

PERSPECTIVE

Improvement of Orthopedic Residency Programs and Diversity: Dilemmas and Challenges, an International Perspective

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Received: 29 May 2018

Accepted: 04 November 2018

Abstract

Background: To date, little has been published comparing the structure and requirements of orthopedic training programs across multiple countries. The goal of this study was to summarize and compare the characteristics of orthopedic training programs in the U.S.A., U.K., Canada, Australia, Germany, India, China, Saudi Arabia, Russia and Iran.

Methods: We communicated with responders using a predetermined questionnaire regarding the national orthopedic training program requirements in each respondent's home country. Specific items of interest included the following: the structure of the residency program, the time required to become an orthopedic surgeon, whether there is a log book, whether there is a final examination prior to becoming an orthopedic surgeon, the type and extent of faculty supervision, and the nature of national in-training written exams and assessment methods. Questionnaire data were augmented by reviewing each country's publicly accessible residency training documents that are available on the web and visiting the official website of the main orthopedic association of each country.

Results: The syllabi consist of three elements: clinical knowledge, clinical skills, and professional skills. The skill of today's trainees predicts the quality of future orthopedic surgeons. The European Board of Orthopedics and Traumatology (EBOT) exam throughout the European Union countries should function as the European board examination in orthopedics. We must standardize many educational procedures worldwide in the same way we standardized patient safety.

Conclusion: Considering the world's cultural and political diversity, the world is nearly unified in regards to orthopedics. The procedures (structure of the residency programs, duration of the residency programs, selection procedures, using a log book, continuous assessment and final examination) must be standardized worldwide, as implemented for patient safety. To achieve this goal, we must access and evaluate more information on the residency programs in different countries and their needs by questioning them regarding what they need and what we can do for them to make a difference.

Level of evidence: III

Keywords: Cultural competences, Educational procedures, Politics, Residency programs, Women in Orthopedics

Introduction

There is currently little information regarding the similarities and differences between orthopedic and trauma training programs throughout the

world. The formation of several institutions, such as the European Union of Medical Specialists (UEMS) and the European Federation of the National Associations of

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THE ONLINE VERSION OF THIS ARTICLE
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Orthopedics and Traumatology (EFORT), was necessary to begin organizing and evaluating the level of orthopedic education in Europe. As another section of the UEMS, the European Board of Orthopedics and Traumatology (EBOT) was built in 1994. Its first achievement was to create a board examination. The EBOT fellowship examination has been created to improve the standard of orthopedic training in Europe (1). Unfortunately, the EBOT currently remains an optional exam.

However, the European countries are united today, and orthopedic education seems to be a driver in these countries. In 2017, Madanat et al compared the differences between the current European orthopedic and trauma residency programs for the first time. The 4 most important topics included the residency duration, the selection procedures, the utilization of log books, and whether there was a final examination. In general, residency was completed in five to six years in all included countries. Almost all countries used a logbook. Approximately 80% of the participating countries had a final examination. The authors concluded that there are numerous similarities between the training programs; however, differences continue to exist in their general requirements and final qualification (2). Ultimately, this was the first study that assembled important information regarding the differences between orthopedic training programs across Europe (2). In particular, in the field of orthopedics and trauma, the coordination of knowledge and practical skills is important (3). This study indicated that a larger portion of female residents than specialists implies a future shift in gender parity. This finding is inspiring, as orthopedic surgery has the lowest percentage of female residents of any surgical specialty (4).

Orthopedics is the medical subspecialty that most closely reflects world politics and social culture. This paper will open a new frontier to understanding our globalized world, highlighting the importance of not only the level of our surgical know-how and precision but also our minds, where we can provide and serve more than at any time previously. To date, little has been published comparing the structure and requirements of orthopedic training programs across multiple countries. The goal of this study was to summarize and assimilate the characteristics of orthopedic training programs in the U.S.A., U.K., Canada, Australia, Germany, India, China, Saudi Arabia, Russia and Iran.

Materials and Methods

We collected all important information regarding residency programs in 10 countries on four continents. We communicated with responders using a predetermined questionnaire regarding the national orthopedic training program requirements in each respondent's home country. Specific items of interest included the following: the structure of the residency program, the time required to become an orthopedic surgeon, whether there is a log book (where the operations performed by residents are listed), whether

there is a final examination prior to becoming an orthopedic surgeon that is applied, the type and extent of faculty supervision, and the nature of national in-training written exams and assessment methods. Questionnaire data were augmented by reviewing each country's publicly accessible residency training documents that are available on the web and visiting the official website of the main orthopedic association of each country. Compared to other developed countries, Germany lagged behind. We therefore sent out an additional questionnaire via e-mail to 40 German orthopedic chiefs in German and received 15 responses.

Results

The results will be presented by country with specific comments. The information regarding the structure of the residency programs is presented in Table 1.

