

## HOW MEDICAL EDUCATION WILL EVOLVE IN THE ERA OF ARTIFICIAL INTELLIGENCE?

### QUNDEEL ZAHRA\*

MBBS, FCPS, MHPE, Associate Professor, Department of Ophthalmology, Azra Naheed Medical College, Superior University, Lahore. \*Corresponding Author Email: drqundeelzahra@gmail.com

### REHAN AHMED KHAN

MBBS, FCPS, FRCS, MHPE, PhD, Medical Education, Professor of Surgery, Dean, Riphah Institute of Assessment, Islamic International Medical College, Riphah International University, Rawalpindi, Pakistan. Email. rehan.ahmed@riphah.edu.pk

### FATIMA ASLAM

MBBS, MPhil, MHPE, Assistant Professor, Department of Medical Education, University of Health Sciences, Lahore. Email: drfatimadme@uhs.edu.pk

### RABIA KHURRAM

MBBS, MHPE, Assistant Director, Department of Medical Education, Muhammad Islam Medical & Dental College, Gujranwala. Email: khurramrabia57@gmail.com

### UNAIZA JAWAD

MBBS, MPhil, Associate Professor, Department of Behavioural Sciences Rashid Latif Medical College, Lahore. Email: unaizajawad@hotmail.com

### AMBREEN TAUSEEF

MBBS, M.Phil., PhD, Professor, Department of Physiology, CMH Lahore Medical College & Institute of Dentistry, Lahore. Email: ambreen\_tauseef@cmhlahore.edu.pk

### Abstract

**Introduction:** In the middle of twentieth century, Artificial intelligence (AI) surfaced as an imminent and vigorous technology that seized the attention of people from every walk of life including medical education. The artificial intelligence-based advancements with regards to the healthcare technology and medical education are at an exceptional stride. Taking into consideration these rapid and dynamic changes medical faculty will have to draw its attention in teaching and incorporating this technology in practice on a larger scale. **Methods:** Fifteen faculty members from different medical specialties were selected via purposive convenient sampling method. Semi-structured telephonic interviews were conducted with prior appointments and informed consent. A qualitative thematic analysis was done by transcribing the interviews and then generating codes, subthemes, and themes. **Results:** A total of 389 codes were generated in the first cycle of coding, that were further merged in to 19 codes in the second cycle. These codes led to six final themes. The first two themes were about the concepts and applications of artificial intelligence in different domains of healthcare and medical education. The other themes emphasized on the ethical issues related to the use of AI in healthcare system. Participants believed that artificial intelligence will influence the roles of many health professionals. They put strong emphasis on teaching the basic concepts of artificial intelligence in undergraduate medical curriculum. **Conclusion:** The study highlights the acceptance and current utilization of artificial intelligence in the medical profession. It focuses on the necessity to understand artificial intelligence and its role and, the urgency to implement necessary changes in the medical education, and to prepare the doctors for embracing AI dominated medical practice in healthcare.

**Keywords:** Artificial Intelligence, Machine Learning, Medical Education, Medical Curriculum.

## INTRODUCTION

There are many definitions of Intelligence ranging from dictionary-definition to the experimental operational definitions in the literature. Few of those definitions were proposed by the researchers [1, 2, 3] of which the later Wang seems most appropriately proposed. It states Intelligence as

**“Adaptation with insufficient knowledge and resources.” [3, p 1]**

A proper definition in the scientific world is crucial, as without properly defining a phenomenon, it becomes very difficult to understand [1]. Here we endeavored to define the term “intelligence” in a very concise manner, and we will focus to elaborate it for better understanding. As humans, we anticipate intelligence being synonymous with “human intelligence”. In our point of view and many others, it is a quality or phenomenon independent of the species.

In a concept, being intelligent would translate into, appropriately responding to the novel situation; to be more specific, to react in a situation with limited or no information would surely be different from a reaction with prior knowledge or experience about that particular situation. As to the latter, it would be just a reaction based on the previous information.

The scenarios we encounter every day may be in many ways similar to the ones we encountered yesterday, but they are never identical down to every detail. Due to the impossibility of identifying every detail beforehand, and knowing everything upfront, “intelligence” must rely on creativity and acquiring new knowledge as a primary way to operate in the physical world. Because of the dynamic worldly scenarios, we are always in a state of lacking knowledge [1].

Is it really possible to predict and acquire knowledge about every possible situation we could encounter in the physical world? I would argue No, so to tackle this plethora of situations the ability of “intelligence” helps us to solve problems, learn and create new things, communicate, reason and the process continues.

“Defining AI is mostly synonymous with defining intelligence. Natural intelligence is specialized to solve problems in the physical world or the world we live in; artificial intelligence deals with the problems described by the programmers (us humans). Both instances can be placed somewhere along a realm of generality, as defined by an agent’s capability to handle variety, complexity, and novelty” [1].

