



**Africa Rising:  
Harnessing the Power of Disruptive  
Technology to Bridge the Development Divide in  
Education and Health is an Imperative  
for Tertiary Education**

**Professor Folasade T Ogunsola, FAS**  
MBChB, PhD, FMCPATH, FWACP,

**7<sup>th</sup> Annual  
Consortium for Advanced Research  
Training in Africa (CARTA)  
Public Lecture**

College of Medicine, University of Ibadan.  
20<sup>th</sup> August, 2019



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Protocols

## **INTRODUCTION**

I will like to thank Professor Akinyinka Omigbodun for inviting me to deliver this lecture. When I was asked to give this lecture, I took a look at your vision and your mission -

*Vision: "To be the catalyst for the emergence of a vibrant African academy able to lead world-class multidisciplinary research that makes a positive impact on population and public health"*

*Mission: "To build high-level capacity for population and public health-related research in Africa".*

I thought long and hard about what my topic should be, then it became clear to me that we needed to think about our future and what we need to do to position ourselves for it. In my present position as DVC (Development Services), I oversee innovation, entrepreneurship, internationalization, strategic partnerships and advancement. This portfolio is about repositioning for growth. At one of the many meetings I attended, I had the pleasure of listening to a brilliant lecture given by an HR manager in one of our banks who said that they had started employing robots to do some of their repetitive work. In fact, a phrase I took away from her was that the 'Future of Work' is here and now! That we should stop talking about the future of work as though it was a distant phenomenon.

We are on the verge of the 4<sup>th</sup> industrial revolution and this revolution will be characterized by great technological disruptions and rapid rates of change. It has been predicted (by Gartner) that "one in three jobs will be converted to software, robots and smart



machines by 2025,” and that about 65 percent of children in primary school today will work in jobs that have yet to be invented.

I have chosen this topic “*Africa Rising: Harnessing the Power of Disruptive Technology to Bridge the Development Divide in Education and Health is an Imperative for Tertiary Education*” because technology is here and changing the work landscape in fundamental ways and at a pace we have never encountered before. It is also changing the knowledge and skills landscape such that we must strategically and intentionally begin to rethink not only the curriculum of healthcare workers but also the way we train them, if we are not to be totally disadvantaged in the global workforce and if we are to remain relevant in the future of work. This lecture may be a little different in terms of its theme, but I hope it will stimulate us to start thinking of how we can better prepare for the rapidly changing world that is upon us.

In this lecture, I want to take us on a journey into history, to see where we are coming from, so we can know where we are going; to see where we fit in this spectrum and ask ourselves what we need to do to catch up. We need to ask ourselves some questions and move into action because the future is upon us. Are we ready? What skills do we need to have in the 21<sup>st</sup> century? What will be the impact of technology on jobs in the healthcare space? How do we harness the power of technology to leapfrog development? What is the role of universities in promoting and harnessing technology for change? How can we respond to the change around us? How can we be a part of the change? I do not have all the answers, but I

believe in our collective intellect. If we can all start thinking about our role, maybe we will start to act in ways that will move us forward.

Through the ages, each era has led to major changes in the way of life that was a reflection of the required knowledge, skills set and competencies required to survive and succeed. These changes in life style as well as development have also reflected on the predominant health issues societies grappled with, and the knowledge and competency requirements to prevent, manage or cure them. Before I go further therefore, let me take you through the various stages of man's economic and social development, juxtaposing on this the knowledge and skills required to thrive, as well as the attendant health problems arising from each level of development. I will seek to explain the highlights of the various stages, or eras, revolutions and the impact these had on knowledge and learning.

Consortium for Advanced Research Training in Africa

## THE PRE-INDUSTRIAL ERA

In the pre-industrial era, man lived in close proximity with nature, hunting for his food and foraging for plant food as hunter-gatherers. Then we developed into Agricultural societies, followed by the industrial era (Industrial Revolutions 1 and 2). Then we moved into the information era (third Industrial Revolution). We are now moving into, or are at the beginning of, the Augmented Era or the 4<sup>th</sup> Industrial Revolution

## Hunter-Gatherer Era

This era lasted for 50 million years and was man's first and most successful adaptation to his environment.<sup>1</sup> Hunter gatherers were prehistoric nomadic groups routinely hunt large animals and forage for plant food. They were the first humans to use fire and adapt to colder climates. They also used simple tools, such as sharpened stones for cutting. As they developed, they learnt to control and domesticate fire. They also developed an intricate knowledge of plants and refined their tools. In this period, the type of skills that gave a competitive advantage were physical strength and speed, and the tools they used were to improve the efficiency of their labour<sup>2</sup>. So, people that were good at performing many tasks, and those who were strong and swift, succeeded.