United Kingdom

Since August 2007, Modernising Medical Careers (MMC) reorganized junior doctor training in the U.K. The shortest period of time required from basic medical qualification to becoming an orthopedic consultant in the U.K. system is approximately 10 years. After the successful completion of the (foundation year) FY1 and FY2 years, the trainee competes for Specialty Training (ST) positions, which take approximately 8 years. The ST years are presently splitted into three stages. The first stage lasts for 2 years (ST1 and ST2) and comprises of 4- or 6-month rotations in surgical specialties. The goal of this program is for the Royal College of Surgeons' entrance examinations to be accomplished within this time-frame. Important fields for trainees include plastic surgery, neurosurgery and cardiothoracic surgery. ST and FTSTA (a training post for a fixed term of not longer than 2 years) trainees are evaluated with a standardized Annual Review of Competence Progression (ARCP). This evaluation is accomplished on a 6- to 12-month basis by consultant trainers. The annual evaluation is the regional in-training assessment (RITA), which compares the yearly research achievement and logbook records. All residents must show their map of the previous work, their "procedure-based evaluations", and their "learning objectives" for the expected period (5).

Australia

The orthopedic training system in Australia is resemblant to that in the U.K. The ratio of orthopedic surgeons to the general population differs from 1 in 16,400 in Adelaide to 1 in 133,200 in South Australia. After graduating from medical school, the resident must accomplish at least 3 years of work in a specialty, first as an intern and then as a resident. The first part of the Fellow of the Royal Australian College of Surgeons (FRACS) examination must be accomplished within this period of time. After passing this exam, the resident is subsequently qualified to apply for an accredited training position in orthopedics. Throughout surgical training, the main focus is on the management of trauma. As far the position of registrar is attained, the candidate is qualified to train in a chosen program over 4 years. In the first year of residency, the

Table 1. A summary and comparison of the characteristics of orthopedics training programs

Countries	UK	Australia	Canada	USA	Germany	Saudi Arabia	Russia	India	Iran	China
Structure of the residency program	FY1- FY2 ST1- ST8	Intern Resident 3 Yrs As a Registrar Training over 4 Yrs	5 yrs of Post- Graduate 1yr of Research	PGY1-5	6 Yrs	5 Yrs	2 Yrs However, most residents Pursue postgraduate study for 3 yrs	Basic medical training 4.5 yrs MBBS Followed by 1 year CRRI* and 3 yrs Residency Program	4Yrs	Depending on the local geography the training is diverse Three plus two training system 3 yrs of basic surgical training, two yrs of general orthopedics
Duration of the residency program	10 yrs	7 Yrs	6 Yrs	5 Yrs	6 Yrs	5 Yrs	2 Yrs	3 Yrs	4Yrs	5 Yrs
Selection procedure	Based on a national Interview	Based on an Interview and FRACS Scores	Based on medical school record and personal evaluation	Based on an Interview and USMLE Scores	Based on an Interview and medical school scores	Based on medical license exam (the entrance exam for training programmes)	Based on an Interview	Based on the outcome of the national exam	Based on the outcome of the national exam	Variable
Is there a log book	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Variable
Continuous assessment	Yes	Yes	Yes	Yes	Variable	Yes	Yes	Yes	Yes	Variable
Is there a final examination prior to becoming an orthopedic surgeon	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Variable

*CRRI: Obligatory Rotating Residential Internship

Orthopedic Principles and Basic Science (OPBS) examination is administered. In the fourth year of accredited residency program, the final fellowship specialty examination is completed, which has a pass-rate of greater than 90%. As in the U.K., a "bottle-neck" ensues during the transition to a certified registrar. The resident needs to spend 2 or more years in the orthopedic service position prior to gaining a position in the accredited registrar program (5).

Canada

The Canadian resident must complete 2 postgraduate internship years. The Orthopedic Residency Training Program in Canada typically comprises 5 years of postgraduate clinical training and 1 year of research training. The 5 years of clinical training contain a minimum

of 3 years in orthopedics and 1 year in non-specialty training. In contrast to the U.K., Canadian orthopedic residency training programs are supported by universities. The research year may be performed at any level. During the residency years, two key examinations are completed. The first examination is a Principles of Surgery examination that is completed at the end of the second year of training. The final examination (the Comprehensive Objective Examination in Orthopedics) is a combined written and oral exam that is completed at the end of the fifth year. After passing the fellowship examinations of the Royal College of Surgeons of Canada, residents are qualified for a license to practice (5).

United States of America

The orthopedic residency program takes 5 years. Initial

resident training (the PGY1 or 'internship') includes experiences in general surgery, plastic surgery, emergency medicine, the intensive care unit and anesthesia, among others. From PGY2 on, residents are overseen by the chief (PGY5) resident. This training mainly includes experience in the emergency room and the operating theater. The chief resident is able to provide patient care with only slight supervision from the director. Every winter, the Orthopedic In-Training Exam (OITE, compared and examined nationally) must be completed by all residents. Most residents pursue a year of research. Following the accomplishment of an accredited residency, the resident can complete a fellowship. Following the completion of an accredited residency, the resident prepares for the Part 1 board examination, which is only in written form. After practicing for 22 months, they can apply for the Part 2 examination. Part 2 consists of an oral examination, and candidates must submit a log book that includes all surgical procedures accomplished during a 6-month period. In spite of the fact that board certification is completely voluntary, 98% of all residents take the Part 2 examination within 5 years of completing residency. Teaching and academic appointments are pursued by 42% of orthopedic surgeons (5).

