

A comparison of curricula at various medical schools across the world

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Abstract: **Background:** Medical education has changed in response to scientific advances and social needs.

Aim: The aim of the study was to examine curricula of medical schools around the world and to observe the trends that currently dominate in medical education.

Method: We have collected information on the current curricula of various medical schools using their official websites. When necessary, we supplemented the information using published articles describing the curriculum of a given medical school.

Results: Our findings reveal that medical schools demonstrate the need for constant reforms and adaptation to changing conditions worldwide. Generally, there is a tendency to integrate basic and clinical fields, to sooner establish bedside teaching, to provide less theoretical and more practical approaches to teaching, to implement more communication skills, and provide students with research training.

Conclusions: Medical education has evolved and will continue to change with time. Medical schools introduce modifications to their curricula and share their experiences.

Keywords: curriculum, medical program, medical schools, undergraduate.

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Introduction

In recent decades, many articles discussed the problem of transformation in medical education, forced primarily by social changes [1–5]. The main challenges that future doctors will face are digitized and computerized health systems [1], rapid advances in medical knowledge [1–3], new discoveries in research education [1, 2, 4] globalization



and an aging society [1]. Hence, medical education should be more focused on understanding patients' needs and orienting students to their external environment and more "towards society" [1]. Learning objectives should be achieved by developing skills to understand and solve problems [1, 2] Current trends in medical education include early exposure to bedside teaching and hospitalized patients, longitudinal integration of clinical practice [1], the need to train competences and practical clinical skills, doctor-patient communication, teamwork, and scientific skills [4].

The aim of this study was to examine current curricula of medical universities around the world and answer the following questions: Has there been a change in the curriculum in recent years? Is there a clear division into basic and clinical sciences? Are the curricula integrated? When do students first have interactions with patients? Are there any classes that shape communication skills and teamwork? Are there any e-learning classes? Is there research training?

Method

While examining official websites [6–14] of various medical schools around the world, we were guided by the following principles: medical universities in different parts of the world, on different continents, information on the university website in English, with the exceptions of Charité-Universitätsmedizin Berlin where we mainly used the articles in English by Hitzblech T. 2019 and Drees S. 2019, detailing the recent reform process and the university's current program, and the University of Sydney where some information about curriculum was taken from the article by Burgess A. 2020. We also used videos and brochures posted on the websites. In total, we collected information from nine universities, including Jagiellonian University.

The material for the research was collected as follows: the first author, after reading the information on the university's website, made notes and placed them in the table, then the second author, using the same sources, checked the correctness of the first author's note. In cases of dispute, the authors discussed the problem until a consensus was reached.

Results

Charité-Universitätsmedizin Berlin, Germany

In 2010, the Charité-Universitätsmedizin Berlin faculty decided on the introduction of an integrated, competency-based modular curriculum of medicine (MCM) [4]. The MCM includes the integration of basic science and clinical teaching, with an emphasis on patient-based teaching from the beginning of the program and continuous basic science teaching until the end of the program, and longitudinal teaching formats that

interconnect the modules. These formats include among others: bedside teaching with patients, use of problem-based learning (PBL), communication skills, teamwork training and scientific skills training. Bedside teaching with patients is divided into general and in-depth patient examination courses (semesters 1–4) and bedside teaching (semesters 5–10) [4]. Within the “Scientific thinking and working” module, students have the opportunity to carry out a scientific research project under supervision [15].

University of Sydney, Australia

The curriculum of the University of Sydney focuses on integrating theory with practice, problem solving and early clinical exposure, arranged in small learning groups. There are two admission paths: graduate entry and undergraduate admission.

Graduate entry is a four-year postgraduate course for applicants with a bachelor’s degree. Undergraduate admission is available for high school graduates who have achieved exceptional results. The Double Degree Medicine program, which lasts for seven years, combines the MD with an undergraduate degree in arts or science.

Clinical classes start with the beginning of the first year of study for the graduate entry program (one day a week), during the second year they are held three times a week, and in the next two years almost all classes are clinical. The program also offers training in research methods, during which students carry out their own research project.