## Agricultural Era

Then man discovered agriculture and moved from a nomadic way of life into settlements. Hunter-gatherers who did not change were displaced or conquered by farming or pastoralist groups in most parts of the world. The farmers learnt to control fire, using it for domestic purposes, and water, which was used for irrigation. They also domesticated animals for food. During this time, man started to live in small communities, in close proximity with their animals. This was the beginning of urbanization and development of governance tools, knowledge and writing.<sup>1</sup> The competencies required to thrive included knowledge of animal husbandry, food plants and, later on, food preservation as well as tools to augment their labour. This was in addition to stamina. Being a specialist with some skills sets began to give one an advantage. The rate at which new knowledge emerged was measured in thousands of years.<sup>2</sup>

## THE INDUSTRIAL ERA

This refers mainly to the first and second industrial revolutions – it was the period of mechanization and mass production and lasted for about 2 centuries.<sup>2</sup>

**The first industrial revolution** marked the end of the Agricultural Era and spanned the 18<sup>th</sup> century to the beginning of the 19<sup>th</sup> century, between 1760 -1840, in the United Kingdom.<sup>1</sup> It is associated with the emergence of mechanization which replaced agriculture. It was powered by coal and the steam engine. This new type of energy accelerated development, with railroads and massive increases in human and material exchange. The presence of coal and steam led to the development of factories and settlements around these industries. This resulted in migrations of people from farms looking for work in the factories and mines. It ushered in the mechanization of production.

**In the second industrial revolution** which began at the end of the 19<sup>th</sup> century, between 1870 and 1914, we began to see more technology and new sources of energy. Electricity, gas and oil powered the 2<sup>nd</sup> Industrial Revolution and led to the emergence of the combustion engine. There was an accelerated application of science to production that established mass production.<sup>1</sup> This was the beginning of the period of scientific discovery. There was also a focus on developing institutions for education and scientific research and the establishment of many universities.<sup>3</sup> It marked the beginning of the growth of the steel industry as a result of the exponential demands for steel. It was the period of accelerated

growth in chemical synthesis, resulting in synthetic fabric, dyes and fertilizer.<sup>4</sup> During this era, communication and transportation were completely revolutionized, with the invention of the telegraph, telephone, cars and airplanes at the beginning of the 20th Century. This resulted in remote communication and effective mass transportation. This was the era of large factories and blue-collar jobs, and the beginning of the world becoming a global village.

This Industrial era that spanned about two centuries, from the 18<sup>th</sup> – 20<sup>th</sup> centuries, totally revolutionized the leap from the agricultural era to the industrialized era. By the end of this period, more people lived in cities than on farms.<sup>1</sup> The ability to be efficient, to prioritize and to optimize production was the required competence for survival. The most competitive businesses or countries were beginning to optimize labour and replace labour by mechanization.

### **THE INFORMATION ERA (3<sup>rd</sup> Industrial Revolution)**

This began in the second half of the 20th century, from about 1960, and marked the beginning of the third Industrial Revolution. This revolution was driven by digitization and marked with a rise in electronics, of transistors and microprocessors. There was a major change in telecommunications, with computers and the development of the internet resulting in another major shift in communications from letters and telegraphs to emails and social media, and a new form of energy, nuclear energy.<sup>5</sup> The new technologies allowed the development of miniaturized material which gave rise to great leaps in space research and biotechnology. In industry, this translated into high-level

automation including robots.

In this era, exponential changes in the rate of knowledge production occurred, such that the new timespan of knowledge was in decades. There was an explosion of knowledge and access to information became more democratic, with the advent of the internet and search engines. Societal development was driven by data. The talents required at this time were the ability to acquire knowledge and skills. To succeed, one needed to be able to reduce knowledge to its component parts and master each part. It was the era of the hyper-specialists. This era which was powered by electronics and information technology was very different from the previous ones which were powered by different forms of energy.

### **THE AUGMENTED ERA (4<sup>th</sup> Industrial revolution)**

It is postulated by some that the world is on the cusp of the Fourth Industrial Revolution, while others believe we are already there. This new revolution builds on the digital revolution of the 3<sup>rd</sup> Industrial Revolution and will be marked by more interaction and integration between man and machine. It is the era of convergence with the development of technologies that blur the lines between the digital, physical and biological arenas.<sup>6</sup> It is the era of artificial intelligence, genome editing, of 3D printing, of smaller and more powerful sensors and more mobile and ubiquitous internet (Internet of things). Artificial intelligence, however, is poised to be the largest technological revolution of our time, with the capacity to disrupt almost all aspects of human life, from governance and production to management and health.

Artificial intelligence (AI) is the branch of the computer sciences that emphasizes the development of intelligent machines, thinking and working like humans. For example, speech recognition, problem-solving, learning and planning. It broadly refers to a group of technologies that allow machines to act like humans in the ability to sense, think and act.<sup>7</sup> These human characteristics are then augmented by the ability to learn from experience and adapt over time. These technologies allow us to control the physical through the virtual world. AI is rapidly developing, with the potential to solve some of the most urgent healthcare problems in the world, and also to be the most disruptive. At the heart of this rapid growth is the explosion of digitized data, which is expected to exceed 163 zettabytes (one trillion gigabytes) by 2050, as well as massive increases in the computational power of computers and the cheapness of cloud storage.<sup>8</sup>

This era powered by data is poised to transfer any task that can be reduced to an algorithm to intelligent machines. This era will be marked by rapid rates in knowledge turnover and it will be important to have cognitive agility (capacity to flexibly operate with openness and focused attention) and creativity (the ability to perceive the world in new ways, to find hidden patterns, to make connections between seemingly unrelated phenomena, and to generate solutions. This era is set to be the 2<sup>nd</sup> major transformation in human history and development. The first was the Industrial revolution about 200yrs ago that saw the development of the steam engine and electricity that led to the automation of muscle power and physical work. This second one is

likely to have more impact on humanity because the technologies that are coming up have the ability to augment and automate cognitive tasks.<sup>9</sup>

