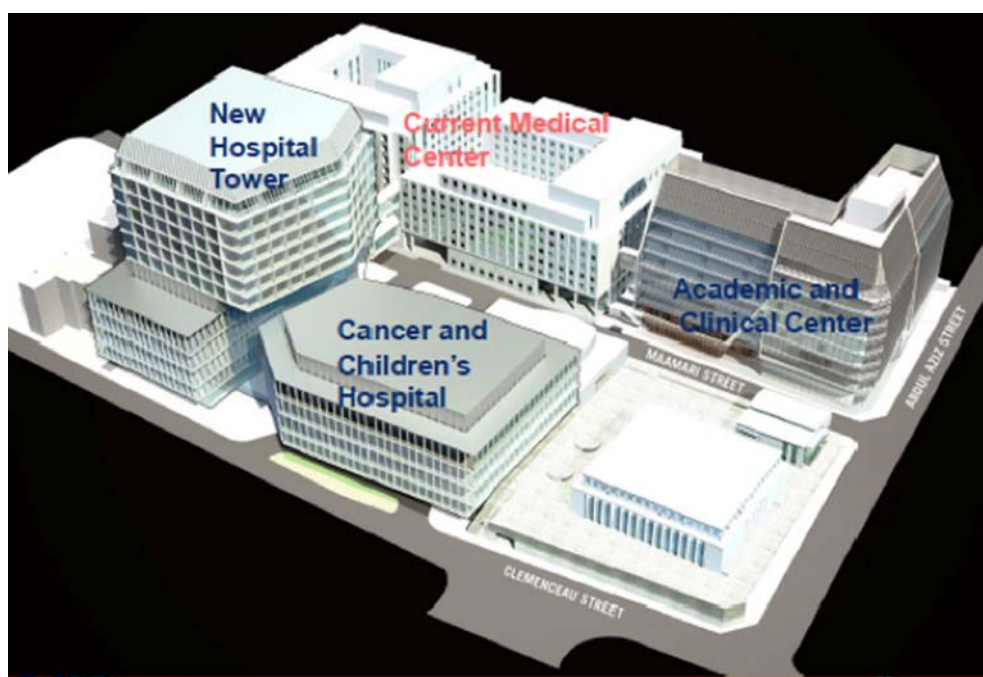


Figure 3. Present and future clinical facilities of the AUBMC complex in Beirut.

and vascular disease, neuroscience, genetics, and other disease areas that represent the principal health challenges to the people of the Middle East.

To support these services, AUBMC has signed over 23 agreements with a network of medical institutions within Beirut and around the country. This will increase its capacity to absorb new recruits and expand its teaching and research opportunities. Concrete milestones have already been achieved in the strategic pathways envisioned in the “2020 Vision,” including construction of new facilities, recruitment of over 100 new faculty members, and significant resources directed to education and research.

AUBMC 2020 Vision in education

The strategic vision in education is to be a regional resource serving the advancement of health professions education in the Middle East. This vision is supported in part by following these recently implemented initiatives:

Establishment of Program for Research and Innovation in Medical Education (PRIME):

The increasing needs and requirements and the growth of scholarship in medical education, coupled with the emergence of medical education as a career option for faculty members, led to the establishment of The Program for Research and Innovation in Medical Education (PRIME). PRIME is becoming recognized as a center of excellence and innovation in medical education, providing expertise and services to local and regional medical schools. PRIME serves the undergraduate and postgraduate education programs at the Faculty of Medicine through six Units:

- I. Curriculum Development Unit.
 - Teaching and Learning:
 - Classroom Education
 - Clinical Education
 - Evidence-Based Medicine
 - Ethics and Professionalism
 - Learner Assessment
 - Cognitive Assessment
 - Performance Assessment
 - Curriculum Evaluation
- II. Simulation Unit
- III. Information Technology Unit
- IV. Inter-professional Education Unit
- V. Faculty Development and Advancement Unit
- VI. Research in Education Unit

AUB is a pilot participant with the American Association of Medical Colleges (AAMC) in Global Health Learning Opportunities (GHLO™). The Global Health Learning Opportunities is an AAMC initiative that will utilize web-based software to streamline the application process for cross-border medical school electives. AUB's Faculty of Medicine is among 16 international medical schools participating in this program.

Undergraduate medical education

In the fall of 2013, AUB-FM implemented a new medical curriculum, “The Impact Curriculum,” which is the first major change in the curriculum in several decades. The new curriculum is the result of five years of preparation and development and will align undergraduate medical education at AUB-FM with global changes in medical education. These changes emphasize an integrated approach to instruction, early introduction of clinical experience and skills development, greater reliance on self-directed learning, extensive training in interdisciplinary and group learning, significant new and expanded course material stressing the humanitarian development and maturity of young physicians, and a keener appreciation for the social and ethical contexts of disease management.

Post-graduate medical education

In 1905, apprenticeship post-doctoral training started within the Faculty and its Hospital. In 1946, the Graduate Medical Education Program (GME) was organized and upgraded along the lines of

established programs in medical schools and centers in the United States. In the 1950s and 1960s, AUB residents were eligible to sit for some American Boards. In 2005 a Graduate Medical Education (GME) Office and Graduate Medical Education Committee (GMEC) were established.

