Competencies of Health Workforce in the age of Artificial Intelligence: A Conceptual Framework

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Abstract

Purpose – This paper follows two objectives. The paper aims to demonstrate a synoptic view of the historical evolution of competence, competencies, and competency. The second objective is to highlight the mismatch between the health workforce (HWF) competencies and the Artificial Intelligence (AI) technologies. Under this objective, there are two sub-objectives, which are: How AI technologies are likely to modify the practices and competencies of HWF? and what would be the new competencies that HWF need to cover this mismatch?

Design/methodology/approach– To answer our research questions, this paper reviews the selected literature spanning from 1959 to date using keywords: competency, competencies, and competences, Artificial Intelligence in healthcare, AI and health professionals and others. A total of 100 articles were selected in the first wave and then we made a detailed assessment until we reached a small group of articles reflected the object. Afterward, we checked several HWF competencies frameworks, and the selected frameworks were based on their clarity and level of similarity between each other facilitating comparison objective. These frameworks are European Region, the UK, New-Zealand, and ASPHER.

Findings – Our results are illustrated by a conceptual framework stating the competencies that HWF will need more and more in the future to keep pace with AI technologies.

Expected practical implications – Expected results may enable higher medical education and health institutions to prioritize their training efforts to grant a successful AI implementation.

Originality/value – The originality of this article lies in the proposed conceptual framework and on the insightful literature review.

Keywords: Artificial Intelligence; Competencies; Health Workforce; and Healthcare.

Introduction

Investing in Health Workforce (HWF) competencies is as crucial now as it has ever been. It is noticeable that society's high expectations from HWF will inevitably lead to modify its competencies. In the meantime, the intervention of Artificial Intelligence (AI) in the HWF practices has put more burden on them. Therefore, nowadays, HWF is working within an unstable and changeable environment. While addressing topics like competencies of human resources, the Resource-Based Theory (RBT) plays a major role in guiding our thoughts. This theory states that the possession of strategic resources reflects how an organization can differentiate its performance and create a competitive advantage (Barney, 1991). RBT claims that only valuable, rare, and inimitable competencies can generate competitive advantage (Kozlenkova et al., 2014). In that regard, AI-relevant competencies could be considered among these competitive competencies in any health institution. On the other side, there are several classifications of resources; however, we limited the scope of the study to Grant's (2005) classification standards. Grant categorizes these resources into tangible, human, and intangible. Subsequently, this paper focuses merely on human resources.

It is a forgone conclusion that AI technologies will lead to an inevitable and fundamental shift in how healthcare is delivered. In essence, AI impact reached the clinical trials (Calaprice-Whitty et al., 2020, pp. 70–74), physicians, patients (Meskó et al., 2018, p. 3), quality of care (Diebolt et al., 2019, p. 157), primary care, and therefore a strong impact on HWF (Lin et al., 2019, p. 1626). However, the lesson lies in the implementation and adoption process. In other words, the key point is to prepare a competent HWF that can safely handle and work withthese technologies is the main point. In consequence, there is a need to re-direct the training efforts of medical higher education.

Starting from these concerns and looking forward to updating the HWF competencies in the age of AI, this paper is structured in the following way: synchronize the information about competence, competency, and competencies in a readable way. Afterward, clarifying the real meaning of AI and its practices in clinical delivery and implications on HWF. Then, scrutinizing the international sets of HWF competencies made by several countries and organizations. Lastly, a conceptual framework is deduced to clarify the new HWF competencies based on the AI intervention.

Human resource development and competence

In management literature, human resources in general and employee competencies, in particular, are envisaged as the most crucial asset for the success of any organization despite its type. In a real sense, the competencies of human resources for health and especially the competencies of health professionals are a treasure as well as the decisive element to ensure sustainable development and effective health services delivery. In light of the continuous changes whether they are technological or related to patient expectations and demands, health institutions need competent health professionals to cope with globalization effects and technological progress. In a nutshell, if the competence approach was appropriately designed and executed covering the main statically the new knowledge, skills, and attitude needed in performing tasks, this will guarantee meeting the new expectations towards building sustainable competitive advantage and accomplishing goals. Therefore, organizations in general, and health organizations in particular need to become familiar with the concept of competence in order to convert it to the practice level especially with the introduction of Artificial Intelligence technology.

