Digital Healthcare Supported by Artificial Intelligence with Emphasis on Egypt

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Abstract

Digital healthcare has emerged as the result of digital transformation, which offers unique opportunities to strengthen health systems and meet different challenges responding to change health need, such as the current epidemics of infectious and chronic disease.

Although that, the health sector in Egypt is still lags behind other industries in seizing the opportunities brought by digital technologies, in spite of the considerable efforts and some promising national success, the health systems are still have not undergone fully digital transformation, such as:

- Different datasets and services still are not linked electronically together, hindering the flow of crucial information,
- The use of telehealth and mobile health is still limited, and
- The use of analytics employing diverse data and technologies such as artificial intelligence (AI) is only slowly emerging, in spite the complexity of health sector processes and activities and the ensuring high reliance on multifaceted information to solve problems.

The barriers are not only technical, but also institutional and organizational. While governmental bodies need to commit to continuous investment in interoperability of flexible digital architecture, to allow for AI systems and applications as well as ensure timely modernization of policy and governance frameworks.

This work outlines how current usage and what role could Egypt undertake of digital technologies that can help to address existing and emerging health policy challenges, and how far Egypt is in seizing the opportunities of digitalization and AI through the following domains:

- Providing an overview of the most prevalent use technologies in health sector, i.e., electronic data communication systems,
- Discussing telehealth and mobile health(mHealth) solutions, such as robot assistant therapies or novel devices that allow diagnostics and therapy at home,
- Identifying current use of existing data and interoperability across segments of health systems as related to Egypt,
- Describing developments in automation, data-driven, prediction, and decision support, including technologies such as adequate digitization and artificial intelligence that support digital healthcare,
- The work concluded the results and recommendations for Egyptian healthcare.

Keywords: Digital Health, Digital Transforma-

tion, Healthcare systems, Artificial Intelligence, Intelligent Healthcare Service, Telehealth, Mobile Heath, Associated -Living Technologies, Data Driven Automation.

1. Introduction:

Healthcare is one of the major success stories of our times. Medical science has improved rapidly life expectancy around the world, but no longevity increases. Healthcare systems face growing demand for their services, rising costs and workforce that is struggling to meet the needs of patients.

Demand is driven by a combination of unstoppable forces such as, population aging, changing patient expectations, a shift in life style choices and the never-ending cycle of innovation being but a low.

This means that health systems will have to deal with more patients with complex needs. Managing such patients is expensive and require systems to shift from an episodic core-based philosophy to one that is much more proactive and focused on long-term care management.

Health care spending is simply not keeping up without major structural and transformation and change healthcare systems that will struggle to remain sustainable. Therefore, building an automation, digitalization artificial intelligence (AI)has the potential to revolutionize healthcare and help address some of the challenges facing healthcare. AI is the capacity of computer program to perform tasks or reasoning process that are usually associate with intelligence in human being. AI can lead to better care outcomes and improve the productivity and efficiency of care delivered. It can also improve the day-to-day life of healthcare practioners, letting them spend more time looking after patients and in so doing, raise staff morale and improve relation it can even get life-saving treatment faster. At the same time, questions have been raised about the impact of AI that could have on patients, practioners and health systems, as well as about its potential risks. Also, there are ethical debates around how AI and the digitalized data underpins it should be used. In the meanwhile, there are several areas that are of importance for the AI in digital healthcare such as: self-care prevention wellness; triage aid diagnosis; diagnostics; clinical decision support; care detection; and chronical care management. Therefore the impact of AI on these medical area will have potential improvement on population health management, healthcare treatment operations and strengthening innovation of the physicians and practioners.

Therefore, this work outlines how current usage and what role could Egypt undertake of digital technologies that can help to address existing and emerging health policy challenges, and how far Egypt is in seizing the opportunities of digitalization and AI through the following domains:

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2. Definition of Digital Health (eHealth):

Digital technologies refer to electronic tools, systems, devices and resources that generate, store, process, and/or transit data. These range from equipment, such as computers and smart mobile phones to intangible products such as software, web-based platforms, and algorithms, e.g., artificial intelligence (AI). Digital technologies are used interchangeably with information and communication technology (ICT or IT).

Electronic medical and heath records (EMR and EHR) contain a range of an individual's health data in digital form. An EMR or HR is created in service or an organization that delivers healthcare, e.g., a hospital or a clinic. A patient centered personal digital record interaction with health system regardless of the settings, reviews or organization. HER includes the prescription and dispensing pharmacies and appoints for booking consultation online.