Since October 2005, GME programs at AUBMC are aligned with Accreditation Council of Graduate Medical Education (ACGME) requirements and AUBMC is currently seeking formal accreditation by Accreditation Council of Graduate Medical Education-International (ACGME-I). Today, AUBMC boasts a robust post-graduate program comprising 21 residencies and 20 fellowships, which has grown significantly with the expansion of the clinical and academic enterprise over the past four years [Figure 4].

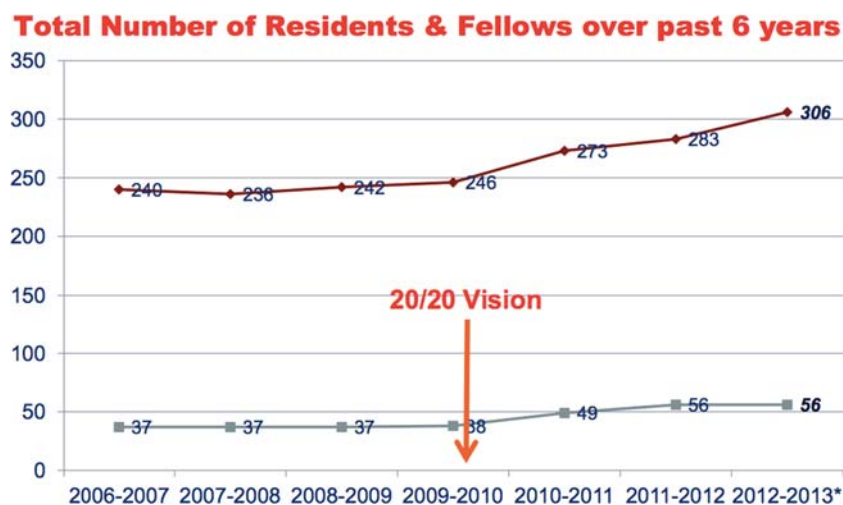


Figure 4. Annual numbers of residents and fellows at AUBMC, 2006–2013 (residents upper line, fellows lower line).

AUB-MC AND AUB-FM OUTCOMES

Advancing health professions education in the Middle East

Since the founding of the medical school (1867), the Nursing School (1905), and the School of Public Health (now Faculty of Health Sciences, 1954), AUB has been providing expert assistance to nearly all countries of the region, with particular emphasis on the founding of local schools for health science education and clinical centers.

Physician repatriation: A new paradigm for regional initiatives in healthcare

Over the past four years, AUB has succeeded in recruiting back to Lebanon over 100 new faculty members, 70 per cent of whom came from the large pool of AUB graduates in the United States and the remainder from Europe and other locations. The repatriation of this large pool of United States trained, exported physicians represents an optimal paradigm to effect the transposition of the United States House of Medicine to regions that have exported these physicians to the West in the past.¹ This repatriation requires significant strategic planning for its success and strong regional collaboration among interested countries.

In summary, the nearly 150-year history of AUB in delivering high quality American health profession education to the people of Lebanon and the Middle East is testimony to the validity and beneficial outcomes of exporting the excellence of American medicine to the global arena. The AUB experience provides ample justification for other institutions and governments to invest in reproducing and innovating using its model of success.

WEILL CORNELL MEDICAL COLLEGE IN QATAR

(Javaid I. Sheikh and Thurayya Arayssi)

Introduction and larger context

Weill-Cornell Medical College in Qatar (WCMC-Q) was established in 2001 as part of an historic partnership between Cornell University and Qatar Foundation for Higher Education, Research and

Community Development. Qatar Foundation (QF) is a non-profit organization established by the Emir of Qatar in 1995 to spearhead Qatar's efforts toward becoming a hub for higher education, research, and technology development in the entire Middle East and North Africa (MENA) region. QF has created a network of institutions and centers to facilitate Qatar achieving its national vision of transforming itself from a carbon-based economy into a knowledge-based society by the year 2030. Included among these institutions are branch campuses of eight international universities, including six from the United States.

Universities Supported by Qatar Foundation

- **1998** – Virginia Commonwealth University opened, with programs in art and design.
- **2002** – Weill Cornell Medical College in Qatar opened, offering a two-year pre-medical program and a four-year medical program leading to an MD degree.
- **2003** – Texas A&M University at Qatar opened, offering programs in chemical, electrical, petroleum, and mechanical engineering.
- **2004** – Carnegie Mellon University in Qatar opened, offering programs in computer science, business, and information systems.
- **2005** – Georgetown School of Foreign Service in Qatar opened, offering programs in international affairs.
- **2008** – Northwestern University in Qatar opened, offering programs in journalism and communications.
- **2011** – Ecole des Hautes Etudes Commerciales Paris (HEC) in Qatar opened, with executive education programs for mid-career and senior executives.
- **2011** – University College London Qatar opened, offering postgraduate qualifications in museum studies, conservation, and archaeology in partnership with Qatar Museums Authority.
- **2013** – Hamad bin Khalifa University (HBKU) opened, an emerging graduate education university with colleges of science, engineering, technology, humanities and social sciences, public health and business.

In addition to the institutions listed above, QF has also established three national research institutes: Qatar Biomedical Research Institute (QBRI), Qatar Computing Research Institute (QCRI), and Qatar Energy and Environment Research Institute (QEERI). Finally, Qatar Science and Technology Park (QSTP) encourages commercialization of the key discoveries from research that is being conducted at all these institutions.

