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INTRODUCING ARTIFICIAL INTELLIGENCE TRAINING IN MEDICAL EDUCATION

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ABSTRACT

As the field of medicine continues to advance, there is an increasing need for a comprehensive reform of medical education. As the field of medicine progresses into the age of Artificial Intelligence (AI), there will be a growth in the utilization of data to improve clinical decision making. This will result in an increased need for skilled interaction between medications and machines. Artificial intelligence (AI) and other technologies are necessary in order to enable medical professionals to make effective use of the ever-expanding quantity of medical information in order to safely and effectively practice medicine. It is imperative that medical workers get adequate training on this emerging technology, which should include not only its advantages in terms of improving accessibility, cost, and the overall quality of care, but also its disadvantages, which include liability and transparency. All aspects of the curriculum need to be seamlessly integrated with artificial intelligence. In the course of this study, it is addressed that the present state of medical education and have proposed a paradigm for the growth of future curriculum that integrates artificial intelligence.

Keywords: *artificial intelligence, medical education.*

INTRODUCTION

It is anticipated that the expenditures on health care throughout the world would rise at a rate of 5.4% annually, going from $7.7 trillion in 2017 to $10 trillion in 2022. In other words, the average contribution of health care to the gross domestic product of industrialized countries is nine percent. There are a number of major global trends that have contributed to this phenomenon. Some of these trends include the following: the United States' tax reform and policy changes that may have an impact on the Affordable Care Act's expansion of health care access and affordability; the population growth and rising wealth of China and India; Russia's implementation of socioeconomic policy reform for health care; Argentina's efforts to make universal health care work; the massive push for electronic health and telemedicine in Africa; and the effects of the world's fastest-ever rate of population ageing.

When seen from the perspective of doctors, there are a number of key elements that influence the therapy that they deliver. One of these factors is the astounding rise in medical knowledge. After fifty years, the quantity of medical knowledge about quadrupled by the year 1950. Seven years had elapsed by the year 1980. In 2010, it was 3.5 years, and by the year 2020, it is anticipated that it would have quadrupled in 73 days. The providers of health care are having a tough time not just retaining but also making use of this rise in their practice operations.

Artificial Intelligence's Ascent in Healthcare

Medical Artificial Intelligence

For the purpose of understanding and developing computer algorithms that are capable of carrying out actions that are traditionally carried out by people, the scientific area of artificial intelligence (AI) is a subject of study. AI is beginning to make a name for itself in the realm of medicine. AI has come a long way from its humble beginnings in Turing's seminal book, Computing Machinery and Intelligence, in which he posed the question, "Can machines think?" Artificial intelligence has become much more sophisticated. The advancement of artificial intelligence may be seen in a number of different domains, including natural language processing (NLP), speech recognition, virtual agents, robotic process automation, machine learning, deep learning, and decision management.

A number of applications of artificial intelligence are now being investigated in the healthcare industry. These applications include enhancing diagnosis speeds and accuracy, supplementing imaging, reducing medical expenditures, minimizing errors caused by human fatigue, assisting and replacing labor-intensive, repetitive, and monotonous jobs, performing minimally invasive surgery, and reducing mortality rates.

Difficulties Presented by Artificial Intelligence

As artificial intelligence becomes increasingly widespread in the healthcare industry, it will be challenging to incorporate it into regular clinical practice. In addition to the need to adapt the conventional procedures that doctors use, among of the most significant challenges that are anticipated to arise include issues over responsibility and the black box conundrum.