When the field of Artificial Intelligence was founded, John McCarthy described it as:

“To find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. For the present purpose the artificial intelligence problem is taken to be that of making a machine behave in ways that would be called intelligent if a human were so behaving” [4].

Keeping in mind the definition of intelligence by Wang and John McCarthy’s description of artificial intelligence do we really think that machines can be intelligent like humans? In

my point of view in the absence of knowledge, making any sort of decision or problem solving till now hasn't been possible by machines.

The main achievements in the last many years have been advances in search algorithms, machine learning algorithms, and integrating statistical analysis into understanding the world at large. However, most of the breakthroughs in AI aren't noticeable to most people. Rather than talking machines used to pilot spaceships to Jupiter, AI is used in subtler ways such as examining purchase histories and influence marketing decisions and making medical diagnosis [5].

The field of medicine, like many other fields, has incorporated AI in many different domains like the use of complex algorithms and software to emulate human cognition in the analysis of complicated medical data. Many brilliant AI based programs are being used in the area of computer vision, where expert machines trained to diagnose melanoma have displayed superior diagnostic accuracy as compared to a team of expert medical practitioners [6].

One of the most successful examples of AI in the field of medicine is the computer program developed by the name MYCIN in 1972. It is a Rule Based Expert System developed as a Stanford Heuristic Programming Project. Physician who wants to use MYCIN replies to the questions asked by MYCIN and the computer program would attempt to diagnose patients based on reported symptoms and medical test results. The program could request further information concerning the patient, as well as suggest additional laboratory tests, to arrive at a probable diagnosis after which it would recommend a course of treatment. If requested, MYCIN would explain the reasoning that led to its diagnosis and recommendation [7].

Like MYCIN there are other AI applications developed for medical purposes like, Present Illness Program (PIP), a system that gathered data and generated hypotheses about disease processes in patients with renal disease; INTERNIST1, a large system to assist with diagnosing complex problems in general internal medicine, and CASNET, an ophthalmology advisor designed to assess disease states and to recommend management for patients with glaucoma [8].

Artificial intelligence-based applications require a certain level of computer literacy and proficiency in order to reap the fruit of this technological advancement [9]. Although majority of the medical professionals are well versed with the day-to-day use of computers and operating systems, less than half of them are unable to effectively use the data sheets and programs like excel which is the core of any intelligent computer system [10].

Without a doubt, Machine Learning (ML) and Artificial Intelligence (AI) are the two advanced technologies ruling the current era [6] and have the power to transform the way medicine is going to be practiced and humans interact with each other to perform complex tasks.

Even though there is increasing interest from concerned bodies regarding the role of artificial intelligence and machine learning in medical education, gaps exist. A study in

NPJ Digital Medicine in September 2018 observing the number of publications in PubMed with terms such as “machine learning” and “medical education” found that although the number of machine learning publications has increased many folds since 2010, a combined search for “machine learning” and “medical education” only brought up sixteen results. Upon further investigation, none of those sixteen publications were focused on education around machine learning for medical professionals [11].

The purpose of this study was to answer the question.

***“How medical education will evolve in the era of artificial intelligence?”*** by identifying the level of awareness regarding the basic concepts of AI and its application in the medical fraternity and the opinions regarding teaching basic skills required for understanding AI in medical curriculum.

## **MATERIALS AND METHODS**

A Qualitative exploratory approach was chosen and carried out over a time span of three months. Ethical approval was obtained. A purposive convenience sampling was done. Fifteen senior medical faculty members were selected who were actively involved in teaching of the undergraduate medical students and training of the postgraduate trainees in Pakistan and United Arab Emirates. An interview guide was developed and emailed to participants which briefly described the nature and course of study along with its objective and how the confidentiality of the participants will be maintained. It also included the interview questionnaire which was validated by five medical educationists and then it was piloted on four medical teaching faculty members. All the participants were thoroughly guided about the procedure of data collection, audio recording of the telephonic interviews [12]. The anonymity of the participants was maintained by giving codes to participants in the form of Alphabets from A to O.

Each interview was audio recorded which lasted for an average of 25 to 30 minutes and transcribed verbatim. The patterns within the data were identified by using the thematic analysis technique. The first three authors thoroughly and repeatedly studied the data to familiarize themselves with each segment to generate the codes. From these codes, sub themes were recognized which were later consolidated into the final themes. These themes were identified by comparing the transcribed data of each respondent individually by all three authors which was later on discussed and mutually agreed upon to establish analytical triangulation and quality check of our study by using COREQ-32 checklist [13].