Philosophy and mission

WCMC-Q's core mission is to play a significant role in producing a skilled biomedical workforce in the country and the region, and to improve the health and well-being of the Qatari population by establishing Centers of Excellence in translational research aimed at the most common ailments in the country, such as diabetes, cardiovascular disorders, and neurological disorders. Six classes of physicians have graduated to date, with most of them pursuing their residency and fellowship trainings in the United States. Many of these young physicians plan to return to Qatar to become leaders and innovators in the planning and delivery of medical care in Qatar and the region.

Program structure

WCMC-Q has a unique six-year program for high school graduates, with a two-year premedical and a four-year medical program [Figure 5]. WCMC-Q designed this six-year program to comply with the British tradition of medical programs in the region, which typically take six to seven years after high school. Being a branch campus of Weill Cornell Medical College in New York, WCMC-Q uses the same admission criteria and curriculum, leading to a Cornell University degree. All of the faculty based at WCMC-Q have appointments at either WCMC-New York (Medical) or at Cornell University (Premedical).

Governance

The Dean of the Faculty at WCMC-Q reports directly to Cornell University's Provost for Medical Affairs, who is also the Dean of the Weill Cornell Medical College in New York City; and, through this individual,

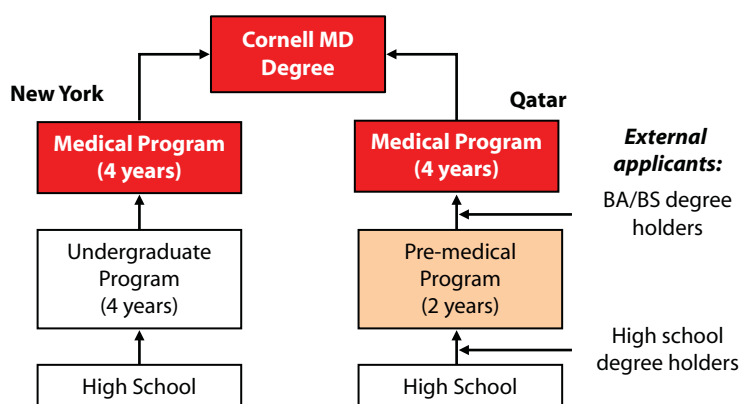


Figure 5. Academic program structure at WCMC-Q.

to the President of Cornell University, WCMC Board of Overseers, and Cornell University Board of Trustees [Figure 6].

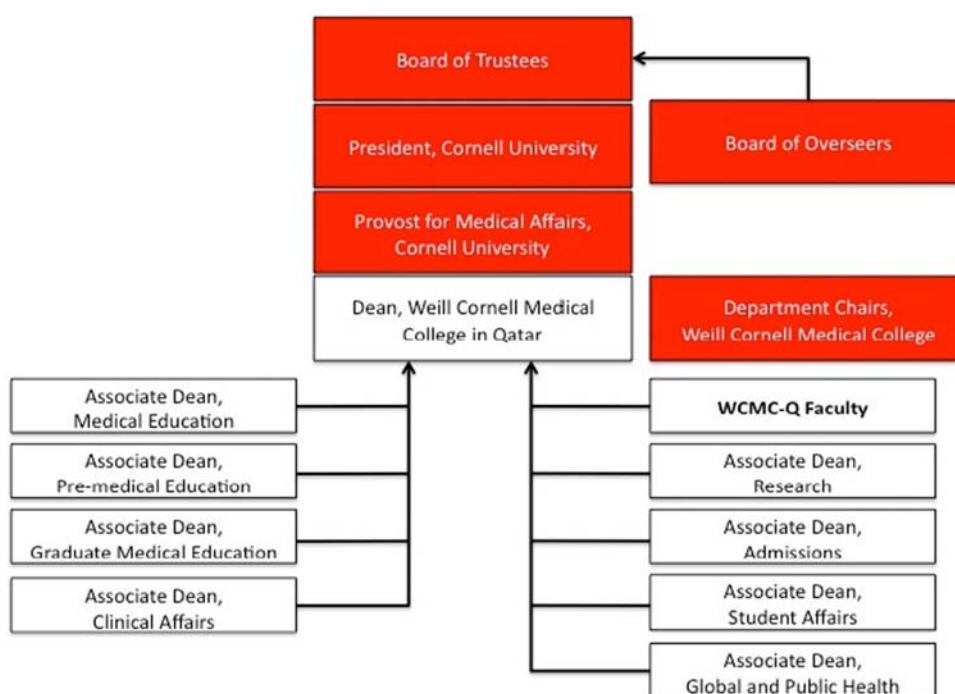


Figure 6. Governance of WCMC-Q.

Admission requirements

To be considered for admission to the Pre-medical program, an applicant must submit the following: proof of high school graduation, letters of reference from high school counselors, Scholastic Aptitude Test/American College Testing (SAT/ACT) scores, English Language Proficiency Test scores, and an interview with members of the Admissions Committee.

WCMC-Q's geographic location gives it the advantage of an applicant pool that is well diversified in terms of gender and nationality. Its current 284 student body, of whom 149 are female and 135 are male, come from 31 countries. The majority of the students admitted into the Medical program are graduates of the WCMC-Q Pre-medical program, recruited from local independent and international high schools in Qatar, as well as from schools from the Arabian Gulf and abroad. For academic year 2013–2014, 19 female and 22 male students from 19 different countries entered the Medical program.