Black Box

The researchers at Mount Sinai Hospital used 7,00,000 patient data sets to teach a deep learning system that they had constructed during their time there. An extremely high degree of accuracy was revealed by this algorithm when it came to predicting the beginning of disorders such as schizophrenia. These findings are even more remarkable when one considers that even medical experts have difficulty correctly identifying this sickness. The most significant problem with this technique is that it is not feasible to ascertain how the system arrived at this prediction or what factors were taken into consideration. This incidence is what we refer to as the "black box phenomenon". In spite of the fact that there would be no precedent in the field of medicine, it is still difficult to put your faith in a system if you are not familiar with how it functions. The physician has to have a thorough understanding of the inputs, the algorithm, and the proper way to interpret the diagnosis that the AI recommends in order to guarantee that there are no errors committed. Even in situations when there is proof of beneficial outcomes in comparison to a standard of therapy, we still need to be aware of the consequences or unforeseen bad effects that may be caused by black box drugs.
Last but not least, a significant number of artificial intelligence systems attempt to imitate aspects of the central nervous systems of humans and other animals, the majority of which are yet unknown. Recently, Zador made the assertion in a research study that in order to comprehend this phenomenon, there is still a great deal that we need to learn about the brains of animals.

Privacy and Control Over Data

When it comes to the creation of artificial intelligence systems, it is often necessary to gather a significant amount of patient data. For instance, in order to forecast the outcomes of hospital patients, Google analyses 46 billion data points that were collected over the course of eleven years from the deidentified medical records of 2,16,221 individuals who were treated at two different hospitals. This gives rise to a multitude of issues, one of which being the patients' right to privacy and control over their own treatment. In the event that a patient makes the decision to decline participation in a research study in which their personal data is used to develop an algorithm, what may be expected to occur next? As a result of the Right to be forgotten, which was established by the European Union, it is now possible for patients to have their personal information removed if they change their mind. In situations when there is a deficiency of patient data, the creators of algorithms will resort to using synthetic or hypothetical data in order to train the models. It is possible that this approach may result in the provision of therapeutic recommendations that are either harmful or wrong. As a consequence of cybersecurity attacks on artificial intelligence systems, there is a possibility that the algorithm would incorrectly categorize medical data.

Medical Education using Artificial Intelligence Training

Current Situation in Medical Education

Before a physician may become qualified to register as a specialist, they are needed to finish extensive training curricula. Conventional curricula continue to serve as the basis for medical education, despite the fact that there have been substantial breakthroughs in medical practice over the course of the last several decades. Although the length of time spent in training differs from country to country, the essential skills that are taught in these courses are common. The primary emphasis of training shifts from preclinical didactics to practice-based learning after an initial period of preclinical instruction. In many cases, the basis of medical education is comprised of six different domains: patient care, medical knowledge, interpersonal and communication skills, practice-based learning and development, professionalism, and systems-based practice.

Accreditation Council for Graduating Medical Education (ACGME) is the organisation that is responsible for establishing these fields. One of the primary objectives of medical education is to acquire as much information as possible while simultaneously learning how to apply knowledge to the actual treatment of patients. A significant portion of this method is still dependent on memorization skills. Residents and students in the medical field are not provided with as much time to get familiar with developing technologies such as artificial intelligence (AI), telemedicine, and mobile health applications. On the United States Medical Licensing Examination (USMLE), these domains are not tested. But ever since the American Medical Association (AMA) established its first policy on augmented intelligence at its annual conference in 2018, which supported research into how artificial intelligence should be handled in medical education, change is unavoidable. As can be seen in Table 1, the American Medical Association has made a variety of initiatives to incorporate artificial intelligence into medical education.

Table 1. Educational initiatives pertaining to artificial intelligence in the field of medicine

Institution	Project
Duke Institute for Health Innovation	Medical students work together with data experts to develop care-enhanced technologies made for physicians

University of Florida	Radiology residents work with a technology-based company to develop computer-aided detection for mammography
Carle Illinois College of Medicine	Offers a course by a scientist, clinical scientist, and engineer to learn about new technologies
Sharon Lund Medical Intelligence and Innovation Institute	Organizes a summer course on all new technologies in health care, open to medical students
Stanford University Center for Artificial Intelligence in	Involves graduate and postgraduate students in solving heath care problems with the use
Medicine and Imaging	of machine learning
University of Virginia Center for Engineering in Medicine	Involves medical students in the engineering labs to create innovative ideas in health care