Research Methodology

The objective of this study is achieved by revising several academic databases like Sage, Science Direct, Emerald, PubMed, and MEDLINE. The search was divided into two parts. The first part was particularly focused on articles that included "competence", "competency", "competencies", "competency management" as keywords. The second part was particularly focused on "health professional's competencies", "health workforce competencies", "health human resources competencies", "artificial intelligence in healthcare" as keywords. Regarding the first part, in the first phase, about 100 articles were chosen based on the keywords criteria. Then, the abstract of included articles was checked and they met the following criteria: if the paper develops the concept, or challenges the existing conversation, contributes to the historical evolution of competence movement, if the paper addresses whether competence, competency, competencies are synonymous or not? if the paper examines the exact meaning of competence, and if the paper adds any new dimension. Table 1 shows the main selected literature.

Regarding the second part, several papers about AI are chosen to delineate the main links between new AI techniques and health professionals. In addition, four competency frameworks are selected for health professionals or the workforce, which were studied and selected by WHO reports with other frameworks to highlight how the term AI is overlooked in these frameworks. However, the selected frameworks in this paper selected based on their clarity and level of similarity between each other, facilitating the objective of the comparison. These frameworks are prepared and stated by several countries and organizations such as the UK, WHO of the European region, New Zealand, and ASPHER (The Association of Schools of Public Health in the European Region).

Table 1: Contributions to "Competence", "Artificial Intelligence in healthcare", and Health Professional Framework

Author/Year	Contribution
Competence	
White (1959)	Introduced the term "Competence"
McClelland (1976)	Pioneer of modern competence movement
Boyatzis (1982)	Extend the concept from psychology to management
Hoffmann (1999)	Distinguish between Input and Output approaches.
Burgoyne (1993)	The competence movement
Brown (1993)	Mysteries of competence
Salman (2020)	Unifying the meaning of competence synonyms
Moore (2002)	Distinguish between competence synonyms
Mulder (2001)	Distinguish between competence synonyms
Nordhaug & Gronhaug (1994)	Concept of competence alliance
Jubb and Robotham (1997)	Challenging competencies myths
Parry (1996)	Developing the concept competency
Strebler (1997)	Developing the term competencies
Woordruff (1991)	Distinguishing between competence synonyms
Health Workforce & AI	
Freidson (1970)	The development of health workforce status
WHO (2006)	Understanding who are health workforce
Public Health England (2019)	Kinds of health workforce
Micholas (2014)	International Standard Classification of Occupations
National Academy of Medicine (2020)	Describing AI interventions with healthcare systems
Reddy (2020)	AI applications within healthcare systems
Wannenmacher (2019)	Surgical Robot
Davinport & Kalakota (2019)	The potential of AI in healthcare
Reddy, Fox & Purohit (2018)	AI-enabled healthcare delivery
Paranjape et al., (2019)	Introducing AI training in medical education
Competency Frameworks	
World Health Organization, Regional office for Europe (2020).	
The Association of Schools of Public Health in the European Region 5th edition (ASPHER),(2018).	
Public health England (2016).	
Public Health Association of New Zealand (2006).	

1. COMPETENCE, COMPETENCY & COMPETENCIES

During the last decades, three buzzwords have gained significant attention in most fields, which are competence, competency, and competencies. The point of departure dates back to 1959 when the psychologist Robert White used the term "Competence" in his article entitled "Motivation Reconsidered" (White, 1959, p. 297). Afterward, the psychologist McClelland in 1976 has advanced the concept of "Competence" by claiming that the behavioral traits are much important than the tested conventional knowledge in examining the job performance (Salman et al., 2020, p. 4). Since that date, the concept has been further embraced in several disciplines,

such as health care, banking, and education. In consequence, Boyatzis (1982, p. 165), has introduced the concept to the management field by establishing a model of a competent manager, and then the concept of "Competence" has expanded from psychology to all fields. More importantly, this journey stretches until 21-century passing by several diverse researchers about the subject.

Accordingly, the term competence is not owned by any specific group or field and this has led to diverse definitions and meaning upon who is using the term. For instance, psychologists' scientists have used it as a measure of ability to see if the observable performance mirrors employees' traits and capacities (Sternberg & Kolligian, 1990, pp. 51–52). In contrast, human resource managers have seen the concept as a way to implement strategic direction in recruitment, training, and assessment (Burgoyne, 1993, p. 9). Last but not least, in education, the concept was used to relate learned knowledge with skills (Hoffmann, 1999, p. 276). As a result, confusion in any path to deconstruct the concept is to be expected.

Rhetorically, confusion arises from the expression itself, namely, some countries and organizations used competence, competency, or competencies interchangeably (Brown, 1993; Salman et al., 2020). However, several researchers have proved the contrary (Hoffmann, 1999; Moore et al., 2002; Mulder, 2001). To this end, confusion is surrounding these terms from all sides. The novelty of this paper is to synchronize the information in a readable way. Based on that, it will be fruitful to clarify the competencies of HWF in the age of AI.