## **IMPACT OF THE INDUSTRIAL REVOLUTIONS ON DISEASE SPECTRUM**

The changes in the 4<sup>th</sup> Industrial Revolution will impact health and education, as have all the industrial revolutions which have changed the way humans live and interact, and have had an impact on the spectrum of diseases that were predominant. As man moved from the hunter-gatherer era, from an era of intense physical activity, to the information and augmented era where intense cognitive activities were required, there was a gradual replacement of not only physical activity by machines, but the beginnings of a gradual replacement of many of our cognitive activities by computers. There was also a consequent change in disease spectrum.

the pre-industrial societies, with their close interaction with nature and animals, were more affected by communicable diseases, though large-scale diseases did not begin to manifest till the introduction of agriculture around 10,000 BC, when man began to settle into communities and farms. This led to the introduction of cholera (contaminated water), malaria (by the mosquito), small pox (domestication of camels), measles, typhoid and scarlet fever (that would plague the world for many years), leprosy (domestication of buffalo), as well as tuberculosis (domestication of cattle).<sup>10,11,12</sup>

These diseases became more acute as urbanization continued and cities grew in population. Trade routes opened up passages for

the transfer of microbes between communities, leading to the spread of epidemic disease. This was the era of the great epidemics and pandemics, with the indiscriminate spread and symptoms of bubonic plague, small pox, typhus, cholera and influenza, which were to continue into the 1950's and claim millions of lives.<sup>14</sup>

With increasing industrialization and the application of science to production, there was also a concurrent increase in the application of science to health. The industrial era brought with it giant leaps in the control of communicable diseases, the discovery of antibiotics and improvements in public health, with safe water, improved sanitation and housing,<sup>1,14</sup>

These improvements led to such phenomenal reductions in the incidence of communicable diseases that there was a euphoria that communicable diseases had been vanquished, and led in 1969 to those famous last words by the American Surgeon-General, Walter H Stuart, that "It was time to close the books on infectious diseases" which reflected the thinking of the day. However, this improvement in industrialization and changes in lifestyle from the very active, labour intensive agrarian lifestyle to the era of mechanization, characterized by the automation of muscle power and work, resulted in a more sedentary lifestyle. In addition, the application of science to mass production led to improvements in production, storage and preservation of food, as well as production of "new food", some of which had no origin in plants or animals; what I call the 'chemicalization' of food. This coupled with

increasing age of populations, as a consequence of improved health, has led to the rise of lifestyle diseases such as diabetes, hypertension and cancers.

As we move into the 4<sup>th</sup> industrial revolution, new patterns are emerging. We are already witnessing reduction in human interaction and relationships as man-machine interaction increases with the advent of the mobile phone and laptops, as well as various social media platforms that give an illusion of human interaction. Could this be a factor in fueling the increasing rates of mental disorders?<sup>15</sup> There is also the continued encroachment of work into private time, with people unable to "switch off" from their computers, which is associated with stress and anxiety disorders<sup>16</sup>

In each era, changes in societal behaviour and life style brought with it health challenges, which also led to improvement in healthcare delivery. The new technologies and digitization of the 4<sup>th</sup> revolution are already impacting healthcare delivery, research and learning.

## HEALTHCARE IN THE 21<sup>ST</sup> CENTURY

The Fourth Industrial Revolution is already unfolding, and it is going to be a complex and transformational period in human development. The 21<sup>st</sup> century is also witnessing rapid changes in climate, population growth and movement into ecosystems that had previously been uninhabited by man. There is also globalization, resulting in ease of facilitation of pandemics. Infectious diseases appear to be emerging more quickly than ever

before. Since the 1970s, there has been at least one newly emerging disease every year, with about 40 diseases unknown a generation ago and 1100 epidemic events worldwide.<sup>17</sup>

This period also brings with it the promise of more cutting-edge technologies, greater understanding, manipulations and applications of genomics to healthcare. There will be major disruptions in how we work, what work exists, how we organize and coordinate work, and what skills are required as new technologies will take over some tasks or augment workers' capabilities, resulting in disruptive innovations to how care is practiced. Disruptive innovation is said to occur when technology makes a more affordable/accessible service available for a new population of consumers.<sup>18</sup> These disruptive innovations will move the field of medicine away from the traditional face-to-face interaction to a more digitally enabled healthcare and precision medicine. Some of these changes exist and are already impacting the way healthcare is delivered.