Telehealth involves a combination of digital solutions that allow for delivering clinical services and monitoring of care and treatment at a distance asynchronously, i.e. with the connecting at different points in time, which creates additional flexibility. Telehealth often includes the use of mobile health devices and digital health applications (mHealth).

mHealth is a short for mobile health, on the one hand, refers to the use of generally available mobiles, communication devices such as wearable devices such as smart watches, on which digital health applications and sensors operate. On the other hand, it also includes mobile devices produced specifically for the use by healthcare providers for services provision and data collection, such as portable monitoring systems.

Associated-living technologies, which is the combinations of the digital healthcare applications and other software, sensors, and sometimes robots that aid, e.g., mobility and independence patients to be in their own forms and live independently longer or return to their homes after a hospital treatment.

Data-driven automation, prediction and decision support is analytics employing data and technologies, such as artificial intelligence (AI). This technology of AI is a machine-based system that can for a given set of operator defines objectives, make more prediction and recommendations. AI systems are designed to operate with varying levels of autonomy. Machine learning (ML) allows digital systems to achieve objectives without being given instructions as how, but by analyzing patterns in training set of data, which has to be prepared adequately, including or excluding labelling. Deep learning (DL) is considered as a subfield in which the digital system achieves the objectively hierarchically determining distinguishing features of the data.

3. Current Use of Existing Data and Interoperability across Segments of Health Systems:

The health systems situation in Egypt is not much better that the pre-digital equivalent of paper records stored by individual health care organizations and practices. Consolidating the facts about an individual across different health organizations is a key structural component of a high-quality systems. This can mean either a one- patient has a one record approach or one made up of disparate platform that are set up the exchange data and information in a secure and unencumbered way, e.g., through a joint access portal.

For many health sector challenges, the most appropriate digital solutions often involves the simple but effective use of data that is already being collected; in particular, through linking data across the many health organizations, units and devices that collect the data from the electronic health records (EHRs) of the patients as related to hospitals, physicians offices, pharmacies, laboratories, bio-banks, statistical units, or medical devices and applications.

Therefore, for a better use of existing data that could attain important opportunities for the followings:

- Given all providers of healthcare access to comprehensive, consistent, and timely information about patients to promote more effective, safer and better coordinated care.
- Empowering people to take part in their own care and treatment, understand their health condition, and communicate with the healthcare clinic, hospital or provider more effectively.
- Better targeting of more personalized inter-

ventions at the persons most likely to benefit from the medical treatment given to them from any healthcare provider.

- Improving public health monitoring and enabling more effective responses to public health emergencies such as the Covid-19 pandemic.
- Identifying waste, inappropriate practices, and inefficiencies to improve policy making, system governance, and stewardship, including better funding and remuneration.
- Assessing and comparing the long-term performance of biomedical technology and treatment, and evaluating new treatments and practices.

3.1 Health Data and Often Remains Segmented across the Health systems and Under Used:

At present, at some of new numbers of key health datasets for hospitals in-patient data, emergency healthcare data, primary care data, or prescription-medicines data are available and used in day-to-day practice of health service delivery.

However, the datasets of different segments of health systems within Egypt still do not communicate with each other electronically. In effect, it often falls on patients to carry and repeat information about their care and treatment history through the health system, and health workers are still waiting for an easier workday where the right information is readily available at the right time. These critical shortcoming have once more brought to light with outbreak of Covid-19 pandemic, with on the other hand, hospitals and clinics having to ask patients, if at all possible for information on comorbidities, on the other hand systems struggling to fo follow-up on the full spectrum of the development in Realtime, also with regard to health outcomes of suspected cases of patients who were not hospitalized.

3.1.1 Patients do not always have access to their full health data electronically:

The majority of advanced countries have been implemented ways for people to access their health data electronically. However, in Egypt, that has not fully adopted person-centered EHRs, patients cannot see their full health data in one place. Moreover, patients continue to have limited access even to their electronic medical records (EMRs) within each sector of a health system.

3.1.2 Regular use of data for monitoring performance improvement and research is not yet a norm:

Regular deployment and linking the health data for secondary purposes, such as to report on health systems performance, is increasingly adopted but relatively less common than primary use of data in the day-to-day provision of health services.