In a nutshell, there is no consensus on what is a good and right definition. Therefore, it is beneficial to display how the literature differentiates between these concepts looking for a primary consensus and more clarity.

In a real sense, both competence and competency are defined from two perspectives based on two schools of thought. Concerning competence, some researchers have mainly linked the term to performance and job. Armstrong (1998) defined it as what people need to perform well the job. In consequence, several researchers have claimed that competence is behavioral characteristic that led to expected standards and performance in the job (Baker et al., 2000; Collins et al., 2000; Frank, 1991; Holton & Lynham, 2000; Mansfield, 1989; Wilson et al., 2020). The former school was used in the UK, and succinctly, this school has focused on performance to determine if the employee is competent- have competences- or not. Therefore, if employees did what they should do, then they are competent without focusing on the attributes that they hold. In contrast, the USA school has linked the term "competence" to the underlying characteristics that lead to superior performance, namely, far from jobs' standards and performance, the employees are competent based on their skills, knowledge, and attitudes (McClelland, 1973; White, 1959). Then if the employees hold the requested skills, knowledge, and attitudes they are deemed competent or having competences without outlining the required standards.

Despite that each school has its arguments, it can be seen that there is room to unify the concept. First, we should agree that nothing happens by luck and coincidence, then if the staff achieve the required standards and performance, they have the required skills and knowledge. In contrast, if the focus is on the skills, knowledge, and attitudes; the organization has to determine who are the most competent performers and what underlying attributes do they have that make them better than others? This identification will also need performance standards to answer the mentioned question. As a result, and following the definition of Nordhuag and Gronhaug (1994, p. 94), competence involves actual competence (one that is mandatory to perform a particular task) and formal competence (required knowledge, skills, and attitudes). Then, competence has the same meaning disregarding from which position it is defined.

Correspondingly, the term "competency" and competencies have been studied from several perspectives without a universal definition (Jubb & Robotham, 1997, p. 171). The first group is the proponents of competency or competencies as person-oriented (McClelland, 1973). That is, the underlying characteristics that lead to superior performance (Boyatzis, 1982), namely the behavior that must exist while performing the task. In other words, competency is a cluster of knowledge, skills, and attitudes (Parry, 1996). Thereby, the advocators of this perspective have seen by competency the behavior of the employee rather than the performance.

The opponents of this perspective have seen by competency or competencies the standards and actual performance that should be performed. Strebler et al. (1997) state that competency is the individual demonstration performance or the minimum standards. Parry (1996) also claims that competency is performance and standard-oriented. This perspective has linked the term competency to the standards and performance rather than skills and knowledge. Following the definition of Parry (1996), which defined competency as the related knowledge, skills, and attitudes correlate with standards and job performance, the term competency includes both perspectives without separating them.

As a result, competency, competencies, and competence are pivoting on the same orbit which are the job performance and employees' attributes. This result was also stated by Hoffmann (1999), in which competence and competency- and competencies have the same dimensions. Accordingly, this paper adopts the model of Parry (Parry, 1996), which states that competencies are a cluster of related knowledge, attitudes, and skills that correlate with performance on the job, that can be measured against well-accepted standards; and that can be improved via training and development.

Last but not least, it is crucial to mention that the father of the term "competence" Robert White (1959) has initially used the term competence and later has adopted the term "competency" without any change in the meaning (Chouhan, 2015). Besides, McClelland has used in its known paper "Testing for competence rather than intelligence", competencies, competence and competency without changing the meaning or the consequences when using each expression. Therefore, competency, competencies and competency are likely to be used interchangeably (Brown, 1993).

2. HEALTH WORKFORCE AND ARTIFICIAL INTELLIGENCE

Consider the fact that AI is impacting public relations sectors (Galloway & Swiatek, 2018, p. 737), jobs (Morikawa, 2017, p. 10), finance (Wall, 2018, p. 62), workplace (Agrawal et al., 2019, p. 38), employment relations (Duggan et al., 2019, p. 3). Besides, AI invades the healthcare sector, such as management of the patient and clinical trial (Calaprice-Whitty et al., 2020, pp. 70–74), healthcare, physicians, and patients (Meskó et al., 2018, p. 3), quality of care (Diebolt et al., 2019, p. 157), primary care (Lin et al., 2019, p. 1626) and therefore Human Resources of health. As a result, the health sector including all its aspects and arms has been affected by the introduction of Artificial intelligence. In essence, after achieving a potential consensus about the usage of the terms above, we will dive into the human resources of health competences taking into account the AI intervention as a requisite to develop and embed the

main competences that HRH should have. In this regard, it is constructive to show how the literature posits the competencies of HRH against how AI nowadays intervenes in surgical and all healthcare operations.