The 4<sup>th</sup> industrial revolution also brings great promise of the possibility of cure of chronic diseases and targeted precision medicine, tailored to the needs of the individual. It has brought with it new technologies that are impacting healthcare and will affect the way healthcare is practiced. Some of these include sensors and healthcare trackers (e.g. Fitbit surge) that help to empower patients to take more control of their health, information and communication technologies that allow remote diagnosis (such as telemedicine and telemonitoring), as well as automation and

robotics in surgery and diagnosis.<sup>19</sup> Artificial Intelligence is helping to simplify and automate tasks and complex data. Nanotechnology can improve diagnosis and provide targeted treatment of cancer and other diseases and there are also targeted drug delivery systems. The human genome project has opened up a whole new area of -omics research and man is on the cusp of 'designer babies' from genome sequencing and the gene-editing capabilities of CRISPR/Cas.<sup>20</sup> Other technologies that are revolutionizing medicine and leading to disruptive innovations include virtual reality and augmented reality, and 3D printing, which can be used for replacing human organs for transplants, speed up surgical procedures, produce cheaper surgical tools, and make cheaper and more efficient prostheses.<sup>21</sup>

With these technologies, especially AI, telemedicine, wearable sensors and improvements in virtual reality, the world will get even smaller and a doctor in America can remotely treat a patient in an African village or diagnose a problem through sensors attached to a smart phone. Robots may become more common-place in the hospital and virtual reality and augmented reality may help us visualize and navigate around, more realistically, the insides of the human body. AI will put more control in the hands of patients and will allow more task shifting as more tasks are automated.<sup>22</sup>

Already patients can monitor their own blood sugar and blood pressure at home and can, using wireless devices, upload their data automatically to a specialist physician who analyses the data and recommends the appropriate treatment, which can be carried

out by a junior physician or other member of the health team e.g. a nurse. Task shifting thus allows less specialised healthcare workers to provide the same quality of care at a lower cost more conveniently.<sup>23</sup> It will mean that some jobs that were traditionally for doctors can be done by nurses; those by pharmacists can be done by pharmacy technicians; and those done by radiologists can be shifted to radiographers. For example, teleradiology, remote interpretation of X-ray images and other radiographs is becoming more common. Patients meet radiographers who record the images required by radiologists and the radiologists report back to the consulting physician. The patient usually gets their images by email or on a CD. This process is an example of a disruptive process where new providers have emerged, and the process has become much more efficient. Each part of the new radiology workflow uses the skills and knowledge of the workers involved more appropriately than in the past.<sup>24</sup>

This disruption is already happening across the healthcare workspace and changing the face of healthcare in ways that we did not envisage. It is also challenging traditional roles of various healthcare workers. I dare say it is responsible for some of the rising tensions between professions in the healthcare space that we see in Nigeria today and it will only get worse as some professions may face extinction.

Artificial Intelligence is automating cognition by its ability to use complex algorithms and software to estimate human cognition in the analysis of complicated medical data on the relationships

between patient outcomes and prevention or treatment techniques. The genome project has also opened a world of -omics, genomics, proteomics etc. and epigenetics which study the impact of lifestyles on genes.<sup>25</sup> The future of medicine is predictive medicine which will be as a result of the fusion of information and communications technology with precision medicine (due to developments in genomics, proteomics and cytomics). There are fears which are warranted that AI will change forever the patient-doctor relationship and become impersonal, though efficient and accurate. There are the issues of confidentiality and safety of sensitive patient information. The benefits of AI in health are many but can be classified into 5 main areas.<sup>26</sup>

1. *Process Optimisation* e.g. procurement, logistics, and staff scheduling. AI solutions can help scarce personnel and facilities do more with less by speeding up initial processing, triage, diagnoses, and post-care follow up, thereby reducing time spent per patient and increasing accessibility.
2. *Preclinical Research* e.g. drug discovery and genomic science. For example, pharmacogenomic studies which focus on the likely response of an individual to therapeutic drugs based on certain genetic markers, AI can be used to tailor treatments to the patient this is pertinent especially as Africa is the most genetically diverse continent,
3. *Clinical Pathways* e.g. diagnostics and prognostication: By analyzing patterns in health and testing data, such as

machine vision analysis of x-rays, AI can make faster and more accurate diagnoses. It enables health workers to interpret findings and to identify specific problems and interventions amid complex scenarios with different variables interacting at one time

4. *Patient-Facing Applications* e.g. delivery of therapies or the provision of information. E.g. online conversation agents and machine vision, can provide access to millions of people and diagnose health conditions remotely using images from the cameras of everyday smartphones
5. *Population-Level Applications* e.g. identifying epidemics and understanding non-communicable chronic diseases. AI can better understand patterns in the spread of disease, and then design more effective public health response.

## WHERE IS AFRICA AND WHAT ARE OUR ASPIRATIONS?

It is largely agreed that Africa missed out on the opportunities of the second and third industrial revolutions and many parts of Africa are still in the Agricultural era. Developing the large factories and engines of the Industrial era will be difficult, expensive and time consuming and will not bring us into the 21<sup>st</sup> century when the world is downsizing, automating cognition and augmenting the physical, biological and digital worlds. Despite the fact that Africa has not yet fully engaged with the 3<sup>rd</sup> and 4<sup>th</sup> industrial revolution the impact of it is already being felt in our lives. I believe this revolution gives Africa a chance to leapfrog and close the gap if we are intentional

and strategic and if our tertiary institutions must wake up. Our collective response is critical otherwise we may become irrelevant in the future.