The Current Status of Assessment in England and the U.S.A.

The syllabi consists of 3 elements: clinical knowledge, clinical skills, and professional skills (6). In the United Kingdom, understanding the principles of fracture management is obligatory for entering specialist training. Typically, this is through the AO Principles of Fracture Management program, which in the United Kingdom merges some of "the Intercollegiate Surgical Curriculum Program (ISCP) workplace-based assessments", including procedure-based assessments (PBAs) and case-based discussions (CBDs) (7). An orthopedic resident must learn how to evolve a proper surgical plan and how to choose the surgical approach, implant and fixation method (8). In addition to informal feedback from superiors, clinical assessments contain "the In-Training Evaluation Report (ITER), procedure logs, and 360° evaluations" (9-11).

Although the ITER is one of the more widely used implement in North America, it has been shown to be inefficient at selecting between different stages of implementation or in recognizing residents who are not suitable (12). The merit of other implements including 360° evaluations and logbooks, is also uncertain (10-13). The most frequently applied examination to evaluate resident knowledge in North America is the OITE, administered by the AAOS (14). This examination is completed annually by all orthopedic residents and includes twelve categories. (14, 15). It has been recommended that the OITE may function as an annual guide for educational superiors to decide what topics should be learned by orthopedic residents and that it may be applied to compare residents academically (15, 16). However, it has been determined that although the OITE achievement correlates with scores on Part 1 of the American Board of Orthopedic Surgery (ABOS)

examination, it does not inevitably correlate with the resident's clinical and surgical accomplishment (16). Additionally, the OITE does not include hands-on surgical skills. In the United Kingdom, an annual online in-training exam (UKITE) is part of the training and provides a chance to create a "benchmark" for both residents and residency programs. The United Kingdom also has an obligatory exit examination with both a written component and an oral component that includes patients, and it is completed toward the end of training (17).

As training trends toward a "competency-based framework", it is feasible that residents will gain advantage from both simulation-based and clinical assessments. This combination is important because although simulation-based techniques have domains, there are concerns regarding the "transferability of skills learned in the simulated setting to the real world" (18). The application of simulation techniques to both teaching and evaluation are crucial to modern surgical education. They grant opportunities for risk-free practice, and their application is beneficial in evaluating, preserving and increasing the skills that have been accomplished, including non-technical expertise (19, 20).

Germany

One hundred years ago, the domain of surgery was conquered worldwide by German surgeons, such as Theodor Billroth (1829–1894), Ernst Ferdinand Sauerbruch (1875–1951) and Gerhard Künzler (1900–1972). However, in 2019, there is a clear contrast between Germany and the U.S.A. or England in regard to the education of future orthopedic surgeons. In the U.S.A. and England, a dynamic education system directs innovation and fosters a new perspective in continued education, whereas in Germany, the training system is deteriorating because of a lack of change and innovation. The U.S. and English residency programs have a distinct duration, "Bundes Ärztekammer" the German Medical Association, i.e., by 17 State Medical Councils "Landesärztekammern", determines a minimum extent of training, whose key criterion is to have performed a minimum number of operative and non-operative procedures that may practically be performed in a set time window, which definitely takes longer than the minimum limit set by the Bundes Ärztekammer. Most often, the residents have their cases confirmed by their chiefs once 6 years have passed. If, in contrast, a chief solely confirms the cases that were performed by the residents, the residents must attend their program beyond 6 years. In contrast to the average U.S. resident, who performs 1,572 procedures during their 5 years of residency, the German resident performs 730 "operative and non-operative procedures" (21, 22).

In Germany they have a probation period of 6 months, during which the education may be terminated. Administrators who are not doctors may terminate the contract. Working under employment contracts for short periods of time in most hospitals makes residents ordinary individuals. It is a very important issue. If the system does not adequately care about the

residents, who will be tomorrow's surgeons, the lack of a guaranteed complete residency contract is a poor foundation for a good residency program and permits additional stress from the administration, which is not a factor that nurtures one's strengths. "The German system therefore lacks a solid foundation for effective training at a particular institution" (23). This is in contrast to most other countries, where residents work under an assured contract for the full extent of their residency at a distinct institution, which allows them to concentrate entirely on their clinical training.

In Germany, residents must frequently perform activities that are delegated in the U.S.A. to physician assistants. U.S. residency programs are examined every 3–5 years, updated and upgraded following standardized complete reviews by a national, specialty-specific, Resident Review Committee (RRC). Programs with shortages are placed on probation. If advances are not made within a certain period of time, the programs are shut down. This is an important variation to the average German residency program, which regrettably "lacks a standardized, periodical quality assessment of residency training" (23).

Flierl noted that U.S. residency programs create "a highly structured, progressive and innovative educational system" (23).