## RESULTS

Fifteen medical professionals and educationists participated in this study, out of whom, five were females and ten were males. Six themes were identified from data analysis of the qualitative interview. (Table1)

Most of the participants described their concepts regarding AI as a data science or like an advanced data calculator. Amongst them were some who were not aware of practical applications of AI being implemented in the field of medicine.

**Table 1: Themes with Representative Quotations**

Themes	Representative Quotes
Concepts and information about AI	<p>“We put in a lot of data of patients and there diagnosis, signs and symptoms and; what computer is doing, it is calculating on a larger scale. My personal concept of AI that thing we use or call AI or what people call it AI is not actually AI, it is just calculations on a larger scale and answers what you want out of it, but still its data input” <b>(Participant F)</b></p> <p>“No idea about where exactly in medical education and in teaching, AI is used.” <b>(Participant O)</b></p>
Applications of AI in different domains of Healthcare and medical education	<p>“Experience with real patients is considered more fruitful and pro learning compared to simulations. But virtual reality simulation program can actually challenge this concept”.</p> <p><b>(Participant C)</b></p> <p>“Currently using AI or Teaching intelligence in under graduation and post-graduation is really very limited”</p> <p><b>(Participant M, I)</b></p>
AI is not being used in Pakistan	<p>“We talk about Pakistan where no medical college is working on AI, not even Agha Khan” <b>(participant D)</b></p>
Problems with use of AI in Medial field	<p>“Privacy of data. If we have a lot of data, we have to maintain the privacy of the data as well, so these are the challenges liability, privacy and control over data and black box phenomena the real challenges of using artificial intelligence in healthcare system” <b>(Participant H)</b></p>
Acknowledging the change and forward thinking	<p>“We have to use it, adapt it. We as educators need to develop things on AI and it’s our responsibility to teach the students and guide the people how to develop it.” <b>(Participant N)</b></p> <p>“We would have to introduce certain courses or modules related to computer literacy and basics of artificial intelligence and how to manage big data as these are all going to come in soon” <b>(Participant G)</b></p>
Impact of AI on the roles of the professionals	<p>“After 100 years we may not need a doctor for the diagnosis of diseases as AI would be doing that along with treatment and management of patients.”</p> <p><b>(Participant E)</b></p>

Participants who were exclusively from Pakistan also pointed out that AI based technologies are not currently being used in the healthcare sector or the medical education sector in Pakistan. The majority of the participants acknowledged that AI should be incorporated in the healthcare system. Medical curriculum should be revised with incorporation of basic concepts of artificial intelligence based-medical education and computer education along with it. Workshops and seminars, CME on AI to be conducted as a part of regular faculty development programs. Some of the participants showed

concerns about data privacy and the black box phenomenon regarding the applications of AI in medicine. Many participants were of the view that healthcare professionals will be replaced by AI based computer programs for the diagnosis of complex diseases in the future.

## DISCUSSION

It is highly desirable for any scientific application and its day-to-day utilization to be perfectly understandable in terms of definition and concepts [3]. While interviewing the participants who were professionals from different specialties of healthcare system, a significantly relevant theme was identified with regards to the “concept” of artificial intelligence, despite that it was not the intended question of this study. We pondered as researchers that it highly relevant and important to discuss in detail what the participants contemplate and have knowledge about the term “Artificial Intelligence” and its application in the healthcare sector.

The majority of the participants perceived the concept of artificial intelligence as “data organizer and interpreter”. They were of the opinion that AI-based applications technologies will help them understand and organize the large number of patient and student data in healthcare delivery and medical education respectively.

There is an extensive debate going on about the working definition of artificial intelligence amongst the scientists who are currently working in this field. Those who originally coined the term “artificial intelligent” at Dartmouth meeting agreed upon some distinguishing and unique feature which is the backbone of all the progress that has been made in this field, as quoted by [3], AI is concerned with methods of achieving goals in situations in which the information available has a certain complex character. The methods that have to be used are related to the problem presented by the situation and are similar whether the problem solver is human, a Martian, or a computer program [4].

The understanding of application of AI by our participants is quite different from the pioneers of the term. They consider it similar to what is known as “data science” [14] and we believe that one of the reasons is lack of understanding and interest in computers, as doctors are known to hate their computers actively, viscerally, and volubly [15], but the reality and matter of fact is that almost every technological advancement that we are witnessing revolve around computers.

Literature is also showing a considerable promise by artificial intelligence-based applications in diagnosis of diseases. One of the meta-analysis that comparing the disease diagnostic capability of AI against the healthcare professionals from the published studies from 2012 to 2019, found AI based applications to be at par with the health professionals [16].

Artificial intelligence is also showing very promising outcomes in the health sector of resource scarce countries. Underdeveloped countries are fighting against the high prevalence of many diseases along with the shortage of trained healthcare providers and



facilities. According to research studies AI is showing positive results in timely detection of the diseases and improving the care of the patient along with the significant reduction of overall expenditures as well [17].