In 2011 Heads of State and Government of the African Union in January during their 24th Ordinary Session the Assembly of the Union in Addis Ababa, Ethiopia pledged, as a part of their 7<sup>th</sup> aspiration in Agenda 2063, to make "**Africa a strong, united and influential global player**"<sup>27</sup>

*"An African turning point, starting at the turn of the millennium with our renewed determination to end wars and conflicts, to build shared prosperity, to integrate, to build responsive and democratic governance and to end the continent's marginalization through the transformation of the OAU into the African Union and the adoption of the New Partnership for Africa's Development (NEPAD). Thus Africa, over the last decade has experienced sustained levels of growth, greater peace and stability and positive movements on a number of human development indicators. We recognise that sustaining this path and pace, though positive, is not sufficient for Africa to catch up, hence the need for radical transformation at all levels and in all spheres. Africa must, therefore, consolidate the positive turn around, using the opportunities of demographics, natural resources, urbanization, technology and trade as a springboard to ensure its transformation and renaissance to meet the people's aspirations."*

They also pledged as part of their call to action to

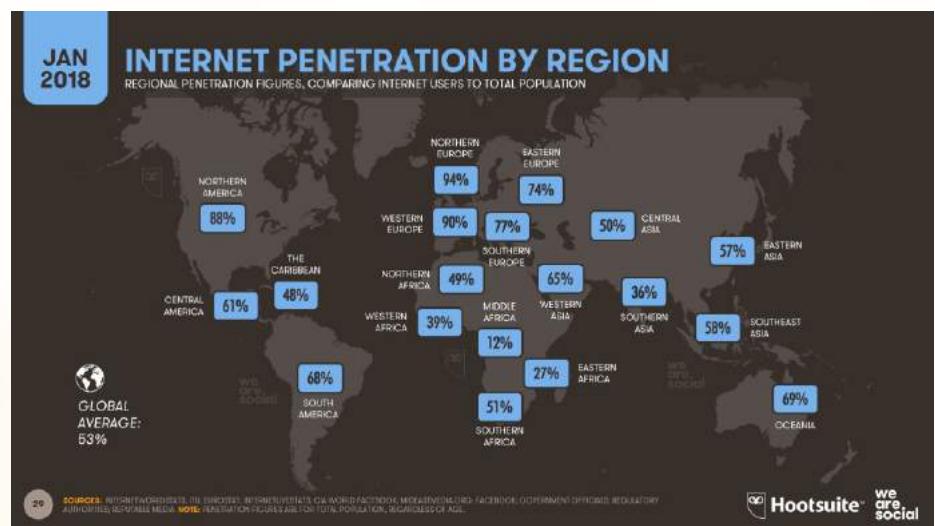
- “.....elevate Africa's role in global research, **technology development and transfer, innovation and knowledge production**”
- “**Harness universities and their networks and other options to enable high quality university education**”

**In addition, African leaders signed up to providing** Universal Health Coverage to all (access to quality, safe, effective, and affordable healthcare, essential medicines and vaccines without suffering financial hardship), within the sustainable development goals, by the year 2030 ..... which is only 11 years away! How prepared are we?<sup>28</sup>

The digital revolution is dependent on energy. The access rate to electricity in Africa has been rising slowly since 2000 and currently stands at 43%, but Africa accounts for 600m of the one billion people globally without access to electricity. Four countries have been responsible for this improvement—Kenya, Ethiopia, Tanzania and Nigeria. The projection for sub-Saharan Africa is that access will double by 2030, but there will still be about 600m without access due to high population growth rates and uneven development.<sup>29</sup> This low rate of access can be turned to a major advantage with the embrace of renewable energy such as solar energy, the cost of which is coming down, and avoidance of the resource-intensive, ecologically-polluting and destructive processes of the 2<sup>nd</sup> and 3<sup>rd</sup> industrial revolutions.

One of the benefits of the information era or knowledge era is that it has created a more level playing field in terms of “potential access”.

The internet has made knowledge more widely available and the numbers accessing the internet has increased exponentially in Africa from about 4.5 m in 2000 to about 525m as at June 2019. However, this rise still only accounts for an 11.5% growth rate when compared to the global increase of 88% in the same time frame. This growth rate has been powered mainly by 6 countries – Nigeria (120m), Egypt (45m), Kenya( 43m), Tanzania(43m), South Africa (32m) and Uganda (18m).<sup>30</sup>



**Figure 1:** Internet Penetration by Region

In addition, the use of technology in solving problems is on the increase and African youth are confident, curious and tech-savvy. Africa has 200m people aged between 15 and 24 years, the largest youth population in the world. They have been developing technological solutions to solve developmental problems. They are

ready and able to compete in the new global ecosystem.<sup>31</sup> Earlier this year, young university students from Senegal won a global innovation contest set up by Ericsson. They did this by creating a VR headset that allows students to complete science lab experiments through VR without the need of constructing a laboratory or buying equipment. In Nigeria a young entrepreneur founded LifeBank, a blood sourcing and delivery service which uses mobile and web technology, and smart logistics, to deliver blood from laboratories to patients and doctors in hospitals across Nigeria.<sup>32</sup>

In healthcare, we are beginning to see digitized health records in some countries (Ghana, South Africa, Zambia, Tanzania) and the impact of technology in health service delivery, in diagnostics, drug discovery and supply chain management is already being noticed. It has been suggested that in Africa, AI offers alternative solutions to communities where trained doctors and resources are scarce<sup>33</sup>

In 2018, Kenya Medical Supplies Agency (KEMSA), started a pilot project using the AI of IBM Watson to aid decision making in their health supply chains in 7 000 facilities countrywide. Users could interact with Watson through SMS, computer and voice-over-mobile data. Supply management stands to benefit from AI, their job dependent on accessing and analysing data which machines can do better than humans can. KEMSA now intends to have AI supervisors share insights on the causes of stock-outs, preventative measures and the identification of relevant resources to improve the availability of products by 50%".<sup>33</sup>

The impact of AI and other technologies on healthcare and other parts of life in Africa is likely to grow in the next decade and they are set to disrupt the ways of delivering care in 5 main areas of healthcare to lesser or greater degrees.