Therefore, the use of existing data to inform improvements in health service and delivery, through for example, designing more tailored or better coordinated service, remains rare in Egypt. While there are some pilot projects aimed at an evidence-based redesign of health services, few implemented new care models on a large scale.

Moreover, there are also missed opportunities with regard to collecting data on patient-reported outcomes of care. Hence, digital technologies can help move away from reactive towards proactive approaches to preserving health by enabling greater participation of patients in care process. Enabling patients to take part in their care also includes collecting data on patients reported outcomes, which in turn could better inform the future development of digital health technologies. This is considered a significant missed opportunity to inform improvements in health systems performance.

Other secondary uses of data, such as the regular linking od datasets for research or the monitoring of long-term effects of selected therapies is even less prevalent. There should be significant investments to be made in implementing the used data for these purposes, especially in cancer care for example.

In sum, there persists high variability across Egypt in the availability, quality and linkage, and use of key national health datasets. However, with the onset of current Egyptian Covid-19 pandemic for

future communicable-diseases pandemic there is a growing recognition that the capacities of health systems to deliver services in a crisis is based in part on digitalization, and thus some of the barriers to digital transformation are being removed.

3.2 Reconciling the Risks and Benefits of Data Sharing is Challenging but feasible:

The health sector has unique characteristics and health data are very primary-sensitive which contributes to th challenges in broadening data sharing and use. Broader data sharing and use increases the risk of data loss or misuse that can bring personal, social, and financial harm to individuals and can diminish public trust in health systems, and governments, which might prove hard to remedy once it has happened.

Nevertheless, protecting data and putting them to work are not mutually exclusive, both can be achieved with strong data governance frameworks. Substantial progress has been made in reconciling these risks and benefits, especially throw laws and guidelines. However, it is recommended that health data governance is to provide a mechanism for further harmonization of the national health data and governance frameworks to create national information ecosystem that can securely extract knowledge from an even larger pool of health data.

The governance of data and privacy protection, is a fast-moving field, where new questions arise continuously with the development of new data-driven digital innovation. This requires deeper, ongoing discussion, also the development of dedicated, clearly articulated ethical frameworks and charters.

3.3 The Future Lies in Flexible Component-Based Digital Architectures:

The adoption of digital data systems within the health sector frequently continues in an environment shaped by paper-record thinking, which limits success. Currently electronic health records (EHRs) for example, do not always permit applications to communicate, or search for and synthetize information. However, with the proliferation of data- collecting mobile devices, connectivity suffers even within single organizations as the use of common standards that allow for interfacing between the electronic records systems and the devices is not widespread adequately.

Various new categories of digital technologies are certainly being deployed, but might merely co-exist within a health system, without being interconnected in any way, and thus put into joint use. Such a situation not only prevents technologies from realizing their potential but also contributes to an impression of a fragmented digital landscape, which can lead to a disillusionment with the technologies among their end-users, i.e., the health workers and patients.

The increasing pace of technological development further increases the need for interoperability and flexible within the health data systems. The future lies in the development of flexible component-based architectures, which function as a unified ecosystem, i.e., an open and supplier-independent common network and components linked by common network consisting of independent services and components linked by common standards and principles.

This is also naturally requires investments, but at first and foremost it necessitates a long-term strategic vision of digital health technologies should be organized together to work collectively in support of health policy goals. Such a strategic vision needs to include a commitment to create supportive legal frameworks and to continuously modernize the digital data securing standards.

4.Telehealth, mHealth, and Assisted Living Progress in Bringing Healthcare to Patients:

During the last decade, telehealth has rapidly evolved far beyond what is traditionally associated with this term, i.e., the real-time consultations between geographically separated patients and physicians. Advanced telehealth models not only help to provide care to difficult-to-reach patients, who otherwise would not access any care, but can generally support the design of more effective

and efficient care models and help to move away from reactive towards proactive approaches to preserving health. For example, during the Covid-19 pandemic, the ability to health systems to enable or increase access to tele-consultations has been of critical importance. Where existing, more advanced telehealth models allowed also for services to, for example, patients with chronic conditions.

At present, telehealth involves a combination of various digital technologies, including mHealth and assisted living, which aim at facilitating, for example, the relocation of services from physicians' offices and hospitals to patients' homes, irrespective of whether a patient lives in a remote area or not. Telehealth can also include virtual health assistants, which are certified online, chatbots that can provide basic health check-ups by ensuring about symptoms and answers to a range of health-related questions at any time.