Artificial intelligence-based applications are already transforming lives by simplifying the time taking, laborious and intelligent tasks in many fields of life like accounting, marketing, and industries. Similarly healthcare delivery system is also being benefited by the technological advancements artificial intelligence is offering like disease diagnosis, long term prognosis, prevalence models and many more. One of the major branches of healthcare delivery system is diagnostics and medical imaging in which AI is playing a major role and has shown a huge impact on disease diagnosis through AI-based imaging technology.

In reviewing the answers given under the theme being discussed it is evident that almost every participant was well informed about the applications of AI in health care system, be it in clinical practice or medical education and they also acknowledge the impact AI is making on the health care development.

Discussing the challenges and concerns with regards to the ethical use of AI, study participants showed considerable apprehension on the privacy of the patient's and student's data. AI based technology relies on being trained and fed by a wide range of data which makes the concern very pertinent as where the data is being stored, who has access to the data and how the data will be managed. As one of our study participants voiced opinion on giving consent for the use of their data. The concern was that data can only be shared if you give consent, so a lot of times how that consent would be, that it's going to be long bended terms and conditions which nobody would see and just agree to the terms and conditions.

Many studies in the developed countries have highlighted this adversarial effect on the AI related systems, as it is still a developing field. Ethical use of data and its privacy, a concern voiced by doctors and patients is the major reason of disquietude and limitation for the global use of AI based applications [18]. A study conducted in United States by Statistical Analysis System in which patients were asked about the concerns if they have over their data security, 35% of the respondents expressed their concern [6].

Research conducted at one of the hospitals in New York USA, where AI based application was trained from the data of approximately 700,000 patients for diagnosis of schizophrenia, which is a very difficult to diagnose disease even by the experienced physicians. The application was successfully able to predict the onset of disease with high accuracy. The main reservations by the doctors were the how the machine has predicted the disease which is known as the black box phenomenon, and this makes physicians and patients very skeptical about the technology [19,20].

Another crucial and most discussed argument in relation to practically implementing the AI-based technology is the human touch phenomenon and the question who is responsible in advent of any mismanagement or wrong diagnosis [19]. A particularly

important issue discussed was the mandatory change in rigid policies and systems of education. The regulatory body like Pakistan Medical and Dental Council does not allow professionals other than doctors to be medical educationists. The regulatory body needs to be more proactive and flexible in assisting and making new guidelines to develop and incorporate ever emerging advancements, as healthcare system is a multi-professional dynamic system.

A similar suggestion was put forward in the annual meeting of the American Medical Association (AMA) in 2018, they discussed the possibilities of incorporating AI in medical education. Duke institute for Health Innovation suggested that Medical students should work together with data experts to develop care-enhanced technologies made for physicians [19].

An encouraging theme emerged from our study was the acknowledgment of the changes artificial intelligence could bring to the healthcare system and medical education. Along with this, many thoughts and suggestions were also put forth for how to proceed in embracing these changes in future.

Healthcare system is a multi-dimensional system in which experts and professionals from diverse backgrounds work together. To incorporate AI in healthcare we need IT professionals and computer engineers' assistance. In future we need a generation of doctors who will work side by side with computer engineers and vice versa. Canadian Association of Radiologists rooted an Artificial Intelligence based working group for the inculcation of AI in imaging techniques which highly impacts their role in patient care. They emphasize the use of AI in radiological imaging and this dynamic team consists of a broad range of subspecialties ranging from radiology to imaging informatics, engineers, biophysics, and researchers [21].

## **LIMITATIONS**

This study was limited to only medical professionals, however participation of other stake holders like IT professionals, software developers and engineers, researchers would have added to the educational value of this study.

## **CONCLUSION**

This study was conducted amongst the medical professionals to explore the readiness of the medical faculty for the AI based healthcare system both in conceptual and practical domains. The participants of the study described their knowledge and shared their information regarding the use and application of AI based technologies in our health system and also some basic concepts, advantages and challenges associated with the developing AI influence.

There was lack of conceptual knowledge with reference to AI and its applications, which could be due to the fact that the healthcare providers are more focused towards their own disciplines while ignoring the computer-based technologies. The lack of healthcare



professionals' involvement in the development of the AI based applications is generating concerns about breach in data confidentiality.

Health professionals showed some unease regarding their jobs and role replacements. In few instances, the technological advancements are perceived as a threat and their overall dominance in practical fields, which creates an obligation for training doctors through certain mandatory faculty development programs and inculcation of basic concepts of AI in curriculum. This study may be considered as a pilot study to introduce some basic AI concepts and their practical applications in the undergraduate medical curriculum.

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#### DISCLOSURE STATEMENT

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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