In 2020, the curriculum was modified, and eight new themes were adopted: basic and clinical science, clinical skills, diagnostics and therapy, research, evidence and informatics, population and global health, indigenous health, ethics, law and professionalism, and interprofessional teamwork. They are introduced from the first year and integrated vertically and horizontally. Problem-based learning (PBL) was introduced to the Sydney Medical Program (SMP) in 1997. However, due to the growing number of students and limited teaching resources, after appropriate preparations, team-based learning (TBL) replaced PBL in 2017 [16].

Niigata University School of Medicine, Japan

Niigata University School of Medicine offers undergraduate medical education and has implemented a new curriculum in 2014. The changes concerned issues such as: cooperation between general education and professional education, developing students’ skills in medical research, vertically integrating lectures on basic and clinical medicine, clinical training in the form of participation in diagnostics and treatment, and the introduction of the post clinical clerkship OSCE (PCC-OSCE). To integrate the six-year-long curriculum, the teachers in charge of general education and those in the medical program closely cooperated. The course “Introduction to Medical Sciences” was introduced for first-year students. In the second year, basic and clinical medicine

teaching was integrated, and team-based learning (TBL) was used as a form of teaching. The problem-based learning method is also commonly used. Clinical training, which was previously held in the fifth and sixth years, now begins in the second semester of the fourth year.

University of Toronto, Canada

The University of Toronto is constantly reforming its curriculum. The graduate medical program lasts 4 years and is divided into two parts: the first two years are “Foundation” which focus on basic sciences, the next two are “Clerkship” which focus on clinical training. Classes for the first two years take place in laboratories, classrooms, clinical and community settings. Introduction to clinic practice takes place by working on clinical cases. Content is delivered through lectures, workshops, e-learning materials, anatomical labs, and student and faculty-led case-based learning (CBL) sessions. Integrated Clinical Experience (ICE) is one of four components delivered during Foundation. This course teaches how to take a patient’s history and conduct a physical examination, and provides for early clinical exposure in a variety of settings, including doctor’s offices, hospitals, local health agencies, and home care visits. Another component of Foundation is Health Science Research (HSR) which provides students with knowledge (tutorials and e-modules) about research projects and how to apply health research results to patient care.

The two-year-long basics curriculum includes numerous thematic elements that ensure longitudinal integration. There is content related to the topics delivered in case-based learning, integrated with other topics covered in the case, as well as dedicated sessions at other times to explore the topics in more depth.

The final two years (Clerkship) of the four-year program offer an integrated learning experience, consisting mainly of clinical subjects.

Assiut University, Egypt

The duration of the undergraduate program at the Faculty of Medicine of Assiut in Egypt is 6 years, which is divided into two stages: the first three years of study are focused on basic sciences, the next three cover clinical sciences. Teaching methods include: brainstorming (within a lecture or class teaching), demonstration and clinical simulation conducted in both the skills lab and bedside. Case study, clinical/practical simulation and role-playing are teaching methods for the acquisition of the skills involving “communication and general skills and attitudes”. Among the main goals to be achieved according to the faculty, are greater integration of academic circles with clinical departments and more implementation in problem solving and case scenarios in departmental exams.

Federal University of Health Sciences of Porto Alegre, Brazil

The program at the Federal University of Health Sciences of Porto Alegre (UFCSPA) consists of four years of courses and mandatory fifth- and sixth-year internships, with clinical sciences beginning in the third year. By implementing the UFCSPA undergraduate program, the student is to acquire knowledge and the ability to learn independently, develop attitudes and skills enabling competent, critical and ethical professional performance based on a humanistic perspective, multidisciplinary teamwork and the organization of the health care system in Brazil.

The undergraduate program consists of compulsory subjects (theoretical, theoretical-practical and practical), elective subjects, compulsory internships and extra-curricular activities. In terms of integration, there are classes during the first year: Seminars Integrating Basic Courses and Integrative Seminar on Primary Health Care. For the third-year-learners there is the course “Integrated Program in Internal Medicine”. However, we have not been able to establish what this integration means in practice.

All-India Institute of Medical Sciences, India

The undergraduate program of the All-India Institute of Medical Sciences lasts a minimum of five and a half academic years followed by a year-long compulsory internship. The course is divided in to three phases: pre-clinical, para-clinical, and clinical. The first phase (pre-clinical) covers the first two semesters, during which classes in anatomy, biochemistry and physiology are held.