WCMC-Q admits students to the four-year medical program in accordance with admission standards of WCMC-Q in New York, and completion of the WCMC-Q pre-medical program does not guarantee admission to the medical program. Admission requirements to the medical program are the same as in New York [Figure 7].

Admissions to medical program

Admissions process replicates that in New York:

- GPA
- MCAT
- Interview
- Letters of Reference
- Volunteer activities
- Extracurricular activities
- Other attributes
- Final decision by combined NY & Qatar admissions committee

Figure 7. Admissions requirements for the WCMC-Q medical program.

Pre-medical program

The rigorous pre-medical program is a two-year, non-degree granting course of study designed to prepare students after high school graduation to meet the requirements for applying to the four-year, degree-awarding medical program. The content of the pre-medical program focuses on aspects of basic science that have direct relevance to medicine, and the courses taught are identical to those taught at Cornell University in Ithaca, New York. These courses include biology, organic chemistry, biochemistry, genetics, neuroscience and immunology, introductory psychology, English, writing, and medical ethics.

Medical program

The curriculum for the Medical Program at WCMC-Q extends over four academic years and mirrors the WCMC-NY curriculum [Figure 8]. All instruction is in English. All faculty members at WCMC-Q hold Weill Cornell faculty appointments in New York. The curriculum is delivered by a combination of faculty based in Doha, as well as New York. Students are evaluated using the same assessment methods, including National Board of Medical Examiners (NBME) exams and must meet the same requirements for graduation as their Weill Cornell New York counterparts.

The first and second years of study consist of five basic science courses: Molecules, Genes and Cells; Human Structure and Function; Host Defenses; Brain and Mind; and Basis of Disease, as well as the Medicine, Patients and Society I and II courses. The core basic science courses are sequential, integrated, and interdisciplinary block courses that employ problem-based learning (PBL) in small groups with the faculty. Lectures are streamlined and emphasize conceptual frameworks. Anatomic dissection and experimental laboratories complete the learning experience.

The Medicine, Patients and Society courses approach the doctor-patient relationship from both conceptual and practical perspectives. Students participate in lecture, small group, and other hands-on training sessions in addition to having substantial interaction with physicians and patients in the office setting. The courses include training in medical interviewing, physical diagnosis, medical ethics, public health, biostatistics, and epidemiology.

The third year is dedicated to clinical learning and emphasizes the core clerkships, including Medicine, Surgery, Pediatrics, Obstetrics-Gynecology, Psychiatry, Neurology, Anesthesia and Primary Care that are completed in Doha. Students are integral members of the healthcare team and actively

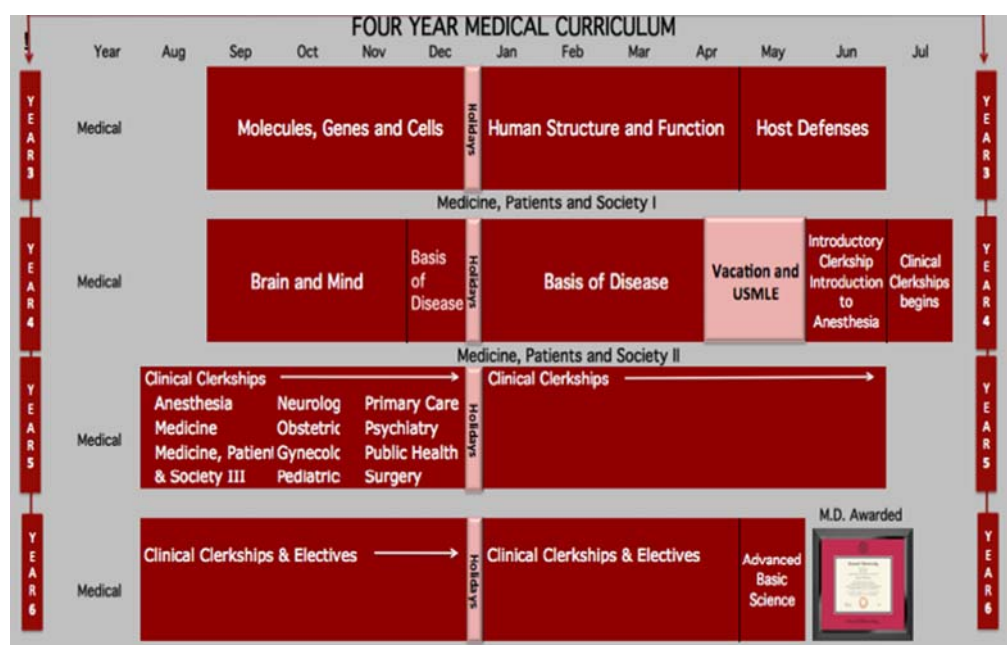


Figure 8. WCMC-Q medical program curriculum.

care for patients under the supervision of the faculty. WCMC-Q's model for clinical learning encourages the student to analyze clinical problems, discuss interpretation with the faculty, and implement the clinical plan. This encourages the student to develop independent clinical skills, while safeguarding the highest level of patient care.