Working with electronic health records (EHRs) is another significant technology-related feature that is often neglected in the field of medical education. Electronic health records (EHRs) not only increase the safety of patients, but they also make it easier to integrate artificial intelligence in the medical field. Since the electronic health record (EHR) is the source of information that AI algorithms utilise, it is crucial to have the expertise necessary to enter data that is objective into the EHR. In such case, the artificial intelligence algorithm will most likely also be biassed. The training on the use of electronic health records (EHRs) for medical students and doctors is not generally included in the curriculum of the medical field at the current time. As a consequence, medical professionals are utilising the EHR as a substitute to collect information on paper without having a comprehension of the actual potential of this technology. In most cases, training on the use of electronic health records (EHRs) is comprised of ad hoc quick introductory courses that only teach the fundamental skills necessary to utilise the system in practice at the hospital. over the quality of the data and concerns over the influence of the computer on the interaction between the patient and the physician, the United States Medical Licencing Examination (USMLE) does not test on these topics either.

How Clinical Practice is Changing

During this period of fast digitization in the health care business, electronic health records (EHRs) make it feasible to get and understand significant data in novel ways that may be used to make choices that are well-informed. Both clinical practice and the results for patients are enhanced as a result of these breakthroughs and the transition from the information age to the era of artificial intelligence. The skill set of future physicians will need to be expanded to encompass the management of data, the supervision of artificial intelligence technology, and the utilization of AI applications in order to make well-informed decisions.

In the process of selecting which of these equipment is most suitable for their patients, physicians will play a crucial role. As a result, this will most likely change the dynamic between the doctor and the patient. In the field of medicine, one of the most significant benefits of artificial intelligence (AI) is that it enable medical professionals to devote more of their attention to the care and communication of their patients. This becomes increasingly clear in situations when the majority of the processing of information is done by computers.

According to the most recent advice made in the age of artificial intelligence, the physician "should combine narrative, mechanistic, and mathematical thinking in their training and consider the biopsycho-social model of the disease with the patient at its centre." "A self-reflective medical expert who understands the strengths and limitations of humans and works in an environment characterised by information overload cannot be replaced by a computer."

What Will Be Asked From Physicians in the Future?

When it comes to the successful use of artificial intelligence in clinical settings, future medical professionals will need to possess a broad range of skills. In addition to having a thorough understanding of the fundamentals of medicine, physicians are required to have a firm grasp of mathematical concepts, the fundamentals of artificial intelligence, data science, and associated ethical and legal considerations. With these capabilities, individuals will be able to manage artificial intelligence technology, make use of data derived from a wide range of sources, and recognise instances in which algorithms may not be as accurate as was first thought. In addition, since AI-based systems will not be able to take into account the whole spectrum of feelings and physical ailments that a patient may be experiencing, interpersonal and leadership skills, as well as emotional intelligence, will be more important than they have ever been. In this day and age of artificial intelligence, a superior physician will be able to demonstrate these characteristics, which are difficult for machines to acquire.

Practical Considerations

It is now going to be required to devote part of the time that was previously spent on acquiring medical knowledge to the acquisition of other forms of expertise. The residents and students will have a very different perspective on their training as a result of this. It is necessary for the system to be modified in such a way that the ability to communicate, emotional intelligence, and computer literacy will be utilised to evaluate competence rather than the knowledge of facts.

It is difficult to adopt new topics when the curriculum is overburdened, even if 85 percent of medical professionals agree that new digital technologies would be advantageous (American Medical Association, 2016). The incorporation of AI-focused training into medical curriculum will take some time to become a reality as technology continues to improve. The establishment of a new educational infrastructure and the hiring of teachers with expertise in subjects such as computer science, mathematics, ethnography, and economics are both essential. Despite the fact that these subjects are not presently covered by the core competencies of the ACGME, the skills "are robust enough to adapt to changing knowledge."