2.1 Health Workforce (HWF) and Human resources for health (HRH)

Freidson (1970, pp. 12–13) emphasized that in the twentieth century after the prevailing of scientific medical foundations, some healers' status had changed from occupational to professional. The occupation of healing and treating were recognized as folk medicine. In contrast, recently specific skills and knowledge became prerequisites to practice medical work, which is so-called medical profession. Accordingly, several medical taxonomies and titles gradually emerged. Health Workforce is considered as the front-line soldiers in health care institutions for the aim of ensuring services directed to patients, such as doctors, nurses, physicians, and others. This definition is consistent with the World Health Organization (WHO) general definition of human resources for health and the health workforce (WHO, 2006, p. 1). This definition has clarified the components of human resources for health, which are, health workforce, ministry of health professionals, health researchers, instructors, and educators in health training institutes. In contrast, the health workforce set is mainly composed of doctors, physicians and their assistants, nurses and their assistants, pharmacists, and others. As a result, it is arguable that human resources for health embodied all the health workers, such as administrative, medical, and academic. Besides, the health workforce is more niche and specific to the medical staff. Therefore, the competencies of the Health Workforce, especially the health service providers or health professionals are addressed to scrutinize their competencies in the age of AI (Michalos, 2014).

Subsequently, WHO (2020, p. 1) has distinguished between core health workforce and wider health workforce. The first one represents those that health activities constitute the major part of their work, and they are obliged to be up-to-date with all the core competencies. In contrast, the second one represents those who are contributing to the health activities and population health but without being fully committed as part of the health workforce. Nowadays, these workforces may be the journalists advocating for the COVID-19 vaccine, or who are in charge of cleaning the metro and ensuring people have their masks. Though a wider health workforce is crucial in promoting health to the population (PHE, 2019, p. 4), the main target audience of this paper is the core health workforce.

2.1.1 Competencies of HWF

Recently, most trials were made to match the HWF competencies with population needs, such as shortage of HWF, enhance patient satisfaction, robust productivity, aging and burnout of doctors, the increase demand on chronic and anesthesia care, patient's high expectations, and overall to improve the quality of care. Linking and matching these competencies would require more than guarantying that HWF has the theoretical knowledge and skills. It requires ensuring that HWF is able to perform them into practice (Frenk et al., 2010; Hastings et al., 2014; Merkur et al., 2008). This evolution has led to alter the focus from valuing the knowledge and formal education to valuing what HWF can do for the patient (Gruppen et al., 2012, p. 1; Hume, 2005).

Given the diversity of competencies' definitions, it is not strange to deduce that in the health sector there is no unified definition of HWF competencies. Commonly, in the health sector, competencies are defined as the standards that HWF performs in providing health services. Consequently, HWF competencies are undoubtedly linked to the improvement of care quality.

Afterward, presenting several definitions of HWF competencies will enhance our knowledge of its aspects and features. Starting by the definition of WHO (2006, p. 3), competencies of HWF are recognized as the ability to perform the task efficiently. In other words, it is a set of information (knowledge), skills (knowing how to do), attitudes (knowing how to do), and experience to reach a certain level of capacity. Then, it indicates that HWF is able to do well-measured task by a certain standard. Besides, Epstein (2002, p. 226) states that HWF competencies are embodied by the habitual and prudent use of knowledge, technical skills, clinical reasoning, emotions, values, communication, and also by being reflective in daily practices for the sake of benefiting the targeted patients. Subsequently, adopting the definition of Langins & Borgermans (2016, p. 3) would be looking more precise, where HWF competencies is defined as "*the essential complex knowledge-based acts that combine and mobilize knowledge, skills, and attitudes with the existing and available resources to ensure safety and quality outcomes of patients and populations*".

Reference to the last framework for the health workforce in the European region (WHO, 2020), the framework is composed of three categories, which are content and context, relations and interactions, performance, and achievement. Succinctly, the first category advocates health workforce to know the epidemiology that stands behind the communicable and non-communicable diseases in their community. Therefore, for achieving this goal, health professionals are requested to perform qualitative and qualitative analysis (statistics and analyses data), promote health (health literacy, citizen empowerment, social programs, and others), apply the international laws, policies, and ethics (European public health law) and lastly health security (food safety and occupational health) and others. In the second category, it mainly advocates for enforcing leadership, teamwork, communication emotional intelligence, and partnerships (across boundaries), and others. Most importantly, in the last category, which is concerned by the human resources management, it advocates putting clear tasks and job descriptions, knowledge of basic business practices (planning and term of reference), enforcing the usage of financial and accounting principles, and others. What is remarkable, is that they did not use the terms of Artificial Intelligence, robotics, and machines in all categories, especially in performance and achievement. However, they used the terms digital technology, statistics, and data analysis but this may not be sufficient.