The fourth-year curriculum centers on completion of clinical requirements, a required sub-internship at one of Weill Cornell Medical College-New York affiliate hospitals, as well as electives. While electives can be taken at any time in the third or fourth years, most students focus on three major types of electives in the fourth year: clinical electives, often in subspecialty areas, research, and international electives. In the month before graduation, students complete the Public Health Clerkship, the Medicine, Patients and Society III course, and the Advanced Biomedical Science course, which allows students to review leading-edge biomedical science in depth.

Faculty

WCMC-Q has 66 resident faculty members based in Qatar: 19 are premedical faculty and 47 are medical faculty. Each year, approximately 40 United States-based faculty members from Weill Cornell Medical College and Cornell University come to Doha, for varying lengths of time, to teach their areas of expertise to our students. Additionally, we have more than 270 voluntary clinical faculty members from our affiliated institutions. Most of these are practicing physicians based at the Hamad Medical Corporation, the largest clinical provider in the State of Qatar and the primary clinical site for our medical student clerkships.

Student and program outcomes

To assess whether our students have attained the desired learning outcomes and to evaluate the effectiveness of the program, the school uses both internally developed examinations, as well as the performance on the United States Medical Licensure Examinations® (USMLE), National Resident Matching Program (NRMP®) match rate, and graduate performance during and after residency.

Although not required for graduation, the majority of the students sit for USMLE Step1 at the end of the second year and USMLE Step 2 Clinical Knowledge (CK) and Clinical Skills (CS) at the end of their third year. Students' performance has been impressive. The cumulative pass rates for all students who sat for USMLE Step 1 is 88 per cent and 96 per cent for the USMLE Step 2 CK. Pass rates for both examinations are approaching or identical to pass rates of graduates from United States and Canadian Medical Schools.²

Average scores of the inaugural class for both USMLE Steps 1 and 2 were above average for United States students, and they dipped for the second class, but have improved consistently over the last five years. Now scores are identical to the United States average, as faculty has gained more experience [Figure 9].

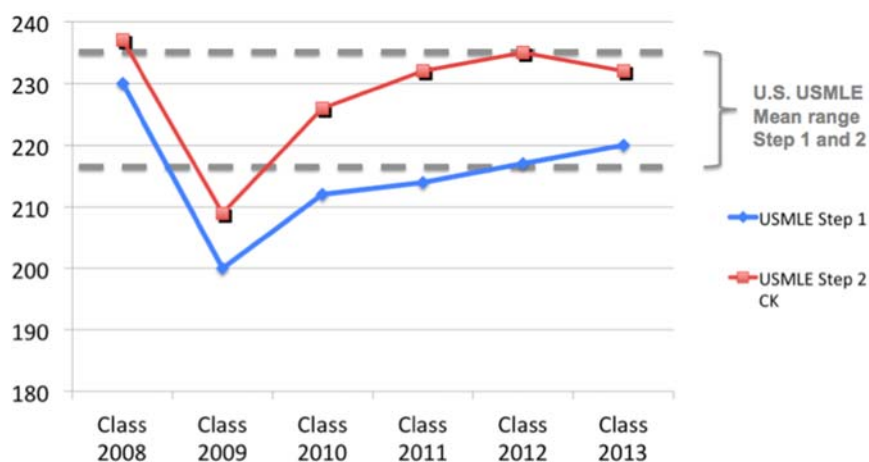


Figure 9. WCMC-Q students' average USMLE scores, Steps 1 and 2.

The vast majority of students choose to apply for residency training in the United States and enter the United States NRMP®. These students have been quite successful, with a match rate for class 2013 of 91 per cent being accepted. They repeatedly secure placements in competitive specialties and at top rated programs [Figure 10].

Repeat matches	Years
Cleveland Clinic	2009, 2010, 2011, 2013
Johns Hopkins Hospital	2008, 2010, 2011, 2012
The Methodist Hospital, TX	2009, 2010, 2012
New York Presbyterian Hospital	2008, 2009, 2010, 2011, 2012, 2013
New York Hospital Queens	2008, 2009
U. Connecticut Health Center	2009, 2011, 2013
U. Minnesota Medical School	2008, 2009, 2013
Vanderbilt U. Medical Center	2010, 2011
Virginia Commonwealth U.	2008, 2009, 2010, 2011, 2012

Figure 10. WCMC-Q graduates' repeat residency matches at United States University Programs.

The students who prefer to remain in Qatar have the opportunity to pursue high quality residency training at the Hamad Medical Corporation (HMC). This major health care provider in Qatar is the only site for postgraduate education, supporting the training of around 600 residents and fellows in 19 specialties and subspecialties.

In 2012, HMC received ACGME-I³ institutional accreditation, following the remarkable transformation in curricula, residents' work environment, and the implementation of a robust faculty development program supported by the WCMC-Q GME office. We anticipate advanced specialty accreditation for several programs in 2013.

Our graduates who have completed residency training are now in fellowship programs at top institutions. Two of our inaugural class graduates are now in practice, one in the United States and one in Qatar.

Clinical affiliates

HMC, the school's primary site for student clerkships, is the major health care provider in Qatar and the WCMC-Q principle affiliate. It is a Joint Commission International (JCI) accredited facility that houses 1600 beds distributed among eight specialized hospitals that care for approximately 60,000 inpatient admissions, 1,000,000 outpatient visits, 23,000 surgical procedures and 18,000 deliveries per year. In 2011, in collaboration with WCMC-Q, HMC announced its plan to transform itself into an Academic Health System by 2016, which will provide world-class patient care, be a hub for medical and interdisciplinary education, and offer relevant translational research.