1. *Organisation*: Human resource management and substitution
2. *Healthcare Delivery*: Increasing efficiency, triaging care and optimising scarce resources
3. *Medical Supplies*. Supply chain management
4. *Patient Care*: Access and delivery – e.g. robotics can, if used for surgery, electrocardiographs, screening for neurological diseases and radiology
5. *Research*: Analysis of complex data, searching literature for relevant studies, drug discovery and predictions
6. *Public Health*: Early predictions, source of disease outbreaks etc,<sup>34</sup>

There have been fears that AI will take over the jobs of healthcare workers. However, despite advances in technology, that scenario is still a long way off. Truly, some jobs will be easier to replace than others because patients still need a sense of personal connection. AI is only as intelligent as the quality and quantity of data to which it has access. It still cannot work as well as the human brain to discern unusual diseases and it certainly lacks the human emotions of empathy and compassion that patients require. AI at this time can be seen as a collaborator in solving health problems where humans define the problems, machines find the solutions and humans verify the acceptability of the solutions; in other words,

man-machine teams.<sup>36,37</sup> In the 21<sup>st</sup> century, as knowledge is taken up by machines, emotional Intelligence becomes a major differentiating point on who gets the patient.

So how can Africa leverage on AI and other technologies to leapfrog into the 4<sup>th</sup> Industrial Era.

There are a number of things that need to happen

- We must energize our continent in an ecologically friendly way by accelerating the development and uptake of renewable energy.
- We must unite Africa and create one large market. For Africa to compete effectively, she must be able to provide local innovators a single digital home market of 1.2 billion consumers. The signing of the Continental Free Trade Area<sup>38</sup> in March this year and the launch of SmartAfrica<sup>39</sup> five years ago are definitely the right way to go and need everyone to key in so that they can flourish<sup>40</sup>
- We must wire Africa and increase the rate of internet access for the youth. All jobs in the future will have a digital component. Africa will by 2030 have the largest potential workforce. We must enable them digitally. We must have the frameworks in place to generate good quality data, the capabilities to sort and analyse the data, while creating a seamless environment for accessing and sharing the data.
- We must work on our population. A lot of our gains have been diluted by the rapid rate of population growth. For example, African youth population is expected to double by 2055 and Africa will be home to three of the largest cities in

the world. Lagos is projected to be (88m) Kinshasa in the Democratic Republic of Congo (83m) and Dar es Salaam (73m) by 2050.<sup>41</sup>

- Finally, the amount of data, knowledge and information in the world is increasing exponentially and doubling every 2 years. One thing that's certain is that the future is uncertain, and change will be occurring exponentially. Technology will be disrupting and displacing traditional systems, processes, relationships and tasks. There must be a mind shift to embrace change, leverage on digitization to create new systems and utilise new technology. Administrative and organisational structures, and procedures, must be nimble and flexible enough to easily adapt to new circumstances.

## WHAT SHOULD BE THE ROLE OF OUR UNIVERSITIES? Research

Access to information and access to sharing the information has translated to a fourfold increase in the number of research papers published in scientific journals having at least one African author, from about 12,500 to over 52,000. Articles by African authors almost doubled from 1.2% to around 2.3% of publications.<sup>42</sup>

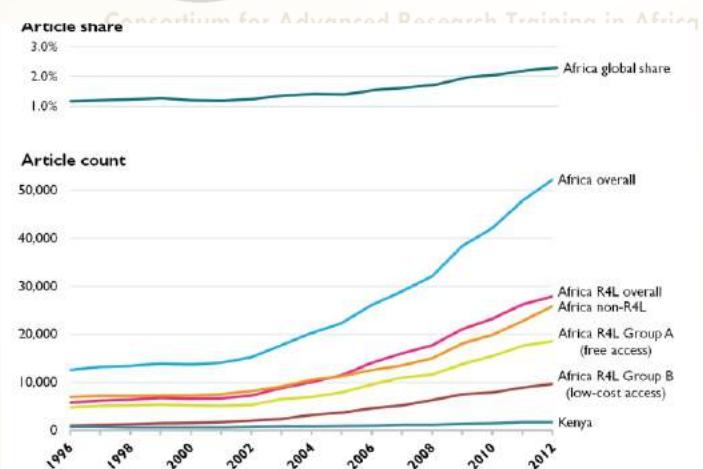


Figure 2: Rising Research Output of African Countries (Schemm Y, Research Trends 2013)<sup>43</sup>

African disease spectrum cuts across the communicable diseases associated with poor public health infrastructure and the lifestyle diseases (hypertension, diabetes, cardiovascular and some neurodegenerative disease) that are the result of a complex interplay of environmental factors, the choices we make (both as individuals and as population groups) and our genome. This understanding has led to whole new areas of '-omics' research, from genomics to transcriptomics and proteomics.<sup>44</sup> We are also beginning to unravel the tools of epigenomics which is the study of changes in gene activity that are not as a consequence of DNA sequence alterations (e.g., DNA methylation).<sup>45</sup> All these studies are collecting fundamental data at the genomic level and these will impact disease treatment in the future.