4.1 Despite Growing Evidence of Benefits the Use of Telehealth Remain Limited:

A growing body of evidence suggests that given the right approach and implementation process, telehealth can be safe and cost-effective, and in some cases provide better outcomes than conventional face-t-face care. This in turn can liberate capacity and enable greater access (Oliveira Hashguchi, 2020).

The gains are frequently due to the potential of telehealth, incorporating mHealth solutions, to move towards more proactive approaches to preserving health. Home telemonitoring of patients with chronic conditions, for instance, allows to better anticipate deterioration by interacting with the patient earlier and more effectively in the course of treatment and not only the patient is physically present at a site. Telehealth can also enable patients to take an active part in their treatment and care, which improves self-management skills, and encourages a more effective co-production of health. Even simple digital health applications that, for example, allow patients to track their therapy and provide real-time information back to the provider for intervention and for targeted follow-up can be effective for prevention purposes, and in improving patients' adherence to pharmaceutical and other treatments (Khan & Socha-Dietrich, 2018).

Therefore, the benefits and advantages of telehealth are as follows:

- More most effective care,
- Improved quality of care,
- Improved access and reduced inequality in supply,
- Increased knowledge sharing and learning,
- Patient-centered care and health literacy,
- Saving in patients' time and travel costs,
- Avoiding hospitalizations and emergency care,
- Fewer unnecessary transfer and subsidized tavel, Bette models of care for chronic diseases,
- Improved timelines of care,
- Higher volume of consultation,
- Reduced provider travel, and
- Improved care coordination.

Most telehealth solutions are devised for primary care, and there has been progress in their adoption in many advanced countries. In spite of that, the overall use remains very low in Egypt.

The main barriers to a wider adoption by not only the shortage of sustained funding, but also the lack of any strategic perspective. Telehealth is rarely perceived as a catalyst for new care models, but rates adoption service. There are also delays in adopting legislative and functional frameworks for the digital era, while telehealth is generally allowed in many advanced countries, there can be restricting with regard to the type of services that can be delivered remotely, or requirements for an initial and/or a follow-up face-to-face appointment between the physician and a patient. Under or outdated regulations on privacy and data security form additional barriers. Moreover, gaps in digital skills make health workers hesitant to adopt telehealth (Oliveria-Hashiguchi, 2014).

4.2 Assisted-Living Technologies can Aid Long-Term Care Workers:

With an aged population and increasing number of single-person households the demand for long-term care services is expected to increase. With continued pressure on public finance, policies that can improve worker productivity many make it easier to meet these needs

Many providers already use or are looking for ways to implement simple technologies, such as alarm systems, fall sensors, and GPS tracking of the movement of elderly peoples in residential facilities, or at home. Mobile devices with health applications can also support remote monitoring of elderly and may reduce time spent by workers in promoting patients' self-care skills. Other devices, such as medication robots can improve adherence to therapies. The degree of penetration of these devices varies considerably across and within countries and organizations with the digital tools and solutions being more prevalent in private nursing homes and home care services, or in those receiving dedicated public funds (OECD, 2020).

5.AI Phases of Scaling AI in Healthcare:

More data, better data, more connected data artificial intelligence in healthcare includes applications that affect care delivery, including both how existing tasks are performed, and how they are disrupted by changing healthcare needs or the processes required to address them. The including applications also enhances and improves healthcare delivery, from day-t-day operational improvements in healthcare organizations to population health management and healthcare innovation. Therefore, it covers natural language processing (NLP), image analysis, and predictive analytics based on machine learning. As such, it illustrates a spectrum of AI solutions, where encoding clinical guidelines or existing clinical protocols through a rules-basd system often provides a starting point, which then can be augmented by models that learn from data.

There are three main phases of scaling AI in Healthcare, that are:

- The 1st phase that is related to solutions which are likely to address the low-hanging the routine, repetitive and largely administrative tasks, which absorb significant time of doctors and nurses, optimizing healthcare operations and increase adoption. In this 1st phase, AI applications based on imaging, which are already in use in specialties such as radiology, pathology, etc.
- The 2nd phase is expected more AI solutions that support the shift from hospital-based to home-based care, such as remote monitoring, AI -powered altering systems or virtual assistants, as patients take increasing ownership of their care. This phase includes also a broader number of natural language processing (NLP) solutions in the hospital and home setting, and more use of AI in a broader number of specialties, such as oncology, cardiology, or neurology, where advances are already being made. This will require AI to embedded more extensively in clinical workflows, through the intensive engagement of professional bodies and providers. It will also require well designed and integrated solutions to use existing technologies effectively in new context. This scaling up of AI deployment would be felled by a combination of technological advancements (e.g., in deep learning, NLP, connectivity, etc.) and cultural change and capability building within organizations.
- The 3rd phase is expected to see more Ai solutions in clinical practice based on evidence from clinical trials, with increasing focus on improved and scaled clinical decision support (CDS) to health sector that has learned lessons from earlier attempts to introduce such tools into clinical practice and has adopted its mindset, culture and skills. Ultimately, respondents would expect to see AI as an integral part of the healthcare value, from how we