Our students also rotate at Aspetar, Qatar's specialized sports medicine and orthopedic hospital, which provides opportunities for education in that discipline for our students. For outpatient training and experience, we are affiliated with Primary Healthcare Centers (PHCC), a network of government-operated, community-based, outpatient clinics.

Our newest clinical affiliate, Sidra Medical and Research Center, is expected to open its doors for patients in early 2015, and will be the first fully digitalized, American style, academic healthcare system focused primarily on women and children's health. As a tertiary and quaternary academic healthcare system with robust translational research programs, Sidra will further enhance a wide variety of training and research opportunities for our students.

Establishing a first-rate research program

In 2008–09, WCMC-Q launched its biomedical research program with the aim of establishing a center of excellence in basic, translational, and clinical research with a world-class infrastructure [Figure 11]. During the last five years, we have established eight core facilities including genomics, imaging, basic, proteomics, metabolomics, bioinformatics, biostatistics, and clinical support. Several outstanding scientists have been recruited to lead translational research programs addressing the most pressing health problems in Qatar (e.g., obesity, diabetes, cardiovascular disorders, complications of pregnancy, disorders of the newborn, and cancers), utilizing molecular and genetic approaches. More than 70 per cent of faculty in our medical program are currently serving as principal investigators for the extramural research funding program, Qatar National Research Fund (QNRF). Virtually all of our students now receive research training and participate in a research project during their premedical and medical years. Many of our students have presented their work at international conferences over the past few

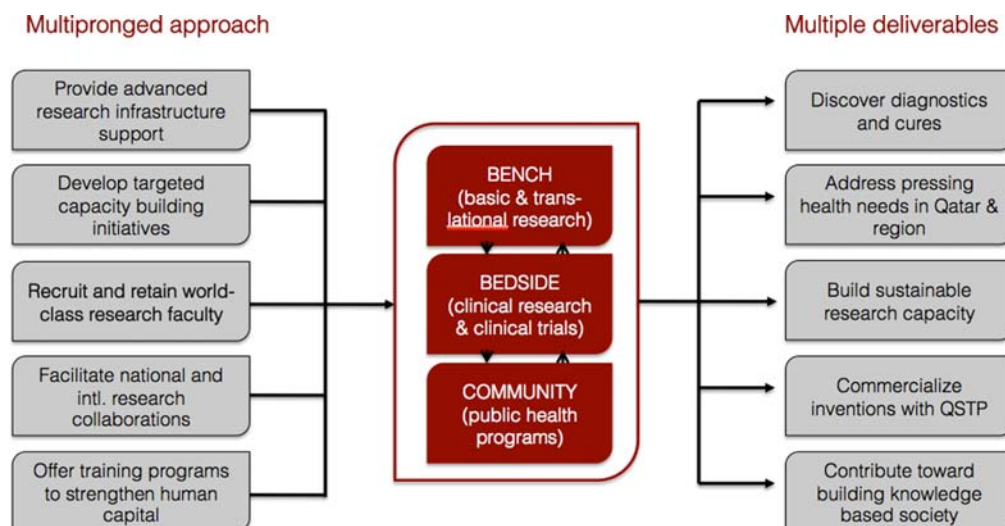


Figure 11. WCMC-Q biomedical research program.

years and published in prestigious journals.⁴ Plans are underway currently to establish a precision medicine institute to focus on “diabetes” and neurogenetic disorders.

In summary, based on the outcomes thus far in the short history of WCMC-Q, it has been extremely successful in its stated mission of contributing to the skilled biomedical workforce in Qatar by producing world-class physicians who match at prestigious programs in the United States for residency training. Many of these physicians are planning to come back to Qatar after completing their specialty and subspecialty training to improve the healthcare and well-being of the people in the region.

We identified the following critical success factors:

- The contract between QF and Cornell University (CU) provides complete academic autonomy to provide world-class medical education, critical thinking skills, and research training to our graduates.
- QF has been generous in providing the resources for building, capital, and operational needs.
- Both partners have exhibited a strong commitment to assuring that we achieve the desired outcomes.
- Strict adherence to United States standard admission criteria for students and recruitment of first-rate faculty with appointments in New York-based departments have yielded excellent results.
- WCMC-Q has established close collaborations with the local stakeholders in a culturally sensitive manner.
- Carefully selected faculty have demonstrated a strong commitment to the mission.

DUKE UNIVERSITY-NATIONAL UNIVERSITY OF SINGAPORE GRADUATE MEDICAL SCHOOL

(Robert K. Kamei)

Background

In 2000, the Singapore government embarked on an ambitious initiative to attract top scientists to Singapore and to develop a biomedical-based economic sector. To support this initiative, a second medical school was started to train academic and research physicians. In 2005, the National University of Singapore (NUS) and Duke University in the United States established the Duke-NUS Graduate Medical School. The new campus is situated by the Singapore General Hospital, the largest public hospital in Singapore and home to several specialty research centers. Duke’s unique curriculum, which consisted of an entire year of research instead of a second pre-clinical year, fit well into the specific objectives of the new school.⁵ As a result, students could learn the practice of medicine and pursue a research project of their own interest.