According to the England health workforce competencies, the framework is also composed of three categories, which are technical, contextual, and delivery. Succinctly, the technical category mainly relies on having the ability to identify the needed data, analyzing data, appraise and recognized the risk from using this data, using data to inform their decision making. In addition, focusing on research to scrutinize, critique published and unpublished research and others. Lastly, applying audit services, economic analysis, assess the new technologies and others to enhance the health services and promoting health (empowering communities, social programs, and others). In the second category, which is entitled "Context", it argues to implement, appraise, or modify the relevant international law, policies and ethics. Furthermore, it advocates making more collaborative efforts across boundaries and countries. The last function is to create cooperation with the political systems that may affect the health services delivery, such as public service policy and parliamentary activities. Lastly, the delivery category advocates to enforce the principles like leadership, integrity, communication (enforce dialogue, social marketing), consistency, and effectively manage the key resources, which are money and people (Public health England, 2016).

To some extent, there are several similarities between the EU and the UK framework even if the competencies are not distributed in the same categories. However, in the UK framework, they focus more on the areas related to aggregate and analyze data to perform informed

decisions. Though, they did not expressly state any terms relevant to Artificial Intelligence, robots, machines or, new technologies.

The European Programme on Public Health Core competencies for public health Professionals was launched in 2006 by the Association of Schools of Public Health in European Region (ASPHER). Succinctly, before stating the core competencies, this journey has undergone several trials, which were lastly embodied in the 5th draft published in 2018. The bold titles of this list are divided into 6 categories. These categories are: methods in public health such as qualitative and quantitative, knowing the social, political, economic, biological, environmental, and physical determinants that may affect the population health, knowing and applying the health policies, organizational theories, leadership, and management. Lastly, promoting health, health protection, disease prevention, and ethics (Foldspang et al., 2018). What is remarkable in the list is that it advocates for using several statistical terms that were not mentioned before such as student's t-test, Chi-square test, linear, binomial, logistics, passion regressions, general IT functioning, and others. This implies that HWF requires more and more advanced technical skills that usually exist under the IT functions. However, there is no explicit statement that advocates integrating the health workforce into the sciences of AI, digital technologies, machine learning, and robotics.

Last but not least, we will present the New-Zealand framework of competencies. This framework consists of 13 categories; however, we will focus on the relevant category which is professional development and self-management. It is composed of the following, knowledge on health systems (all the health services and practices) and the relevant policies and regulations, research and evaluation, knowing the society culture, communication, leadership and teamwork, planning, and lastly professional development (Public Health Association of New Zealand, 2006). In the latter category, they advocate to have basic knowledge of accounting, budgeting, and IT tools, without any citations relevant to the terms of Artificial intelligence, robots or machine learning, or new technologies.

It could be arguable that most competencies frameworks for the health workforce are almost similar with a slight difference based on the context in which they are implemented. Of note, to date, the domain of AI is not seriously taken by the health workforce policymakers. In other words, we have seen that most frameworks argue for having a basic knowledge of several business and management terms, such as budgeting, IT functions, and others without addressing the AI domain in the same way.

2.2 Artificial Intelligence

2.2.1 General Understanding of AI

To date, AI scientists and experts have no exact definition of AI, in which the field is constantly redefined. AI is a computer science that aims to perform tasks replicating human or animal intelligence and behavior. In other words, it is a term used to describe machines that can emulate the human cognitive process, such as reasoning, and understanding. Lastly, Artificial Intelligence could be defined through two terminologies: "Autonomy" and "Adaptivity" (Smithers, 1997; Zhang & Lu, 2021). The former means the capability to perform tasks in an unstructured environment without constant guidance by a user. The latter is the capability to enhance performance by learning from experience. It is arguable, that nowadays AI is a "hot topic", in which the public discussion about AI is almost impossible to be avoided. Thus, everyone is talking about AI, in that context, the main question is, does everyone know

what AI exactly is? What it means? In other words, the term AI has been used to refer to things that have previously been called by other names.

For the sake of clarity, we will pose several examples that they have been used in training sessions to show the difference between AI and not AI. The spreadsheet that calculates several functions is not AI because the result is determined by the user-specified formula (No adaptivity and Autonomy). The GPS navigation that only provides the location is not AI while determining the shortest and fastest routes taking into account traffic variables is of course AI (Automatically and Adaptivity). The application that proposes a song based on the user behavior is of course AI.