learn, to how we investigate and deliver care, to how we improve the health of populations. Important preconditions for AI to deliver its full potential in Egypt, for example, will be the integration of broader datasets across organizations, strong governance to continuously improve data quality, and grater confidence from organizations, practioners, and patients in both AI and the ability to manage the related risks.

6. Artificial Intelligence and Data-Driven Decision Support, New Potential, and New Challenges:

Data-driven automation, prediction and decision support draw from fields like statistics, linguistics and computer science, and use techniques, such as rule-based systems, regression, predictive analytics, and artificial intelligence especially the recent advances in deep learning (DL), has attracted much attention with regard to its potential to transforming healthcare and health systems in general.

The potential of artificial intelligence in health profound, given the growing volume of electronic data, as well as the inherent complexity of the health sector, its reliance on multilayered information to solve problems, and the variability of how diseases interact with individuals and population. AI cam identify unknown patterns or irregularities in data, thus helping to improve the accuracy of administrative or clinical decision making better allocate resources, anticipate risks, or drug discovery, among many other things. AI has also been tested in public health surveillance, foe example, in predicting the spread of communicable diseases based on combination of data from various sources (OECD, 2019).

The use of AI is emerging in some areas of healthcare as shown in the following figure:

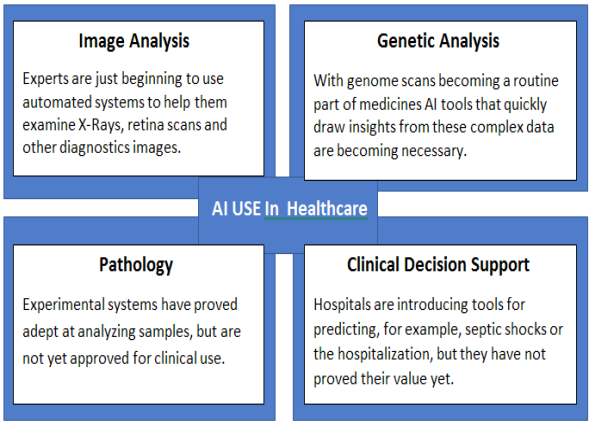

Figure 1: Emerging Use of AI in Healthcare (Source: IEEE, 2019)

But we could notice that most applications are still in research and development stage until now. A recent review of 12 studies claiming an AI performs better than radiologists in diagnostic image analysis, finds that only a handful were tested in population that were different from population used to develop the algorithms (Reardon, 2020). The majority of AI applications in health require large amount of training data to make predictions. Because these methods are narrowly focused on specific task and trained using a specific set of data, these algorithms may not work well when used with data that is even slightly different from the training data. Other examples from image recognition show that changing a single pixel in an image, which is completely irrelevant for the assigned a category at high confidence levels. It is still not understand why AI had some astounding success in image recognition, or why it fails spectacularly when facing setting modifications that are irrelevant for humans (OECD, 2019).

Generally, computing power and flexible (especially in the sense of unbiased or agnostic) algorithms can be harnessed to find correlations in vast diverse datasets that human operator would not have imagined testing for. Still, no matter how sophisticated any statistical analysis might, it will suffer from the elements like under-and overfitting multicollinearities, and it still can only identify a correlation. Hence, the role of the computer anal-

ysis is to propose connections that remain to be scrutinized.

Tacking into account the above characteristics of data-driven prediction and decision support systems as well as the characteristics of jobs performed by health workers. To date there is no evidence to suggest the AI will replace humans and machines learn how to do things in very different ways (OECD, 2019). The latter was once again illustrated by challenges posed by Covid-19oybreak. Already at the onset of the crisis, radiologists quickly learned to recognize the typical signs of severe SARS-and Omicron diseases (Drosten, 2020). For training AI system, it might take years to collect enough images and to adequately prepare and label training data, so it could start learning how to detect Covid-19not mensin diagnosing it.