In order to alter the curriculum, a significant amount of political and administrative labour will be required. It is necessary for educational institutions, programme structures, and objectives to undergo transformations in order to produce new learning outcomes. Prior to the implementation of a change, it is necessary to create a substantial body of evidence with supporting evidence. The point at which advancements in artificial intelligence can be put into effect has not yet been reached. In addition, a large number of distinct medical specializations argue that they have not received the attention that they are entitled to get. The benefits of artificial intelligence (AI) need to be shown, as well as the reasons why it should be taught at medical schools rather than in other fields that do not currently have adequate medical training requirements.

Framework

The traditional medical curriculum, which is mostly dependent on memory, has to be updated in order to accommodate the transition from the information age to the age of artificial intelligence. Those who are interested in becoming physicians should be instructed in the ability to effectively integrate and apply information obtained from a growing number of different sources. In order to successfully incorporate this information into medical practice, it is essential to start teaching these concepts right from the beginning of the training process. In many countries, prospective medical students are required to take the Medical College Admission Test (MCAT) in order to be considered for admission to medical school. The current edition of the MCAT examination in the United States, for example, has a focus on the subjects of logic, psychology, sociology, physics, chemistry, and biology. Questions on fundamental mathematical concepts, such as calculus and linear algebra, could be included at the beginning of these examinations. These concepts will serve as the basis for the rest of the project and are necessary for a fundamental understanding of artificial intelligence for the general public.

In the core portion of preclinical didactics, topics such as dealing with electronic health records (EHRs), artificial intelligence (AI) fundamentals, ethics, and legal difficulties associated with AI should all be taught. This includes dealing with health data curation and quality, provenance, integration, and governance. In addition to this, it is of the utmost importance to enroll in classes that focus on the statistical analysis and critical assessment of artificial intelligence and robotics technologies. In the beginning, these subjects could be taught as stand-alone courses in order to teach the basic knowledge that will continue to be helpful long after the applications that are now in use become obsolete. These stand-alone courses have the potential to enhance and potentially replace the statistics and medical informatics courses that are now included in the curriculum on a regular basis. Secondly, they need to be included once again into clinical courses so that students are familiar with the clinical applications of artificial intelligence and are able to deal with electronic health records in a variety of settings. Utilising artificial intelligence in educational settings such as evidence-based medicine is one approach to introducing technology to the general public. Incorporating concepts from data science, utilising artificial intelligence technologies such as natural language processing, and conducting scenario analysis to evaluate students' knowledge on ethical and liability concerns are all ways that the process of teaching students to evaluate evidence through databases such as PubMed, diagnostic tests, and systematic reviews could be improved. It is necessary for students to get training in the fundamentals of computer and software engineering in order for them to appreciate the meaning behind practical applications of artificial intelligence. For example, having a fundamental grasp of user experience design, hardware, and software development might prove to be advantageous.

In the course of clinical rotations and residency programmes, the focus should shift to relevant uses of artificial intelligence in clinical settings. Students have to also be instructed in digital therapeutics and digital biomarkers, given that these sectors are dependent on artificial intelligence that is being developed. they may make it feasible for comprehensive diagnostics and treatments to be administered in the comfort of one's own home. Following training, the final tests for the United States Medical Licensing Examination (USMLE) should have a substantial number of questions that address the fundamentals of data science and artificial intelligence. Keeping medical workers up to date on the most current breakthroughs in artificial intelligence (AI) in health care might be accomplished via the provision of incentives for attending conferences on AI in

health care. Comprehensive courses in artificial intelligence and data science need to be incorporated in continuing medical education for attending physicians. Note that Table 2 has more information.