On the other hand, nowadays the discourse about AI and robotics is unlimited. The main point that should be also insightful about is not all robots are artificially intelligent. Moreover, most of the available robots are not artificially intelligent. In essence, when the robot has limited function, such as encapsulating a box within a specified environment and context, this is not AI, because, for any slight change or modification in the process, the robot will not operate accordingly. In contrast, there are several robots with AI, such as Tevel robot, which is responsible to only pick the ripest fruit and then packaging them by using several algorithms. In healthcare, the "DaVinci" robot is the most popular one, which consists of several sensors, layers, and cameras. This robot is used in surgery taking into consideration all the relevant factors and variables, and if it sensed anything abnormal directly the robot will stop working.

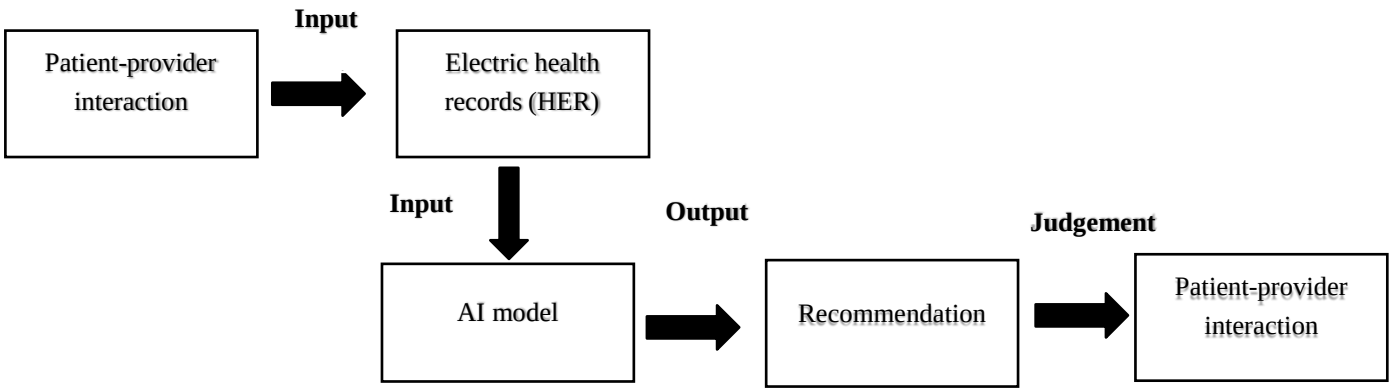
Based on that, it is arguable that AI exists in robots, computers, and mobiles with a limited ability to work in an unstable environment by analyzing the available data, interpreting it, and then making a decision.

2.2.2 Applications of AI tools in Healthcare

Of note, that AI invaded all healthcare sectors, its implications have reached the administrative, financial, operational, and clinician delivery aspects. However, based on our scope, which is the health workforce, we will shed the light predominantly on the clinician delivery side. The main categories where AI has shown promise within the clinical environment are: predicting health trajectories, recommending treatments, guiding surgical care, monitoring patients, and supporting population health management (National Academy of Medicine, 2020, p. 7).

- Predicting health trajectories and recommending treatment

Generally, the normal workflow that the health workforce is likely to perform with the introduction of AI is as follow:



National Academy of Medicine (2020), sample workflow for AI-based clinical decision support system.

As indicated, the interaction between AI tools and the health workforce will be daily and continuous. Diagnosis and treatment have been a focus of AI since at least the 1970s. In essence, machine learning (ML) models support clinical decision support systems to assume the probability that a patient's situation will deteriorate. ML contributes mainly to –precision medicine- which is what treatment protocols might have the greatest success on a patient based on various patient attributes (Davenport & kalakota, 2019). For instance, ML techniques can help oncologists by classifying the tumors as if they are benign or malignant (Bi et al., 2019). Also, AI models have shown promising results by specifying the time of giving and weaning the ventilator treatments (Ting Kwong et al., 2019, p.)

During the normal workflow, several Natural Language Processing (NLP) techniques might be used. These techniques include speech recognition, text analysis, translation others. These applications involve the creation, understanding, and classification of structured and or unstructured clinical notes. Due to NLP, professionals will inclusively have more time to communicate with patients. Therefore, more attention is required during the encounter like keep eye contact as much as possible, be humanistic and empathetic.

- Guiding surgical care

In the surgical field, AI may implicate in guiding the surgical field through planning the pre- and post-operative care, and by assistant surgical robots with AI, such as "Da Vinci". The first part is represented by predicting the risk of complications after surgery, such as infection, and identifying the areas, in which they can take a biopsy (National Academy of Medicine, 2020, p. 13).