Africa as the cradle of humankind has the highest genetic variation of any continent. Examples abound of poorer responses to therapies that have been observed based on the genetic expression of some of cancers e.g. triple-negative breast cancer more commonly found in women of African descent or the more aggressive course of some prostatic cancers in black men.<sup>46,47</sup> The future of Medicine is moving towards *Precision Medicine* (application of computational analysis to genomic data) and shifting healthcare towards preventive medicine. It recognizes the complex interplay of the environment and the genome in the aetiology of disease<sup>48</sup>. We are also beginning to understand the import of the microbiome. Research areas that are required will include genomics, bioinformatics, and the cross-cutting areas of system biology and bioengineering. There is also a whole new

area<sup>50</sup> of drone technology and 3D printing that may bypass traditional challenges of replacement organs and parts.<sup>49</sup> We must therefore be intentional in moving into the genomics research area if we are to be major players in the future of Medicine. Precision (personalized) Medicine requires data and we must intentionally plan to create our own large data sets. There is a lot of data out there that can move us forward; we must as universities have strategies of research focus.

We need to gather data, large good quality data, which will come from our teaching hospitals and other hospitals. For data to be usable, it must be captured from patient clinical activities. Rich sources include medical notes, electronic recordings from medical devices, physical examinations and clinical laboratory and radiological images.<sup>51,52</sup> Paper records, as found in many African hospitals, are inefficient and are difficult to maintain, standardize or access.

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A first step to the being able to move us to the future is that all our hospitals must be wired to collect data. Electronic management systems are not only to ease work and make it more efficient, they are a rich source of data that will form the foundation for Africa's propulsion into the 4<sup>th</sup> Industrial Revolution. These data can then be used for machine learning to produce systems that are suited to our environment and our peoples

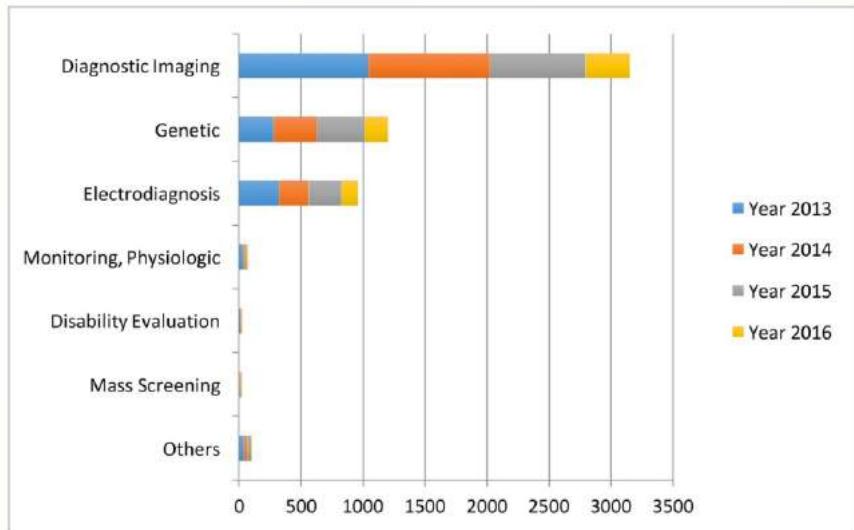


Figure 3: Areas of Medicine that could be Assisted by Artificial Intelligence

We must expand South-South relationships so that we can form the critical mass to move our science along. There must be an intentional strategy across all universities to train not just students, but faculty too, on quality research and how to gather data that is credible. This needs groups of people working together. It requires the coming together of multidisciplinary teams. It requires skills sets that we may not always have in the medical field but may be in the physical and biological sciences, or in engineering. It requires the basic scientists, the clinical scientists, the engineers, the sociologists and other social scientists, the patient and the man on the street. We also need to leverage on our alumni both here and in the diaspora. We need to work across countries and plan multi country studies. We have to embrace team science if we are ever to compete globally.

We must set our own research agenda and priorities and follow through. A systematic review carried out in 2014 that looked at how research priorities were set in low-and-middle-income countries (LMIC) found that they were initiated by an international organization or in collaboration with them 46% of cases, by the LMIC government in 32% of the cases and by a researcher 15% of time. In only 29% of cases was a patient consulted, but most telling of all was that there was no implementation or follow-up strategies planned for any of the studies.<sup>53</sup>

*Will it be difficult? Yes! Impossible? NO!!!* I can read some minds now: “where will the funds come from?” And that is a valid question. The answer I believe is on multiple levels. At the researcher level, my reply is **ideas first!** “Come up with the good idea, well thought out, well researched with potential impact and it is easier to generate interest in funding. At university level, it is imperative that we must enlist our stakeholders, industry, Government and alumni for research funding. This will have to be strategic. We must identify those stakeholders that have influence and have the will. We must join forces with the private sector to lobby Government to put more money in research. The strategies adopted, the industries and organisations targeted will differ between countries and according to research focus. One clear thing is that we must change our research models to be truly locally-relevant, not just for the short term, but for the long term. We also must work with stakeholders in industry across all fields to pressure our governments.