Table 2. Listing of AI in health-related Continuing Medical Education courses

Program	Faculty: organization	Number of Continuing Medical Education credits
Artificial Intelligence and the Future of Clinical Practice	Computational biologist, Business economist; Massachusetts Medical Society	2.0
Intro to AI and Machine Learning: Why All the Buzz	Medical Informatics, Radiology; The Radiological Society of North America	1.0
Current Applications and Future of Cardiology	Healthcare Technologists, Bioinfonnatics, Cardiology; Mayo Clinic	10.0
Artificial Intelligence and Machine Learning: Application in the Care of Children	Pediatric Medicine; University of Pittsburgh School of Medicine	I .0
Artificial Intelligence in Healthcare: The Hope, The Hype, The Promise, The Peril	Medical Informatics, Business Administration; Stanford University School of Medicine	6.0

In addition, the capabilities of artificial intelligence need to be paired with non-analytical and patient-centered aspects of medicine in order to produce a more well-rounded physician of the future. Other skills that will become more crucial for physicians to possess include empathy, the ability to work well with others, leadership, creativity, and the ability to make decisions via joint efforts. At the Dell Medical School at the University of Texas at Austin, the length of the core scientific curriculum has been cut in order to provide room for instruction in soft skills such as communication, creativity, and leadership.

Interdisciplinary training is required in the fields of implementation science, operations, and clinical informatics in order to provide physicians with the ability to think creatively and build care models that are enabled by technology. The Stanford Medical School has established a course that integrates a human-centered design approach into graduate medical education in order to better prepare clinician-innovators for the digital future. This programme is intended to train clinicians for the future of digital medicine. The Healthcare Transformation Laboratory at Massachusetts General Hospital in Boston is now accepting applications for a fellowship in health care innovation that will need a duration of one year. Data sciences, machine learning, health care operations, services, design thinking, intellectual property, and entrepreneurship

are some of the topics that resident trainees are exposed to via this programme. These are brand-new projects that are the first steps towards using artificial intelligence into instruction in the medical field.

First Steps

In light of the fact that it is not feasible to carry out all of these interventions simultaneously, it is recommended that a few preliminary actions that will serve to establish the foundation for the years into the future, that the Mathematics and Computer Applications Test (MCAT) should start with questions on mathematical concepts, inspired by the mathematics section of the Graduate Record Examination. Free Online courses with high quality should be made accessible throughout the core period of medical school. These courses should include the fundamentals of intelligence and data sciences. During the years that follow, it could be simpler for students to focus on the practical applications of the courses they have taken.

Throughout the remaining period of their medical education, residents and medical students who have already completed this phase of training should have access to and be required to attend courses on the basic themes. Students who are interested in establishing unique medical care models that are enabled by technology should be encouraged to participate in specialized training in health care innovation during a gap year during their clinical years or after they have completed their residency. Furthermore, it is essential that attending physicians have access to both initial training and opportunities for further education. It is necessary for this specific group to undergo substantial training in order for them to be able to partly accept the task of teaching medical students and residents on these subjects in the future. The following is a list of the suggested content that may be included in the various levels of medical education shown in Table 3. Attending one of the conferences mentioned in Table 4, which is a small selection of the rapidly growing number of AI in healthcare conferences, is an option for medical professionals and trainees who are interested in gaining more knowledge about artificial intelligence and its applications in the healthcare industry.

Table 3. Suggestions according to medical education stage

Medical education stage	Recommendations	Suggested content
MCAT[a]	Introduce questions on linear algebra (vectors, linear transformations, and matrix, solutions for linear systems), calculus (limits, differential calculus, and integral calculus), probability (joint, conditional, and distribution)	• Education Testing Services' Graduate Record Examination mathematics test