The third, fourth and fifth semesters are a para-clinical phase involving community medicine, forensic medicine, pathology, pharmacology, microbiology, along with clinical postings in wards and in outpatient settings.

The clinical phase lasts for 4 semesters, (semesters from 6 to 9). The practical examination is being carried out by an Objective Structured Clinical Examination (OSCE) consisting of a dozen or so stations. Communication skills are taught, among others, during the “Health education” course and checked during the OSCE exam. The program involves the use of the SET (Skills, e-Learning, Telemedicine) facility, which is a state of art facility set up to innovate medical education using simulation-based skill learning and e-learning methods to improve current teaching at the institute.

University of Glasgow, Scotland

Since 2012, the curriculum at the University of Glasgow consists of an undergraduate program that uses various teaching techniques and methods. Besides lectures, they use podcasts and other e-learning media, small teaching groups (including tutorials and

problem-based learning), laboratory and dissection classes. The university emphasizes the need of constant development and reform of the curriculum to meet the challenges of medicine and medical training in the future. The university follows a “spiral curriculum” in which subject material is revisited at different stages of the curriculum with increasing depth and clinical focus. The entire program is carried out in four phases (Phase 1: Basic Biomedical Sciences, Phase 2: Systemic Biomedical Sciences, Phase 3: Clinical Science, Phase 4: Clinical Practice and Preparation for Practice) which overlap during the five years of the course.

In addition, vertical themes are also introduced, these are thematic areas that run through the whole five years of the program and include: Clinical Skills; Vocational and Professional Studies (including communications skills); Health of Populations and Communities (Public Health); Pharmacology; Clinical Pharmacology and Prescribing (PPP); Anatomy and Imaging (A&I); and Basic Biomedical Sciences (including biochemistry, immunology, cell biology, microbiology, molecular biology and physiology). Teaching of clinical skills begins during Year 1 and continue till the end of the program. Students can undertake their research project under the SSC, i.e. Student Selected Components.

Jagiellonian University Medical College, Poland

Jagiellonian University Medical College offers a six-year-long undergraduate medical program. Currently, first two years are mostly theoretical, focusing on basic sciences like anatomy, histology, physiology, pathology, microbiology, etc. From the year 3 students start their clinical rotations that continue till the end of the program. What is worth mentioning, during the last year, students are provided almost individual training with teachers; the whole class is divided into pairs that are matched with teachers in clinics (mandatory training in internal medicine, pediatrics, surgery, gynecology, psychiatry, emergency medicine, family medicine). The aim is to provide practical clinical training and include students in a ward’s daily routine — students should follow doctors and help them with everyday responsibilities, such as examining patients, ordering laboratory tests, assisting with simple procedures, and so on.

The curriculum includes a few courses that are taught through several years, e.g., Laboratory Training in Clinical Skills. The course starts at year 2 and ends at year 5. Students firstly are taught the fundamentals of the physical examination and medical interview, and during next two years they learn about communication and develop their skills using standardized patients. During year 5 they are provided a safe environment to combine non-technical skills and theoretical knowledge during simulated classes, training their teamwork skills, too. During clinical rotations some seminars covering anatomy, physiology, and microbiology relevant to discussed diseases are included, integrating basic sciences with clinical experience. Second-year students take

the Introduction to Clinical Sciences course, which is a PBL course that provides students with chances to work with peers on different medical cases. During year 3 students are obliged to pass the course that covers themes like EBM, research, and statistical analysis. They are not asked to conduct their own research. Additionally, at the end of the 2nd, 3rd and 6th years students are evaluated through an OSCE. The COVID-19 pandemic forced the university authorities to accelerate the introduction of e-learning to the curriculum. Currently, all lectures are held online, with some seminars and practical classes are online as well; these include Medical English, Introduction to Clinical Sciences, Internal Medicine, Laboratory Training in Clinical Science.