There is, nevertheless, plenty to suggest that data-driven prediction and decision support will fundamentally augment Human tasks and responsibilities in health care. This will require a number of changes first and foremost in education and professional training of health workers, ho will need new digital skills (OECD, 2019).

Moreover, going forward, health policy makes should beware the hype and ensure that AI addresses real health sector challenges, instead of being developed first and then searching for problems that it could solve. In decision bout public investment in AI, it is important to recognize that the field has been researched and discussed earlier (Berryhill, 2019). In face of insufficiently farsighted funding schemas as well as other market forces, parts of AI community respected succented results in their struggle for limited resources, which also made this parts gain above average visibility. Over the years, this led to several so-called (AI Winters", where disappointment about unkept promises, resulted in repeated severe funding cuts for AI, or sectors of it, given that AI is extremely diverse field.

Taken as a whole, AI break throughs are known to have returned many years of investment. As in the case with research, however, when exactly a particularly hard problem will be solved is particularly hard to predict.

Therefore, there is a need to recognize and address the risks of unintended and negative consequences associated with AI, which relis critically on the availability of data at scale and linking of different datasets together. This brings up the question of how to effectively increase data availability without compromising privacy and data security. Moreover, the performance of AI will depend on the quality of the data it uses. If the data is biased, due to, for example, the inherent biases in human thinking, or social norms, the broaden use of AI such creates the risk of entrenching such biases instead of removing them. AI, deep learning in particular, might also leek transparency, without which identifying, for example when human rights have been violated or seeking remedy and determining accountability will be difficult. Thus, there is a need to delineates actions consequences associated with AI.

7. Adequate Support of Health Workers:

Successful digital transformation and artificial intelligence applications in health sector is not a simple matter of technical change, but require a complex adaptive change in human expertise and skills. Digital technologies provide the tools, but cannot transform the health sector on its own, and needs to be put to productive use by the health workforce. However, health workers after report not having sufficient opportunities for up-skilling required to put the technologies to full use. This skill considered a gap that needs to be effectively addressed to ensure progress and avoid unnecessary strain on health workers.

While the skills gaps and other health workforce, related barriers to success fully digital and AI transformation. Thereby it is worth considering that the examples of digital technologies can be deployed in almost any aspect of health case provision, across different service sectors, care settings, and patient groups. This implies that

all health workers will be exposed to the various types of digital tools and solutions offering information, automated decision support, and new options for engaging with patients as well as collaborating with other workers across the system.

Whether some categories of digital and AI technologies will be more often used by physicians, nurses, or other formal care providers depends on the particular configuration of health services in Egypt, for example, that include the scope of practice of different professional groups. It should also be taken into account that care models evolve, with tasks or entire services being shifted between different service sectors from hospitals to primary or home care.

Therefore, support for the development of digital and AI skills will need to be provided for all categories of health workers. This implies substantial effort on the part of educators. However, the fact that digital and AI skills are commonly needed across the different professional groups indicates also that there is a substantial scope for interprofessional collaboratin and pooling of expertise, which can ease the development of digital health education content.

8. Change Needed to Encourage Introduction and Scaling of Digital Transformation and AI in Egyptian Healthcare:

The numerous studies conducted in the fields of digitalization and AI in healthcare have been moving to a world in which both can be deliver significant, consistent and global improvements in care will be more challenging.

The following is a set themes that most of the players in healthcare systems and ecosystems will need to be addressed within digitization and AI:

8.1 Working Together to Drive Quality Digitization and AI in Healthcare:

Quality could come up from factors such as the design and development of applications and systems as well as their ease of use, performance of algorithms, and robustness and completeness of underlying data. The lack of multidisciplinary development and early involvement of skilled healthcare staff were cited as major barriers to addressing quality issues early on and adopting solutions at scale. One problem AI is building clinical evidence of quality and effectiveness. While start ups are interested in scaling solutions fast, health practioners must have proof that any new idea will do no harm before it comes anywhere near a patient. Practioners also want to understand how it works, where the underlying data came from, and what biases might be embedded in the algorithms, so are interested in going past the concept of AI as a "black box" to understand what underpins it. Transparency and collaboration between innovators and practioners will be key in the AI quality.