Medical school—core phase	Working with medical data sets (curation, quality, provenance, integration, and governance), EHRs[b], AI` fundamentals, and Ethics and Legal	• Datasets: • HealthData • Public datasets in health care • University of California San Francisco Data Resources • AI fundamentals • AI 101 course from MIT[I] • Ethics and Law • Teaching Al, Ethics, Law and Policy • Al Law • EHR training
Medical school—clinical phase	Familiarize with Al-based clinical applications and expand knowledge beyond bask principles of data and Al	• Clinical utility: • Overview of Clinical applications ofAl • Al for Health and Health Care (US Department of Health and Human Services) • Center for Al in Medicine and Imaging • Al in Healthcare Accelerated Program
USMLE[e]	Introduce questions on data sciences, Al, and working with EHRs	• Data science courses
Residents	Detailed knowledge on clinical applications and attend conference in health care Al	• Table 4
Specialist	Stay up-to-date on data/A1 through CME[f] credits and attend conference in health care Al	• Tables 2 and 4

Questions should be introduced concerning linear algebra (including vectors, linear transformations, and matrices, as well as solutions for linear systems), calculus (including limits, differential calculus, and integral calculus), and probability (including joint, conditional, and distribution conditions).

Working with electronic health records (EHRs), artificial intelligence basics, ethics and legal issues, and medical data sets (curation, quality, provenance, integration, and governance) Mathematics portion of the Graduate Record Examination administered by Education Testing Services Recommendations for content

[a]MCAT: Medical College Admission Test.

[b]EHR: electronic health record.

[c]AI: artificial intelligence.

[d]MIT: Massachusetts Institute of Technology

[e]USMLE: United States Medical Licensing Examinations

[f]CME: Continuing Medical Education.

Table 4. A list of conferences using artificial intelligence in healthcare

Name of conference	Topics
Ai4 Ala Healthcare Conference	Exploring top use cases of AI and MLb in health care
AI in Healthcare	Business value outcomes of AI and experience in clinical care and hospital operations
Machine Learning and AI forum (Healthcare Information and Management Systems Society—HIMSS)	Data, analytics, and real-world applications of ML and AI
AI in Healthcare @ JP Morgan Healthcare Conference	AI applications—drug discovery, secure data exchange, insurer coordination, medical imaging, risk prediction, at-home patient care, and medical billing
Radiology in the age of AI	AI in medical imaging
American Medical Informatics Association Clinical Informatics Conference	AI in medical informatics
Association for the Advancement of AI	"Increase public understanding of AI, improve the teaching and training of AI practitioners, and provide guidance for research planners and funders concerning the importance and potential of current AI developments and future directions"

CONCLUSIONS

When doctors and robots work together, there is the greatest potential to improve clinical decision making and the consequences for patient health. Artificial intelligence has the ability to gather and analyse extra data, such as genetic reports, pharmacological notes, medical records, and environmental data, in order to allow for

the storage, retrieval, and analysis of a greater quantity of medical data. On the other hand, it is not capable of replacing the ability to care for others. As artificial intelligence (AI) becomes more extensively employed in the healthcare industry, it is imperative that medical students, residents, fellows, and practicing physicians have a solid understanding of AI, data sciences, electronic health record (EHR) foundations, ethics, and legal issues that are associated with AI.

It will be necessary for them to be included in the curriculum of medical schools. It is recommended that medical students get their education in many phases as they go through their training.

Artificial intelligence will assist and replace labor-intensive, laborious, and repetitive operations; it will also facilitate less invasive surgery; it will improve imaging; it will enable faster and more accurate diagnosis; it will reduce errors caused by human fatigue; and it will reduce mortality rates.

The immense potential of artificial intelligence may be used to advance the triple aim of health care, which is to improve the health of the population, reduce costs, and enhance the experience of providers. This is especially important considering that it is anticipated that worldwide health care expenditure would approach $10 trillion by the year 2022.