Our mission at Duke-NUS is to create an academically oriented, international medical school that will train physicians to not only practice medicine, but also to improve the practice of medicine. In addition to the research skills already incorporated into the Duke curriculum, we decided it was important to include other skill sets not traditionally woven into medical education: teamwork, critical and creative thinking, and leadership. We did not want these skills to be taught in isolation, but instead to be practiced in the course of education. We took the start of this new school as an opportunity to reexamine the current methods of medical education and find ways to include these new skills in our curriculum.

TeamLEAD

In the traditional classroom, unprepared students quickly feel overwhelmed by the informational deluge, becoming passive learners. They then leave class to only return to this material when they cram for their exams. Considerable evidence showed that this learning process is not effective for long-term memory,⁶ yet this is the standard way teaching is done.

Our faculty saw the new generation of learners as multitaskers, constantly connected to information. We wanted our future practicing physicians to use their skills to turn to the Internet for answers and the latest research, instead of relying on knowledge memorized in medical school. Moreover, we wanted our students to learn to work together in teams, as they would in clinical practice or research.

These aspirations led our faculty to the development of a different learning strategy called TeamLEAD,⁷ where students Learn ahead of time or class, and while in class Engage each other and the faculty. Students then Apply what they learned and Develop skills necessary to have successful

academic careers. TeamLEAD used team-based learning principles developed in business school by Michaelsen.^{8,9}

Students are given clear learning objectives, and provided with curriculum content and are expected to learn these materials prior to class as individuals or in teams. Class time can then be broken into two phases: Readiness, and Application.⁷

In the Readiness phase, students start class with a test to ensure that they have come prepared for the discussion. However, before given the answers, the students retake the same test in their teams. Teams are composed of six to seven students and remain set for the entire year. The team tests encourage students to teach, challenge and debate each other, and work together to commit to a single answer. Answers to the test are then revealed to the teams. Faculty will brief the students on any remaining questions and summarize the major concepts learned. Since students clarify most of the misunderstandings within their team discussions, there is typically very little left for our faculty to explain. Students then break for lunch before the Application phase in the afternoon.

During the Application phase, the same teams are given a new set of problems, however these questions require them to apply the pre-clinical science principles learned during the Readiness stage. Students are allowed to use any resource to answer these questions. Often very difficult, these questions are used to reinforce student understanding of basic concepts and to challenge students to apply them to solve clinical problems. Next, each team shares their answers with the class. Debates between teams are common and expected as questions may have more than one right answer. Finally, the faculty summarizes the salient points.

Approximately half of each student's grade comes from individual activities (including final examination) and the remainder from teamwork. Despite a one-year basic science curriculum, instead of the more common two years, TeamLEAD is only held on average of twice a week for approximately five hours. A variety of laboratory classes like pathology, histology, and anatomy are offered to supplement the TeamLEAD program. Students are off during the rest of the time.

Learning outcomes for our students using this method have been outstanding. At the end of their first year, the students take the United States National Board of Medical Examiners® (NBME®) Comprehensive Basic Science Examination (CBSE), which is often high stakes and usually taken at the end of the second year in United States medical schools. The CBSE is given the day after we finish the last course and used as formative evaluation only. We have been pleased to see that, despite the shorter course time devoted to pre-clinical education, our results are identical to the United States average [Figure 12].

We also administer the CBSE again after the students' clinical clerkships in year two. By this time, their scores are significantly above the United States average.⁷ In year three, our students take the United States Medical Licensing Examination (USMLE) Step 1 exam, and Figure 12 shows that our Step 1 scores are higher than the United States average.

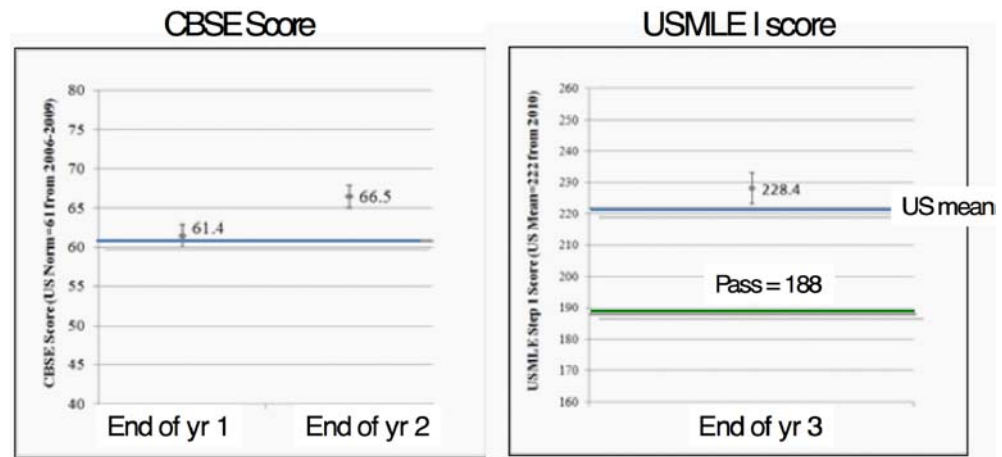
Our educational experience in Singapore has motivated the faculty at Duke University in North Carolina, to start using their own adaptation of TeamLEAD. The undergraduate campus has begun to use elements of TeamLEAD, such as expecting students to come to class prepared, with peer-learning forming part of their teaching strategies. We have taught our instructional strategy to faculty worldwide, as well as trained over 100 Singapore teachers from the local public secondary schools in the technique.