"The surgical caseload" for U.S. residents has more than doubled, over a shorter time-period of training, compared with that in Germany. Residents also have a higher level of guidance by senior surgeons. In a questionnaire distributed by the German surgeon association, 61% of the 500 interviewed residents were unsatisfied with their superiors' teaching and education, and 33% had meetings on a regular basis with their superiors. Sixty-one percent received no financial aid to educate themselves, and 36% attended education classes during their holidays (24). Internet-based interviews of 730 orthopedic residents by the DGOU (German Association of Orthopedics and Trauma surgeons) that ran from 10.09.2011 to 31.03.2012 noted that 80% of residents would choose orthopedics again, whereas 73% of famulus (medical student) accompanying orthopedic residents and 53% of students around their family and related individuals would not choose orthopedics as a residency program (25). Eighty percent of orthopedic residents learn from simulation-based assessment techniques, and the majority wish to have the AO Part I and II courses, an advanced trauma life support (ATLS) class and a sonography class as an integrated part of their education (26). For example, having a shoulder arthroscopy simulator is a good way to be prepared for shoulder arthroscopy (27).

To obtain direct input, we distributed an electronic questionnaire to 40 chiefs of orthopedics and trauma in Germany and, in some cases, included a personal interview to shed additional light on what could be improved to have the same level of residency education in Germany as is available in Canada or the U.S.A.

All chiefs recognized the need for a change. They must try to set up a way for residents to evaluate their programs and make these results publicly available. In this way, only good organized surgical programs will be

able to offer doctors a residency position in the future, and clinics that do not provide a high-quality, resident-oriented program must be closed for the purpose of resident's education. Training should only be performed at accredited training institutes. Most chiefs agree that the German logbook cannot be fulfilled within 6 years. Thus, the logbook requirement should be shortened to include all possible options suggested, or the hospital chiefs should make their surgical case data public so that all logbooks could be checked for accuracy. We also strongly highlight the importance of having residents not work under an ordinary working contract; instead, a full-time contract at a well-organized hospital for the full duration of the residency is recommended. Trainees must be regularly evaluated during each rotation. Resident evaluation is the commitment of the attending physician, who records the level attained by the resident according to a specific scale contributed on the resident assessment form. Residents should be given the chance to assess faculty members. The Ärztekammer must directly regulate and monitor residency programs.

Unfortunately, in Germany, there are currently approximately 17 Ärztekammer, which regulate the Länder (States) separately. We are positive that the use of a central monitoring system, such as the RRC, will permit both the better monitoring of orthopedic residency programs and their improvement. Programs with deficits must be placed on probation. Training should be performed solely at accredited training institutes.

We emphasize that in Germany, there must be a bonus program for clinics that take care of their residents by means of teaching through a DRG-System (coding the cost system), i.e., the clinic must be paid for having a good residency program.

Saudi Arabia

The Saudi Commission for Health Specialties (SCFHS) is the accredited governmental organization that accredits training clinics and oversees the qualification of residents and doctors in Saudi Arabia. It manages post-graduate training in various medical terrains. The Saudi Orthopedic Residency Program is responsible for orthopedic surgery training which is, managed by the SCFHS. The Saudi Orthopedic Residency Program has divisions in several Saudi cities, and training is only accomplished at certified training institutes. Five years is the minimum orthopedic training extent, and residents are generally evaluated during each rotation. Resident assessments are performed by the attending physician who archives the level accomplished by the resident, which is built on a specific scale on the resident assessment form. The resident assessment form tests 4 main training fields: "knowledge, clinical skills, operative skills, personality and ethics". Residents must succeed an obligatory test at the end of each training year to be allowed to progress to the next stage of training. Once the fifth training year is accomplished, the resident is board certified. Candidates who succeed the theoretical and clinical units of the final test are certified by the Saudi Board of Orthopedic Surgery (SBOrth).

The Saudi Orthopedic Residency Program steps forward toward guidance in the Middle East (28).

In 2014, Al-Ahaideb et al. compared the orthopedic residency training program in Saudi Arabia with elected Canadian residency program. The study indicated that the Canadian and Saudi residents had equal male-to-female ratios, and both groups of residents had an uniform level of knowledge. Together, the Saudi and Canadian feedbacks confirmed that textbooks were their fountain of specialty knowledge, pursued by peer-reviewed scholarly articles and, scientific debate among staff. However, Canadian-trained residents favored to review academic papers more often (46.7%) than their Saudi-trained colleagues (10.5%) ($P=0.002$). The assignment of a mentor for trauma rounds was highly valued by most residents, rather than prolongation their extent. Residents in both countries noted less surgical training in upper extremity and arthroplasty surgery.

In the Saudi program, residents were not granted with the option to assess faculty associates. Furthermore, Saudi board-eligible trainees had less self-confidence in the performance of standard orthopedic procedures without guidance, which suggests that their "surgical exposure" was insufficient. The authors concluded that the surgical logbook should be redefined in the manner that confirms that each resident had adequate surgical practice in basic orthopedic operations (29, 30).