Besides, it is worth mentioning that "Laparoscopy" is one of the main surgical fields that use an assisted surgical robot. This is a "minimally invasive" surgery that is performed by inserting a small tube into the patient's body at several locations close to the target organs. However, there are several drawbacks to its usage. The surgeon will no longer see the surgical field; he can only see the screen that offers (2D) image, unstable video camera, poor ergonomic for the surgeon, limited motion, and impedes surgeon's depth perception. In contrast, the introduction of robot-assisted surgery solves these issues. In-depth, the surgeon will be sitting behind a 3D screen somehow apart from the patient where other team members will be around him, ergonomically for the surgeon (reduce stress, fatigue), intuitive gestures, and others. This robot consists of 3 parts: the console, screen, and machines with arms (Wannenmacher, 2019, p. 320).

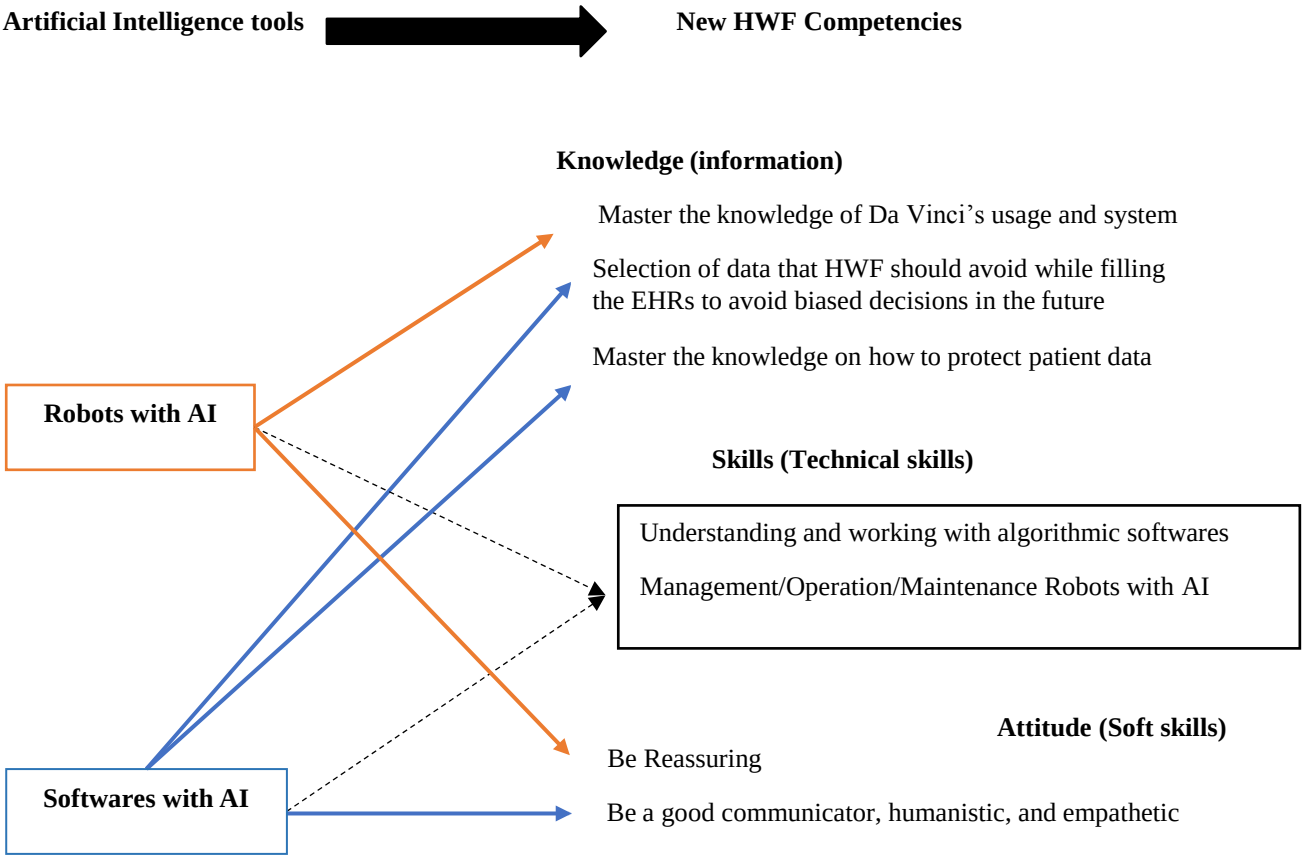
- Patient Monitoring

Succinctly, health providers may use AI models to analyze the vital signs of the cardiovascular and respiratory systems. Furthermore, AI models may decrease the likelihood of patient falls using computer vision techniques that alert the team based on the movements of patients (Reddy et al., 2019, p. 2).