Other Duke-NUS outcomes

Our school has drawn considerable attention from students all around the world; we receive well over 1000 applications annually. We have an international student body: approximately 60–65 per cent are from Singapore, and the remainder hails from 23 other countries, including 5 per cent from the United States. Applicants are attracted to our teaching methods and academic success. In fact, while we can be extremely selective, our only prerequisites for entrance are an outstanding academic record and Medical College Admissions Test (MCAT). As a result, a quarter of our students come from engineering, several with no background in the biological sciences, yet they typically do quite well in our curriculum.

Our students have been productive in their research efforts as well [Figure 13]. Although only four classes (of 26–56 students) have completed their research year, they have already published over 100 research papers, and many have presented at international research conferences. Three students have already submitted patents.

21st Century Learning in Medicine: Traditional Teaching versus Team-based Learning*



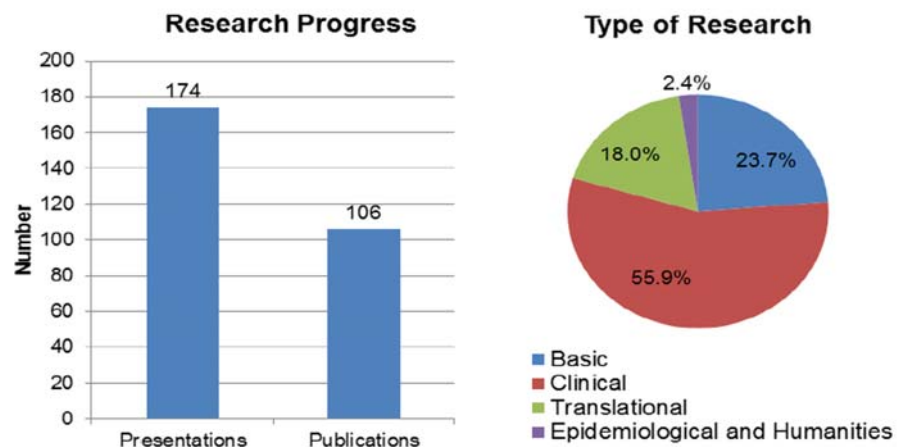
*Kamei RK, Cook S, Puthuchery J, Starmer CF. Med Sci Educator. 22: 2012.

Figure 12. CBSE and USMLE Step 1 Scores. The blue line reflects the average scores of United States medical students taking the CBSC, typically given at the end of their second year. Duke-NUS students take the CBSC at the end of their first and second years. They continue to do similarly for the USMLE Step 1 examination.

Career pathways

We have graduated three classes to date. Since our mission is to train academic physicians for Singapore, our students have a four to five year service obligation to Singapore after graduation. They are expected to complete residency training in Singapore. The time spent in postgraduate residency in Singapore helps fulfill each graduate's service obligation to Singapore. The Accreditation Council for Graduate Medical Education (ACGME) in the United States started ACGME-International, which has begun to accredit Singaporean residency programs to United States standards. Over the past several years, 39 Singapore postgraduate training programs have been accredited by ACGME-I.³

Duke-NUS Research Year Graduating Classes of 2011-14



as of 14th Aug 2013

Figure 13. Research productivity of NUS students.

Each year, a small number of Duke-NUS students are allowed to apply for United States residency training and defer their service obligation in Singapore until after their training is completed. These students have been successful at matching in some of the most competitive training spots in the United States. For example, we have placed our students in top residency programs at Duke in Ophthalmology, Surgery, Urology, Anesthesiology; at Stanford in Psychiatry; at Massachusetts General Hospital in Anesthesiology; at University of Oregon in Radiology; at Mayo Hospitals and Clinics in Surgery; and at Tufts in Pediatrics.

In summary, bringing the Duke curriculum from North Carolina to Singapore has given us the opportunity to rethink medical education and has presented an opportunity to create a pedagogical paradigm shift. We have demonstrated that an international medical school partnership provides a unique opportunity to take a leadership role in medical education and research. We are especially proud that our work in Singapore has been an influence beyond our campus and has had a positive impact on the educational programs back at Duke in North Carolina and even in the public school system in Singapore. Duke-NUS offers the chance for a group of truly outstanding international students from around the world to obtain a high quality Duke education, which would otherwise not be available to them.

CONCLUSIONS

The reports from these three medical schools demonstrate that the American model of medical education has been successfully adapted into three diverse cultures in the Middle East and Far East. Each institution describes how its students are provided state of the art medical education and have access to highly innovative healthcare technologies during their clinical training. Though their individual approach and innovative modifications of the standard model might be different, they all share the common objectives of producing international quality graduates as measured by standardized assessments and indicators of their students' competitive success. One consistent indication of success is that first attempt scores on USMLE Step 1 for these students do not differ significantly from the United States mean for comparable students. These institutions are on the cutting edge of the growing movement toward globalization of medical and health education. It is only a matter of time when success of their innovative methodology encourages reciprocal exchange with well-established institutions in the US and elsewhere.

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