Russia

In Russia, the density of orthopedic surgeons is approximately 9.2 per 100,000 citizens; approximately 1% are females, and they work mostly at outpatient clinics. Officially, residency programs in Russia require only 2 years of training; however, most residents pursue postgraduate study for 3 years, which includes research. Candidate selection varies between hospitals and is based on an interview. Each resident maintains a daily diary, recording all operations and manipulations wherein he/she is involved. At the end of each week, the chief resident verifies and approves the log entries. Residency training programs are structured according to the ordinance program software, which delivers 120 credit units of training materials over 2 years. Following the completion of residency programs according to the curriculum established by this software, the graduates gain proficiency in universal and professional competencies. Following the completion of training, an orthopedic specialist should master the following topics:

a) Anatomy and function of the musculoskeletal system in normal and various pathologic states, the algorithm used for patient examination, the major pathological symptoms and consequences of injuries and diseases, and the primary treatment and rehabilitation measures for these injuries and diseases.

b) Ability to organize specialized medical care for patients, obtain and analyze clinical and laboratory data, and diagnose and perform basic medical procedures.

c) Comprehensive examination and primary care methodology, primary methods of conservative and surgical treatments, ability to appropriately perform anti-shock measures and identify life-threatening disorders,

and ability to apply relevant rehabilitation measures.

Evaluation tools have been created to monitor academic performance and intermediate certification that include mandatory course requirements and surgical procedures and hospital-based research that varies between programs. Residents undergo intermediate certification that is held twice during the training period. Final certification is a summative evaluation of a mandatory, 3-part, final examination, which comprises a written test, oral interviews, and evaluation of practical skills using simulations.

Degree programs that include research enable doctors to expedite the process for achieving the next level of expertise. Orthopedic surgeons of the highest category must possess knowledge regarding all modern technologies, including endoscopy, osteosynthesis, and endoprosthetic devices. In the future, it is necessary to increase the residency duration to 5 years with expanded simulation-based training and improved education in foreign languages. Many orthopedic surgeons working in Russia belong to countries of the former Union of Soviet Socialist Republics (Belarus, Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan, and Ukraine); doctors from Africa and the Middle East have also pursued specialized education in Russia.

Developing countries

More than 80% of the world's population and an enormous reservoir of orthopedic pathologies are present in developing countries. More than 80% of all casualties in these nations are the result of road traffic accidents, and more than 90% of those that involve children take place in developing countries (31).

In Malawi, only four orthopedic surgeons are responsible for a population of 12 million individuals. In most of the 25 community hospitals work only one Senior House Officer physician and no specialists. Developing countries offer three options for training orthopedic residents. A country may attempt to conduct all training within its own boundaries. For larger countries with settled medical structures, such as Nigeria and Uganda, this is reasonable. They have well-conducted postgraduate programs in orthopedic surgery. In smaller countries with less advanced services and very few experienced trainers, the extent of their training is confined. Another alternative is to solve this issue through a regional rather than national path.

The third alternative is to educate trainees in more developed countries. Historically, this approach was the only choice for developing countries. Although this training is typically of a high standard, there are considerable burdens to this solution: the pathology in industrialized countries is varied, and some residents who finish all of their postgraduate training in industrialized countries do not return to their home countries. There are advantages to expend a short period in an industrialized country, typically at the end of national or regional training. This can be for one year with a focus on a specific field, such as joint arthroplasty or spine surgery. These visits may be arranged as a "formal exchange" between trainees from industrialized and developing nations (32).

India

The basic medical training includes the first 4 and a half years of medical school. The Bachelor of Medicine and Bachelor of Surgery (MBBS) degree can be obtained after completion of the basic medical training. After finishing the basic medical training, students start with a 1-year Obligatory Rotating Residential Internship (CRRI). This program is comparable to a rotating or transitional internship. Following the achievement of the CRRI, medical students obtain medical college diplomas. In order to apply for residency specialty training, MBBS graduates should succeed a national and/or state-level "postgraduate entrance exam", a written exam that is the determining factor for placement in postgraduate training. The Medical Council of India confirms that there are 225 MS(Orth) training programs accessible to resident physicians. There is a 3-year residency program, after which a doctor earns the right to proclaim himself/herself to be an orthopedic surgeon. After graduating from medical college, an entrance examination is administered, and students are subsequently allotted seats in colleges based on these results (33-40).

This 3-year program is an academic and clinical education program. The residency program is always attached to a teaching hospital. These may be funded privately or by the government. In the first year, the resident is introduced to inpatient work, history taking, clinical examinations, differential diagnoses and the basics of how to prepare a patient for treatment, whether surgical or conservative. He/she is attached to a unit that has specific trauma call days, outpatient clinics and operative theater days. They work under the constant supervision of their senior residents and a consultant. The consultant is in charge of their training and supervises the dissertation work of the resident. The residents also take undergraduate level classes. Over the course of the next two years, the residents learn to operate under strict supervision. Basic training in India involves the treatment of trauma and fractures. Specialized clinics or sub-specialties are present in only a few hospitals. Following the completion of the three-year residency, the resident must clear a theoretical and practical examination, after which he/she will receive a post-graduate degree (M.S., Masters in Surgery-Orthopedics, or a D.N.D., Diplomate of the National Board in Orthopedics).