- Supporting population health management

One of the main areas in that AI may be used to benefit the community is identifying the broad health risks and treatment opportunities for their communities. Also, it specifies who is the riskiest patient in the future that may be exposed to have chronic diseases, and accordingly undertake pre-treatment practices to reduce this risk (Lin et al., 2019). In other words, reduce mortality rates.

2.4. Towards a Conceptual Framework



Based on the outlined conceptual framework, AI technologies are likely to be presented either by robots with AI or software with AI. In both cases, health professionals will need to understand beyond the results of visual diagnostics and the disease or treatment suggestion process. This intervention could request more and more new competencies including new knowledge, skills and attitudes. New knowledge may consist of understanding key information about how robots with AI technique works and basic information in ensuring privacy and security of patient data. Technically, it could be beneficial to train professionals how to use AI software (algorithmic software) and how to operate and manage AI robots. Lastly, with this new technological environment, the patient could need more reassurance and good communication with health professionals in order to understand everything that surrounds them. This, in turn, could require the practitioner to be more humanistic and empathetic.

2.3 Discussion

Given that the practice of medicine has begun to engage more and more AI tools, the need for competent health professionals-AI tools interaction is more urgent. In essence, as is shown above, AI tools will have a predominant role in diagnosing and recommend treatments. It is difficult for health professionals to trust these systems without knowing how it works. Then, health professionals have to understand the inputs and the algorithm and analyze the proposed diagnosis to ensure that there are no errors (Paranjape et al., 2019, p. 7). In other words, they

have to be aware of the limitations of such technologies. This could give them the ability to explain to patients how this result gets out.

While the surgical operations are embedded by health professionals and robots, new competencies are required in the long term. Professionals need to be knowledgeable about this kind of operation, which includes the main limitations and information that they should know. Besides, knowing how to interact with robots, with consoles and mechanical arms, which needs training on some technical skills. In this regard, Da Vinci may be considered as a good prototype to be trained and knowledgeable on. Lastly, patients who will be under this new surgical environment will definitely be more hesitant and may ask unexpected questions, which are deemed essential to be answered for them. Then, the relevant professionals have to reassure patients, which could be presented by explicitly expressing the afore two sets of competencies (knowledge and skills). This in turn will reflect a sense of safety and trust in patients.

There is a public discourse within the health community about the benefits of using electronic health records (EHRs) and subsequently about biased algorithms within AI community. While EHRs assist largely the implementation of AI in health, health professionals should be trained and knowledgeable on how to enter unbiased data into EHR and on the concept of quality of data, which could be asked. Likewise, protecting the patients' security and privacy.

As a result, in the near future health professionals will need to be competent in managing data, supervising AI tools, recognizing AI fundamentals (Rampton et al., 2020, p. 2), use AI applications and robots to make informed decisions and operations (Paranjape et al., 2019, p. 10). Most importantly, this advent will not change the principles of the patient-practitioner relationship since the computer was introduced into the encounter room. However, it will stress and emphasize some attributes like being humanistic, empathetic.

Accordingly, this paper acts two roles. The first role is developing the literature review by adding a potential conceptual framework that necessitates new competencies to be fortified. The second role is highlighting a potential room for development within the proposed health workforce competencies framework by starting to add the term "Artificial Intelligence" as other management terms were explicitly expressed.

Lastly, this surge has led several medical universities to start introducing AI and machine learning courses in their curriculum. For instance, Duke Institute for Health Innovation has introduced courses that permit medical students to work with data scientists to understand and develop care-advanced technologies. Likewise, Carle Illinois College of Medicine has introduced courses provided by clinical scientists and engineers to reinforce the apprehending of new technologies in health care. Also, Stanford University Center for Artificial Intelligence in Medicine and Imaging has trained its post and graduate students to use machine learning to solve health care problems. Lastly, Sharon Lund Medical Intelligence and Innovation Institute have opened free courses for the medical students to recognize the new technologies in health care (Paranjape et al., 2019).

Conclusion

Due to the insufficiency of having a handful and real evidence of AI intervention in healthcare, it was clear that the competencies frameworks have escaped from using the term AI and Robotics within its content. However, this does not prohibit preparing HWF for the upcoming era. So far, there is only one validated robot with AI used in operations, while in the near future we will witness a drift of constructing new robots with AI to work beside HWF.

It is worth mentioning that although the paper has showed more the new technical competencies, it is crucial that HWF has to robust all their soft skills- teamwork, cooperation-leadership, empathy, reassurance and others. Reference to the proposed conceptual framework, several new competencies should be integrated into the new HWF frameworks, training, and curricula. On the flip-side, this framework was built through a conceptual analysis, which stimulates its empirically scrutiny through quantitative and qualitative techniques to have more valid and reliable results.

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