REFERENCES

1. World Health Organization. 2018. Current health expenditure (CHE) as percentage of gross domestic product (GDP) URL: http://apps.who.int/gho/data/node.main.GHEDCHEGDPSHA2011 [accessed 2019-10-31]

2. Committee for a Responsible Federal Budget. American Health Care: Health Spending and the Federal Budget URL: https://www.crfb.org/papers/american-health-care-health-spending-and-federal-budget [accessed 2019-08-25]

3. Commonwealth Fund. Health Care Spending in the United States and Other High-Income Countries URL: https://www. commonwealthfund.org/publications/journal-article/2018/mar/health-care-spending-united-states-and-other-high-income [accessed 2019-08-25]

4. The US Department of Health and Human Services. About the Affordable Care Act URL: https://www.hhs.gov/healthcare/ about-the-aca/index.html [accessed 2019-07-27]

5. Fahy N, Hervey T, Greer S, Jarman H, Stuckler D, Galsworthy M, et al. How will Brexit affect health and health services in the UK? Evaluating three possible scenarios. Lancet 2017 Dec 4;390(10107):2110-2118. [doi:10.1016/S0140-6736(17)31926-8] [Medline: 28965715]

6. Deloitte. China's healthcare provider market: Riding the waves of reform URL: https://www2.deloitte.com/cn/en/pages/ life-sciences-and-healthcare/articles/china-healthcare-provider-market.html [accessed 2019-07-27]

7. Global Burden of Disease Health Financing Collaborator Network. Trends in future health financing and coverage: future health spending and universal health coverage in 188 countries, 2016-40. Lancet 2018 May 5;391(10132):1783-1798 [FREE Full text] [doi: 10.1016/S0140-6736(18)30697-4]

[Medline: 29678341]

8. Horton R. Offline: The new politics of health in India. Lancet 2018 Sep 15;392(10151):902 [FREE Full text] [doi: 10.1016/S0140-6736(18)32211-6] [Medline: 30219330]

9. Rand Corporation. The Crisis of Russian Health Care and Attempts at Reform URL: https://www.rand.org/pubs/ conf_proceedings/CF124/CF124.chap5.html [accessed 2019-07-27]

10. Rubinstein A, Zerbino MC, Cejas C, López A. Making universal health care effective in Argentina: a blueprint for reform. Health Syst Reform 2018;4(3):203-213. [doi: 10.1080/23288604.2018.1477537] [Medline: 30067439]

11. The World Economic Forum. How new tech can propel Africa to the forefront of healthcare URL: https://www.weforum.org/ agenda/2018/01/africa-lead-healthcare-fourth-industrial-revolution/ [accessed 2019-07-27]

12. World Health Organization. Ageing and health URL: https://www.who.int/news-room/fact-sheets/detail/ageing-and-health [accessed 2019-10-14]

13. Densen P. Challenges and opportunities facing medical education. Trans Am Clin Climatol Assoc 2011;122:48-58 [FREE Full text] [Medline: 21686208]

14. Schinkel M, Paranjape K, Nannan Panday RS, Skyttberg N, Nanayakkara P. Clinical applications of artificial intelligence in sepsis: A narrative review. Comput Biol Med 2019 Oct 7;115:103488 [FREE Full text] [doi: 10.1016/j.compbiomed.2019.103488] [Medline: 31634699]

15. Turing AM. Computing Machinery and Intelligence. Mind 1950 Oct;LIX(236):433-460 [FREE Full text] [doi: 10.1093/mind/LIX.236.433]

16. Kreimeyer K, Foster M, Pandey A, Arya N, Halford G, Jones SF, et al. Natural language processing systems for capturing and standardizing unstructured clinical information: A systematic review. J Biomed Inform 2017 Sep;73:14-29 [FREE Full text] [doi: 10.1016/j.jbi.2017.07.012] [Medline: 28729030]

17. Gold B, Morgan N, Ellis D. Speech and Audio Signal Processing. Hoboken, NJ, USA: John Wiley & Sons, Inc; 2011.

18. Shaked NA. Avatars and virtual agents - relationship interfaces for the elderly. Healthc Technol Lett 2017 Jul;4(3):83-87 [FREE Full text] [doi: 10.1049/htl.2017.0009] [Medline: 28706725]