There is a shorter 2-year program referred to as the Diploma in Orthopedics, where no dissertation is presented. Following the completion of residency, a young orthopedic surgeon has an opportunity to join a 3-year senior residency program in a government-funded or private hospital. They are always attached to a senior consultant.

In a government hospital, there is always a shortage of doctors and beds; however, the clinical experience is so vast because of the inflow of patients that in this three-year period, he/she will likely be exposed to nearly all orthopedic conditions. They will also have honed their surgical skills. This vast clinical experience comes at a cost, as the resident's duty hours are very tiring, sometimes stretching to 36 hours at a time. In a private hospital, it is rare that a resident is allowed to

operate because the treating consultant is responsible for the surgery and cannot afford slipups. Residents who do not opt to join a hospital for their senior residency start their private practice or join a government hospital to begin their career. Fellowship programs have started over the past few years and range from 3 months to 1 year in duration. These fellowships are offered in all sub-specialties of orthopedics. Three years after completing medical school, one can become an orthopedic surgeon. There are 70 female orthopedic surgeons in India. Women are involved in most orthopedic specialties, such as general orthopedics, hand surgery, arthroscopy, pediatric orthopedics and spine surgery. Improvements for the next generation of Indian residents would be to lengthen the orthopedic residency to a minimum of 6 years, with the last two years dedicated to the sub-specialty training of their choice. The last year should be a sub-specialty year; however, trauma on-call duties should also continue. This will ensure that the entry of the surgeon into practice makes his/her skills more robust. With most hospitals certified by the National Accreditation Board for Hospitals and Healthcare Providers (NABH), patient safety practices are diligently followed and are a prerogative of both healthcare employers and providers. Furthermore, non-Indian doctors from neighboring countries, such as Nepal and Bangladesh, are enrolled in residency programs following inter-governmental agreements. They are supposed to travel back to their respective countries to practice following the completion of their training. Cooperation with the Western world will help Indian residents broaden their horizons and bring the best practice guidelines to the forefront of patient care.

Iran

The orthopedic surgeon density (number of surgeons per 100,000 population) in Iran is approximately 5 per 100,000. The selection of candidates is based solely on the outcome of the national exam, which is a multiple-choice questionnaire. This exam is held one time each year by the ministry of health; thus, it is a central selection system. Residents select their desired residency program based on their interests and their exam score. The duration of an orthopedic surgery residency program is 4 years. The program typically covers all aspects of orthopedic surgery, and residents have the option to rotate through different specialty services. They must also perform research activities and contribute to the education of interns and students. The residents participate in all activities (ward, outpatient clinic, operating room, emergency room and on-call services), educate students and perform research. There is also a logbook, which will soon be transferred from paper to an electronic log. A rotation through sub-specialties, such as hand surgery, foot surgery, sports, joint replacement, rehabilitation, and pediatrics, is required.

There is a final exam (oral, written and an objective structured clinical examination, OSCE). All residency programs originally required an oral OSCE and 360° resident evaluation. If the residents obtained high scores, they became eligible to participate in an annual promotion exam. If they received an appropriate score on

this test, they could advance to the next year of residency. In Iran, it requires a minimum of 4 years to become an orthopedic surgeon. The board exam also consists of a 150-question multiple-choice written exam and an oral OSCE exam. Once these tests are passed, the resident may be board-certified. Orthopedics has the lowest percentage of female residents compared to other subspecialties. Although it is a male-dominated specialty, the number of female orthopedists is increasing, and they are very successful. Female orthopedists are most commonly involved in hand surgery or pediatrics. The most important improvement for the next generation of residents in Iran must involve the improvement of the selection criteria for their residency programs. The length of their residency should also increase to 5 years. In Iran, patient safety is important to daily practices. It is mandatory for every hospital to observe patient safety protocols, and it is monitored by the ministry of health. Non-Iranian doctors from Sudan and India are also enrolled in Iranian residency programs.

China

China advanced from a “domestic product” in 1980 of under U.S. \$200 billion to U.S. \$5 trillion in 2010 (41). Depending on the local geography, orthopedic specialist training in China seems to vary. After the completion of the five years of basic medical school education, follows the postgraduate MPhil, which prolongs for seven years or a postgraduate PhD, which extends to eight years. Graduate curriculums are clinically tailored and primarily occur at the hospital, with various amount of priority on laboratory assignment. Teaching is often didactic in China, whereas debates and tutorials are not conventional.

There is a three years of basic surgical training followed by two years of general orthopedic training, the three plus two training system.

To date, there is no orthopedic sub-specialty training in China, with the exception in hospitals such as the Beijing Jishuitan Hospital. The orthopedic profession in China acknowledges the necessity to establish a residency system that considers the diversities of a large country.