The 4<sup>th</sup> Industrial Era feeds on data. There is a dearth of good data in Africa. The data is often small and cannot be extrapolated. As a continent we must come together to publish studies across countries, using similar protocols and indicators that allow our data to be comparable between countries. We have similar problems and we can work together.

Our response to the change going on around us now will determine whether the health inequities of the past will be worse in the future or not. Whether we in African universities will be able to solve the health issues of Africans in the future or whether our people will have to keep looking to the global North for help depends on the choices we make now. We do have a window of opportunity; the digital age has better democratized knowledge and skills in the internet and the world is getting smaller, so we must leverage the new technologies because the future requires that we all be tech-savvy to be able to mine the data available on the internet

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## Training

Universities produce the researchers and workforce for each generation. The World economic forum made the following projections<sup>34</sup>:

1. While it is predicted that 41% of all work activities in South Africa are susceptible to automation, as are 44% in Ethiopia, 46% in Nigeria and 52% in Kenya; this is likely moderated by comparatively low labour costs and offset by new job creation. Despite this longer window of opportunity, the region's capacity to

adapt to further job disruption is a concern, although there are important nuances at the country level.

2. Currently trending professions on the continent include the creative industries, food technologists, 3D designers, data centre workers, care, education and health workers, according to our analysis in partnership with LinkedIn. In the longer term, there is strong job growth potential in hard and soft infrastructure, green jobs, the ICT sector and through new work formats.

3. The greatest long-term benefits of ICT intensive jobs in the region are likely to be not in the lower-skilled delivery of digital products or services but in digital design, creation and engineering. To build a pipeline of future skills, Africa's educators should design future-ready curricula that encourage critical thinking, creativity and emotional intelligence, as well as accelerate the acquisition of digital and STEM skills to match the way people will work and collaborate in the Fourth Industrial Revolution.

University Education has traditionally prepared people for work, but work is now changing too quickly for the latest professional skills to be easily translated into curricula. This means that, at any time, what is being taught is near-obsolete by the time the student is leaving the university. The rapid acceleration of change in knowledge and information requires students and faculty to be lifelong learners, to remain curious, open to new information and ready to discard old paradigms in short time spans. As the boundaries blur between man, machine and his environment, and

between the physical, the biological and the virtual, new levels of creativity and multiple perspectives are needed to ask the right questions and solve the complex health problems of our time. Achieving this level of competence will need more creativity and competencies than one person can have and will therefore require multidisciplinary teams.

These teams will be augmented by devices that augment cognition and skills or require us to even build new tools. Those that are technologically competent will therefore have the advantage. Finally, this rate of change means that universities today are preparing graduates for a future that is unknown but in which they can only be guaranteed change, rapid change. Graduates are being prepared for a future in which facts may become obsolete within a few years, a future in which the specialty for which they were trained may cease to exist, a future where their workplace may not reflect their present reality and for jobs that may not yet exist. The additional skills needed by students to help them cope in this uncertain world are those skills that cannot be reduced to algorithms, *i.e.* human skills. Educational institutions must put together curricula to address the skills set requirements for the future. However, only few countries globally have in place the education systems to deal with this change.<sup>8</sup>

Students will need the skills of ideation, team work, communication, critical thinking, problem solving, inter-professional respect and emotional intelligence. Our job is to develop curricula that will facilitate the acquisition of these skills,

and the mind-set of curiosity and openness to change of the concepts and the evolving healthcare delivery paradigms. To promote these required skills, there is a need for faculty to move from lectures to more participatory learning styles. Universities need to ensure that their medical education departments adapt to current realities. African youth have shown that they are at home with technology and can harness the tools of this era, the faculty must catch up too.

## CONCLUSIONS

Will major disruptions happen in Africa soon? I do not know, but the disruption has started, and it will reach an inflection point from which it will accelerate. Can we afford to ignore it? No, because of the globalized world in which we live, we will be impacted whether we are ready or not. The future is already here. I believe we have a great opportunity to embrace the changes that come with it and drive the African agenda. Let us look to our societies to identify our problems and let us work together to produce the solutions as Africans.

Before I close, I will like to share with you a definition of a University which I believe truly captures the spirit of universities. A definition which calls us to action as universities in Africa and demands from us cognitive agility and creativity. It requires from us a courage to break down barriers between specialties and professions, between African countries, to move out of our comfort zones and to let our minds be free.

This definition is by John Henry Newman in his book “*The Idea of a University*” written in 1852 where he called a university a “*Studium generale*” or “School of Universal Learning.”<sup>53</sup>

***“It is the place to which a thousand schools make contributions; in which the intellect may safely range and speculate, sure to find its equal in some antagonist activity, and its judge in the tribunal of truth. It is a place where inquiry is pushed forward, and discoveries verified and perfected, and rashness rendered innocuous, and error exposed, by the collision of mind with mind, and knowledge with knowledge.***

It is the place where the professor becomes eloquent, and is a missionary and a preacher, ..... ***It is a seat of wisdom, a light of the world, a minister of the faith, an Alma Mater of the rising generation. It is this and a great deal more,.....One generation forms another. ... We must consult the living man and listen to his living voice, ... and by familiar intercourse ... to adjust together the claims and relations of their respective subjects of investigation. Thus, is created a pure and clear atmosphere of thought, which the student also breathes.”***

Thank you for listening

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