Discussion

As seen in Table 1, medical programs differ around the world even in the length of the program, which is four, five or six years depending on the country and its internal education system. North America and some other countries are accustomed to two cycles of higher education in medical education, often referred to as academic education and medical school, which typically last four years. While in Europe, most medical universities conduct one longer course, in line with the European Community Directive and the Bologna Declaration [17]. It should be emphasized that most of the Bologna goals were welcomed. The plans for establishing two-cycle structure of medical education were opposed, i.g. by students and Executive Board of AMEE and WFME. As stands in European Commission's report on implementation of Bologna Process [18] integrated programs are mostly in medical sciences, followed by those in law, architecture, and pedagogy. What is more, there are qualification requirements for some professions, including medical ones, that are described in the Directive [19].

In the world of rapidly developing field as medicine, students are not able to learn every detail about every disease. They are supposed to gain fluency in research, how to implement knowledge that they obtain and what may be more important in days of widely available knowledge, how to communicate what they find. Care providers should be equipped with skills that can help them face patients' needs to understand their current situation, the treatment process, and so forth. Students should be able to practice those communicative skills during dedicated classes in simulated conditions to begin with [20, 21].

Communication skills are one of the foundations of proper teamwork. The importance of teamwork as necessary for effective patient care and to reduce the medical error rate was emphasized by the report from the Institute of Medicine (US) Committee on Quality of Health Care in America entitled "To Err is Human: Building a Safer Health System" (2000) [22]. It was recognized that teamwork should be taught and assessed, resulting in communication skills being included in most of

Table 1. The summary of differences and common features of curricula in analyzed programs.

Medical schools	Number of years of study	Curriculum reforms recently	Integration of basic and clinical sciences	First contact with patient/clinical classes	Themes run throughout the curriculum (longitudinal/vertical)	Communication skills	Research training (with running your own project)	Teamwork training	E-learning	PBL
Charité Universitätsmedizin Berlin	Six years of study with a final-year clerkship	+	+	From the first semester	+	+	+	+	+	+
University of Sydney	Four-year graduate-entry course/seven-year Double Degree Medicine program	+	+	From the beginning of year 1	+	+	+	+	+	PBL replaced with TBL
Niigata University School of Medicine	Six years	+	+	The clinical training starts in the second semester of the fourth year	+	Not found	+	Not found	For graduate students	+ PBL and TBL
The University of Toronto	Four years (graduate medical program)	+	+	From the third year #	+	+	Tutorials and e-modules about health research projects. **	+	+	CBL (case-based learning)

Table 1. cont.

Medical schools	Number of years of study	Curriculum reforms recently	Integration of basic and clinical sciences	First contact with patient/clinical classes	Themes run throughout the curriculum (longitudinal/vertical)	Communication skills	Research training (with running your own project)	Teamwork training	E-learning	PBL
Assiut Faculty of Medicine	Six years plus house officer year	+ (continuously adapted curriculum)	No integration, clear division on the basic science (first three years) and the clinical classes (the next three years)	From the fourth year	Not found	+	Not found	Not found	+	Not found
Federal University of Health Sciences of Porto Alegre (UFCSA)	Six years (the fifth and sixth years are mandatory internships)	Not found	Insufficient data	From the third year	Not found	Not found	Two courses: Critical Analysis of Evidences and Scientific Methodology**	Not found	Not found	Not found
All-India Institute of Medical Sciences (AIIMS) New Delhi	Five and a half academic years including one year's compulsory internship	+ (continuously adapted curriculum)	In some fields (pediatrics, surgery)	In para-clinical phase — from the third semester	Not found	+	Learning statistical analysis only	+	+	+

Table 1. cont.

Medical schools	Number of years of study	Curriculum reforms recently	Integration of basic and clinical sciences	First contact with patient/clinical classes	Themes run throughout the curriculum (longitudinal/vertical)	Communication skills	Research training (with running your own project)	Teamwork training	E-learning	PBL
University of Glasgow	Five years	+ (continuously adapted curriculum)	+	In the first half of the 1st year	+	+	To be selected during "Student Selected Components and Electives"	Not found	+	+
Jagiellonian University	Six years	+	-/+ (in some fields)	From the third year	+	+	EBM, students are not asked to provide their own research	+	+	+

* Senior students engage in medical research and practice for 2 months to learn the importance of medical research, but we don't know if it's mandatory.