There are approximately 50,000 doctors who practice orthopedic surgery in China (42). In 2012 the Chinese Medical Association under the commission of the Ministry of Health announced compulsory residency training standards (43). The training guidelines were branched into four areas for each specialty: “training objectives, rotation length requirements, training content, and reference material”. In 2014, 8,500 residency programs had been settled in 559 hospitals, registering 55,000 residents (44). In 2015, the Chinese government applied a proposal for the nationwide commencement of 3-year uniformed residency training programs (45).

According to the government’s mandate by 2020, an employed physician must accomplish one of the new residency programs. These adjustments impact the health of one-fifth of the world’s community. Recently published Chinese literature suggests that the improvement of the residency training programs needs a considerable amount of time and effort before it is precisely Standardized.

Cultural Competence in Orthopedics

Competency in orthopedic surgery depends on managing complicated cases with minimum complications. A patient and his treatment include both medical and psychological competency. In today’s globalized world, we interact with other cultures and thereby unconsciously unify diversity. Resident selection is a multifactorial procedure that significantly differs from the recruitment processes that other professions enjoy. The proportion of international medical graduates (IMGs) that practice in the U.S.A. is significant. IMGs represent one-quarter of U.S. physicians, up from 15 percent in 1967 and 6.3 percent in 1959. In 2004, twenty-eight percent of the residency cohort was depicted by IMGs, with a major presence in psychiatry and nephrology (46). The literature widely documents racist experiences by patients and the differential treatment and healthcare disparities built on race (47, 48). Medicine is overshadowed by infamous experiments, such as the Tuskegee and Guatemala experiments, and routine studies confirm the insufficient treatment of minority patients (49-51).

Unfortunately, the consciousness concerning racial and ethnic discrepancies in Orthopedic care is low. However, although most evidence of racial and ethnic discrepancies is linked to cardiovascular specialty, discrepancies have also been identified in Orthopedic specialty.

Minorities tend to undergo lower rates of total joint replacement, showing more complications subsequent to joint replacements, higher readmission rates after orthopedic cases, lower screening and treatment rates for osteoporosis, and increased morbidity and mortality consecutive to hip fractures (52-55).

In 2016, Adelani and O’Connor performed a study in which three hundred five associates of the American Orthopedic Association finished a survey to evaluate their know-how of racial/ethnic discrepancies and their insights regarding the associated origins. Twelve percent of the interviewees believed that patients frequently obtain different care rely upon their race/ethnicity, nine percent believed that discrepancies exist in orthopedic care, three percent believed that there are discrepancies within their hospitals/clinics, and one percent reported discrepancies in their own practices. Despite these findings, sixty-eight percent admit that there is clear proof of discrepancies in orthopedic specialty. Fifty-one percent conclude that the absence of insurance considerably contributes to these divergencies. Moreover, thirty-five percent of the respondents concluded that variety of the “orthopedic workforce” would be a “very effective” approach to decrease discrepancies, twenty-five percent believed that research would be “very effective”, and twenty-four percent believed that surgeon training would be “very effective”. They noted that the awareness of orthopedic surgeons regarding the racial/ethnic discrepancies in musculoskeletal specialty is low. Moreover, respondents admit to discrepancies in the services of other colleagues than themselves. Increased research, diversity, and training may advance the awareness of this dilemma (56). “Prejudice and discrimination are profoundly harmful to

individuals and society as a whole." (57). As we move to a more multicultural society, it is the hope of the authors that these infrequent racist encounters will continue to diminish and that medical schools and residency programs will train physicians and include more IMGs who are understanding and culturally competent (58).

Women in Orthopedics

Ruth Jackson, the first female orthopedic surgeon, opened her practice in Texas in 1932 after graduating from the University of Iowa. In 1937, she completed and passed the board exam to become the first female board-certified orthopedic surgeon (59). The addition of the 1972 Education Amendments to the Civil Rights Act in the U.S.A., helped to initiate the rise of the number of female graduates from medical school at a constant rate (60).

Analogous movements have pursued in Western countries. Although half of medical school graduates are currently women, they represent only 13% of all orthopedic surgery residents and 4% of the members of the AAOS (61). Orthopedics is therefore the most gender imbalanced area of medicine. This imbalance suggests the presence of obstacles to the advancement of women in this specialty.

The Perry Initiative is a "nonprofit organization" that concentrates on enrolling women in orthopedics. The organization is built in 2009 and managed by female surgeons and engineers. They managed "out-of-school programs" for women. In 2012, the Perry Initiative commenced the Medical Student Outreach Program (MSOP), which focuses on female medical students, who started medical school. The MSOP inherits a syllabus of educational programs led mostly by female residents and surgeons. In 2016, the MSOP performed an investigation and concluded that the Perry Initiative's MSOP certainly inspired women to select orthopedic surgery as a career. The "match rate" for program graduate was twice (28-31%) the percentage of women in contemporary orthopedic residency classes. Considering these optimistic outcomes, the MSOP may function as a "model" in both its "curricular content" and "logistic framework" for other diversity enterprises in the specialty. The MSOP provides medical students with the option to connect with "female role models" in orthopedics and increase their "hands-on exposure" to orthopedic surgical approaches (62). The lack of female faculty and mentorship in residency programs has been addressed as a possible reason for the limited number of female medical students who enter this field (63). We must strive to significantly improve the rate of female and minority admissions to the orthopedic profession. Our goals are to advance the patient and physician relationship and eliminate the disparities in healthcare, regardless of gender, race or religion. We must foster the launch of an atmosphere of goodwill and collegiality toward women and minorities in the orthopedic profession and make this known to the world of medicine (64).