8.2 Rethinking Education and Skills:

Digitization and AI in healthcare will require authorities well-versed in both biomedical and data science. There have been recent moves to train healthcare workers in in these sciences where medicine, biology and information meet through joint degrees, through this is still less prevalent in Egypt as well as in many developing counties. Therefore, more broadly skills such as basic digital literacy, the fundamental of genomics, AI and machine learning need to become mainstream for all practioners, supplemented by critical thinking, skills and development of a continuous learning mindset. Alongside upgrading clinical training, healthcare systems need to think about the existing workforce and providing ongoing learning, while practioners need time and incentive to continue learning.

8.3 Strengthening Data Quality, Governance, security and Interoperability:

Data challenge breaks down data, collecting the data, and setting up the governance around data management. Still healthcare in Egypt is lagging behind in digital business processes, digital spend pe workers, digital capital deepening, and the digitization of work and processes. It is critical to get the basic digitization of systems and data

in place before embarking on AI deployments.

In addition, as more healthcare is delivered using new digital technologies, public concerns about healthcare data are used have increased and grown. Healthcare organizations should have robust and compliant data-sharing policies that support the implementations in care that AI offers, while providing the right safeguards.

Another data challenge is getting to talk each other of policy makers, funding bodies, and nonprofit organizations that need to support efforts to sufficiently anonymize and link data as well as build databases that can be access3d by users with appropriate safeguards

8.4 Managing Change:

Managing change while introducing digital transformation and adopting AI applications and systems is no different to managing change in complex institutions more broadly but healthcare, clinical leadership is key as being open to identifying the right use cases that support rather than antagonize practioners and truly augment rather than substitute their ability to deliver the best possible care to their patients. Thus could include prioritizing solutions that focus on reducing the time people spend on routine administrative tasks, rather than those that seek to act as virtual assistants who interact directly with patients or clinical decision support (CDS) tools that facilitate activities physicians see as core to their professional role, i.e., the clinical diagnosis.

8.5 Investing in New Talent and Creating New Roles:

Healthcare organizations need to consider how they will develop and recruit the new roles that will be critical to the successful introduction and adoption of digital transformation and applying AI applications and systems, such as fata scientists or data engineers. Demand for such skills is becoming important across industries, and completion of talent will be fierce especially in advanced communities, but many young data professionals find a true vocation in healthcare and its mission and are excited about the potential of digital health and AI. Developing flexible, agile models to attract and retain such talent will bea key part of these organizations' human resource's strategy.

8.6 Working at Scale:

The lessons from public and private sectors aiming to develop their digital transformation for applying AI in healthcare to date suggest that scale matters, largely due to the resource needed to develop robust AI solutions, or make them cost-efficient. Not every hospital will be able to attract new AI talent, or have access to enough data to make algorithms meaningful. Smaller organizations can benefit from working in innovation clusters, that bring together digital health, AI, biomedical research, translational research or other relevant fields. Larger organizations can develop in centers of excellence that pave the way for regional and public-private collaboration to scale AI.

8.7 Population, Policy Making and Liability, and Managing Risk:

Responsibility for AI solutions both clinical and technical, for example, is split nowadays between healthcare organizations and their workforce. Therefore, it is to be emphasized the importance of clarifying whether AI will be regulated as a product, or as a tool that supports decision making, and of introducing a consistent regulatory approach for AI for medicines, or medical devices.

Another issue to be clarified is the extent to which patients access to some AI tools needs to be regulated or restricted to prescription. The issue of liability and risk management is a particular challenge. Patient safety is paramount, but healthcare providers also have to think about the professional accountability ultimately rests with clinicians as well as the protection of their organizations from reputational, legal or financial risks.

8.8 Funding:

The reimbursement of medicines and medical devices is much complicated, and is even less clear when it comes to digitization and AI solutions. The responsibility for decisions on the reimbursement of medicine or device rests with national and lo-

cal play or organizations depending on the country, and this decision usually covers that will be reimbursed and at which price. Clear criteria for the potential reimbursement of digitization and AI applications and systems that will be crucial for their adoption of scale, alongside creative funding models that ensure the benefits are shared across organizations.

9.Conclusions: Results and Recommendations:

1. **Digitization and AI are potential to transform healthcare:** Healthcare is one of the success stories of our time. In the meantime, it is also in crisis. Huge advances in public and private health and prevention, biomedical knowledge, health delivery, and technology have all helped raised life expectancy, and expectations from healthcare itself. But as healthcare costs continue to rise exponential outcome grows, Therefore, it is needed to deliver care that is better, faster, and more cost efficient, as well as provide more and better services to more people.