The first two years of the MD Program are held, among others, in the clinic, but we do not know exactly how these classes are conducted and whether there is direct contact with patients.

** The possibility of running your own research project — not found.

analyzed curricula. Examples of such training are: problem-based learning (PBL), team-based learning (TBL), critical incident simulations, role playing, case-based scenarios, and actual patient encounters. Feedback is an integral part of such training, which can take the form of a debriefing session [23]. Special courses teaching and checking preparation for teamwork (interprofessional teamwork) are conducted at Charité, Sydney, Toronto, AIIMS and Jagiellonian Universities. The other presented medical schools do not have a separate “teamwork” course but provide this skill in their learning outcomes and through classes conducted using PBL, TBL, and simulation.

Another innovation that has emerged in recent years is e-learning. In the literature, e-learning is defined as the use of computer technology and electronic media to train, provide, support and improve both learning and teaching, including technology-enhanced learning online, offline, or both. Online learning, computer learning, virtual classrooms and digital collaboration represent different types of e-learning [24, 25]. A distinction is also made between the e-learning mode, distance learning and computer-assisted interaction (CAI) [24]. Distance learning is designed to allow access to learning by people who are geographically distant from the instructor, while CAI is an interactive technique where instructional material is presented on a computer and student progress is monitored and assessed throughout the process [24].

The COVID-19 pandemic has sparked a rapid growth in e-learning. Universities around the world have been forced to incorporate modern techniques into their routine coursework to allow for a timely completion of programs while complying with pandemic related restrictions. On-line lectures and seminars have been implemented permanently at some universities and some have chosen to treat this as a temporary solution to the uncertain situation. On the other hand, new generations are being brought up among computers and in the internet era, which will affect the way they are taught. If the current generation of teachers does not change their attitude to modern techniques, a generation gap in higher education may arise which will reduce satisfaction and affect the learning environment. Additionally, online learning can provide students with easier and more effective access to knowledge. E-learning classes are available in almost all medical schools we have reached (we did not find information about e-learning at UFCSPA, while in Niigata University School of Medicine, we only found the information about e-learning for graduate students).

The integration of basic and clinical sciences is becoming a trend in medical education. Some universities have a fully integrated curriculum, others in only some subjects for the time being. There are examples in the literature aimed at defining the concept of integration in the curriculum. According to Brauer *et al.* [26] integration in medical education breaks down barriers between basic sciences and clinical sciences

and which they define as a “fully synchronous, transdisciplinary delivery of information between the foundational sciences and the applied sciences throughout all years of a medical school curriculum”. Until now, students had to complete basic science courses to start clinical classes. Some medical schools, such as Charité Universitätsmedizin Berlin, reject the traditional approach and allow students to study at the bedside from the first year.

Research training, in the sense of carrying out your own research project during the program, is not common among medical programs. Students typically complete a course that focuses on research, learn about statistical analysis, and research techniques in medicine and health sciences, but are not required to conduct individual research. Nevertheless, many students choose to pursue a research career even before graduation and become authors or co-authors of published peer-reviewed articles. In our review, some universities introduce a multi-week course, during which students go beyond the theoretical level of conducting research work and have the opportunity to design and carry out their research project, as demonstrated by the programs in Sydney or Berlin.

The limitation of this study is the inclusion of medical universities whose websites provide information in English. We realize that through this method we often know only part of the curriculum. What is more, the medical programs were chosen randomly, with no strict established inclusion criteria. On the other hand, the aim of that paper was to present the current situation around the world.

Conclusions

Medical education has evolved and will continue to change in response to scientific advances and societal needs. Many medical universities continue to introduce changes to their curricula and share their experiences. Generally, there is a tendency to integrate basic science and clinical courses, to establish bedside teaching earlier, and adopt a more practical approach to teaching.

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D.Z. and G.C. had the idea for this study. D.Z., R.K. were responsible for collecting data, writing manuscript. D.Z., R.K., I.P. were responsible for the final version of the manuscript. G.C. reviewed the manuscript for the important content. All authors have seen, commented and approved the final version of the work.

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