Orthopedics and Politics

According to the "Working Group on Research of the Causes of War" (Arbeitsgemeinschaft Kriegsursachenforschung) of the University of Hamburg,

>90% of wars have occurred in developing countries since 1945, with 32 wars and armed combats recorded in 2010 (65).

These facts should be considered when planning for improvements in global health and the achievement of worldwide health equity. Within the context of war in developing countries, military surgeons are among the few who can provide medical support and humanitarian aid, along with educating local doctors. The participation of military doctors with intentions to advance "global health" is highly needed and appreciated. The concept of a military surgeon includes the goal of being a competent surgeon, along with support for all human beings, regardless of their heritage. These doctors treat soldiers who are injured in war or have non-hostility-associated harms, civilian staff of the United Nations and "non-governmental" organizations, and noncombatants from the regional community, as part of humanitarian assistance. Preferably, military surgeons not only have the competency to conform to medical standards within the country but are also capable of performing emergency field surgery. The "Duo plus" template for educating surgical officers in Germany includes training in general surgery in addition to a second training, in visceral or orthopedic/trauma surgery. In consensus with the definition authorized by "the German Committee of Military Medicine" on May 14, 2004, the Duo plus model considers deployment related injuries and medical diseases, is based on real-life situations, reflects new improvements in the civilian hospital setting, and conforms to present qualifications for authorized professional training managements (66).

Where there is no war, for developing countries, orthopedics is dependent on instruments. These instruments should be imported from developed countries, and politics may influence this process. Easy travel to other countries and having experts travel from other countries are important for sharing knowledge and skills. Permission to travel is affected by political situations. Scientific exchange with developing countries is imperative to improving surgical education.

Developed countries are also under the influence of political decisions. For example, how many hospitals can be built, how many should be closed or how many organizations and which types of organizations should be in charge of resident education? What is the financial support from the government? How will this funding be distributed? Which hospitals will be funded, and which will not?

Research articles published on ways to improve residency programs will serve as proof for politicians, who require facts from experts in the field, researchers and clinicians.

Discussion

Orthopedic surgery is an interesting and diverse field that will continue to develop, with increased subspecialization and enhanced research at the molecular level and an increased emphasis placed on outcomes and healthcare costs.

Our goal should be to improve the level of orthopedic

training worldwide. Forthcoming studies should seek to gain additional details regarding these training curriculums and include data from more countries. It is well established that global health is an area that has expanded definitely in "scope and popularity" (67). Globally, trauma kills more individuals than HIV/AIDS, malaria, and tuberculosis combined and inclinatory influences low- and middle-earnings countries, as well as the young population. We should put more effort into standardizing the educational content and minimizing the variability among residency training programs worldwide (68-73).

The improvement of international orthopedic specialty will necessitate economic aid, involvement, research, teaching and support. We inspire internationally orthopedic surgeons to distinguish the significance of training, education, and performing research with the ambition of approaching a high-quality orthopedic care.

Internationally, the absence of the standardization of instructional content leads to great variability within the residency training programs (74).

The main goal of orthopedic training programs is to educate skilled orthopedic surgeons who are competent, dedicated to care for patients in a skillful manner, technically qualified, have the ability to communicate, and are highly skilled instructor. Guidelines are published and applied in many countries to achieve these objectives.

To conclude, we endorse including the following points in the international orthopedic residency program outline:

1. The skill of today's trainees reflects the quality of future orthopedic surgeons.

2. We must standardize many educational procedures, i.e., assessment tests, in the same way we standardized patient safety worldwide.

3. Global health is currently the study, exploration, and practice of developing worldwide health equality.

4. Forthcoming studies may intent to include information from more countries. We should aim to improve and harmonize orthopedic training worldwide. As European residency programs vary but a European orthopedic surgeon can work anywhere in Europe, we suggest that the EBOT examination function as a conceivable evaluation of the proficiency of orthopedic surgeons in all European countries.

5. Hands-on cadaver and simulation labs should be accessible to residents.

6. The status of the orthopedic residencies (i.e., care) in all countries should be assessed to better comprehend the global current discrepancies and their origin to develop new concepts.

7. Cooperation and logistics must be nurtured at every stage of orthopedic service, between healthcare practitioners of various cultures, different organizations, and countries with different financial status and barriers.

8. Novelty is crucial, and we should foster inventiveness, meticulously examine new concepts, and contribute to novel innovations with the option for global implementations such that, in the future, we can provide an equal level of orthopedic know-how and care worldwide (75).

As stated by Fleischman and Rothman, "hard work, life

balance, and at the right moment, a stroke of luck are all keys to success" (76).

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