2. **Status of Digitization and AI in Health Interoperability:** The pace of change in digitization and AI within healthcare has already accelerated significantly over the past few years due to advances in algorithms, computing power, and the increasing breadth and depth of data that can be used. In response healthcare systems, investors and innovators are all shaping focused on the topic.

3. **Impact on Healthcare practioners:** The implication of data transformation and AI in healthcare settings on the work of practioners are starting to emerge. It is highlighted that healthcare is one of the sectors least prone to automation. Therefore, most of healthcare practioners are unlikely to displaced by digitization and AI, but their professional live will change. They will be augmented, supported and in some cases challenged by their introduction, through the followings:

• Focusing their energy on their patients, spending less time on administrative tasks and more on direct delivery of care.

• Some activities will be mor efficient or deliver better outcomes or both.

• Will increasingly undertake new roles for which they are neither prepared nor been trained.

• Hospital patients may have mor complex needs.

• New professionals will need to be welcomed and integrated in healthcare.

4. Barriers and Enablers: It is well recognized that a unique and balanced assessments of the views and opinions of healthcare professionals, investors, and digitization and AI decision makers across national and local settings, about what is holding back from realizing the potential of digitization and AI in healthcare. The main themes that affect adoption of digital health comprising AI services, include the followings:

- The quality and suitability of solution,
- Changing skills of healthcare practioners and long-term medical education,
- Introduction of New talent,
- Working at scale,
- Regulation, policy making and liability, and managing risks, and
- Funding.

5.**The Implications of Healthcare Organizations and Health Systems:**

Health care providers and health systems need to assess what their distinctive role or contribution can be in introducing or scaling digitization and AI in healthcare. Also, they need to take stock of their capabilities, level of digitization, availability, and quality of their data, resources and skills, to define their level of ambition, digitization, and AI as they fit with their strategic goals. This could be achieved on the following actions:

- Develop national and local digitization and AI, defining medium- and longer-term vision and goals, specific initiatives, resources and performance indication,
- Define use cases to support through targeted funding and incentives to enable scaling of digitization and AI solutions across the system; ensure these deliver organizations both clinical and operational outcomes,

- Set standards of digitization, data quality and completeness, data access, governance, security and sharing as well as system interoperability; incentivize adherence to standards through a combination of performance and financial incentives,
- Redesign workforce planning and clinical education processes to address the needs of both future healthcare and digitization and AI focused professionals; and invest upfront in upskilling frontline staff and designing lifelong programs through continuing professional development and degrees for healthcare practices,
- Provide incentives and guidance for healthcare organizations to collaborate in centers of excellence or cluster of innovation at national and local levels, and
- Address digitization and AI regulation, liability, and funding issues, creating the right environment for appropriate, safe, and effective digitization and AI solutions to be adopted, but minimizing the risk to healthcare practioners; ensure this is reflected in funding and reimbursement mechanism for innovation in healthcare.
- 6.What Role Could Egypt Undertake?
- Egypt could embark on undertaking the following roles on national and local levels:
- Defining a small core of Egypt's digitization and AI funding priorities and consolidate funding to support rapid testing and scaling the development solutions in clinical areas,
- Encouraging and supporting the creation of centers of excellence across Egypt, to help concentrate scarce AI talent in high-profit roles in agile networks, and to ensure talent creation and continuous learning are prioritized and enhances at the Egyptian level.
- Creating a common undertaking field across Egypt, with common standards and data, regulation, access, privacy or interoperability, and shared requirements on data exchange. This will enable solutions in cost-effective way and would increase user confidence,
- Finalizing an approach on and confidentiality, leading the way nationally, regionally and internationally and removing unnecessary barriers to using and scaling digitization and AI, and
- Offering targeted approach to upskilling healthcare practioners through tailored talent and educational on well as training programs across Egypt, potentially delivered by diverse set of education and training providers, and through other diverse channels.

In concluding, digital health and AI have the potential to transform how care is to be delivered in Egypt and in some cases, they are already doing so. Speeding up the pace, through the thoughtful and systematic introduction that could deliver significant benefits to Egyptian patients and population. Therefore, Egypt can build on the unique strengths of its national health systems and datasets, as well as on innovation health systems and ecosystem to ensure that patients' rights to their data remain sacrosanct, while ensuring those same patients get their full fit from the tremendous promise of digital health and AI in healthcare.

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