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Abstract

Background: The Ebola virus disease outbreak of 2014 was the largest, longest and most devastating in the history of the disease. It demonstrated the social and economic impact an emerging infectious disease can have in a globalized world. Health systems in affected countries were stretched to the point of near collapse, while social relations and traditional practices were negatively impacted. Heads of African research institutions, African government representatives, leaders of global pharmaceutical companies, global infectious disease experts and close to 100 young African researchers from 25 countries; Assembled in Geneva on 19 and 20th October 2015, for the inaugural UNESCO-Merck Africa Summit sponsored by the United Nations Educational, Science and Culture Organization and Merck KGA

Goal of Summit: The primary goal of the summit was to develop strategies to increase health research capacity in Africa, with special focus on Ebola and enhancing pandemic preparation for emerging infectious diseases. The summit was also provide a forum to showcase the research taking place in Africa, and provided platform for African researchers to network. Some of the key issues discussed included; strategies for enhancing policy frameworks to promote knowledge translation, strengthening of health systems, enhancing knowledge and data sharing, and increasing innovation in Africa.

Conclusions: Summit attendees recognized that Africa still bore the heaviest burden of infectious disease, and increased commitment by African governments to fund health research, offered the best hope for developing health solutions and interventions to improve the health of Africans. Improved health in turn would enhance the productivity of Africans, further supporting the socio-economic transformation currently taking place on the continent.

Research is a catalyst for Social, Economic and Sustainable development in Africa.

The health of a population, is critical for social and economic productivity(WHO 2015). In recent years, majority of African countries have experienced positive growth and development. In order to expand and sustain the positive trends, African countries need to prioritize investments in health research as a means of reducing the heavy burden of disease on the continent. The hope is that, increased health research will translate into innovation, discovery of novel compounds or expanded knowledge, which would greatly assist the continent to address its most pressing health needs. Africa is also faced with novel health challenges, in the form of increasing prevalence of non-communicable diseases (NCDs), rising antimicrobial resistance and emerging infectious diseases (WHO-AFRO 2014). Some of the recent gains made at improving the health of Africans, can be built upon by further strengthening individual country health systems, an effort requiring partnerships between public and private sectors, non-governmental organizations (NGOs) and academia. UNESCO-MARS summit brought health researchers from Africa, together with to executives of global pharmaceutical companies, UNESCO officials and representatives of African government, to dialogue on ways to improve global cooperation on combating emerging infectious diseases and other challenges facing the life sciences and health research in Africa. It also provided a platform for discussing ways of improving knowledge translation of research already taking place on the continent as a means of bridging the 'know-do-gap'.

The North (developed) to South (developing world) 'loans and aid' model initially used to bring development to postcolonial Africa, has since transitioned to the more 'collaborative' approach which seeks to enhance development through mutually beneficial North to South and South to South relationships. This collaborative approach in the words, Prof Imbuga Godia- Kenya's representative at UNESCO, enabled the World to make significant strides through initiatives such

as the development of Millennium Development Goals (MDGs) of 2000, and more recently the UN Sustainable development goals (SDGs) of 2015, when ideological differences between countries, organizations, public or private sectors were put aside.

The Ebola outbreak in 2014-2015 in West Africa, demonstrated the need for strengthening the areas of disease surveillance, diagnostics, emergency response, health infrastructure, training of health workers and preparation for outbreaks of emerging infectious disease.

UNESCO's Partnership with Africa

Ten years ago, UNESCO made enhancement of research capacity in Africa a priority, and sought to achieve this through a number of initiatives. First, by developing of centers of scientific excellence or UNESCO natural science category 2 centres in already existing African research institutions primarily financed by local governments, who then received UNESCO's support for their staffing needs and running costs, through structured agreements with national governments. More recently, UNESCO started a research awards scheme to promote scientific competition and excellence through awards such as; the Equatorial Guinea International Prize for Research in the life sciences meant to stimulate and promote interest in life sciences in Africa and the developing world; The Carlos J Finlay Price in microbiology; UNESCO L'Oreal prize for Women in Science, to motivate women to pursue careers in Life and health sciences, among others.

UNESCO in collaboration with the World Health Organization and World Bank, have in the past supported a number of initiatives seeking to develop human capacity for health research in Africa, such as the 2008 Global Ministerial forum on Health (Bamako 2008) that resolved to increase institutional and capacity building in Africa. Other human capacity building and training initiatives in Africa supported by UNESCO include; The Network of Brain Sciences in Africa formed through a UNESCO-International Brain Research Organization-IBRO partnership, which seeks to enhance brain research in Africa, advanced optics and photonics training offered by International Centre for Theoretical Physics (ICTP- a Category 1 centre). Majority of these were formed in collaboration with African Union, in line with the implementation of the harmonized Science Technology and Innovation Strategy for Africa (STISA-2024)(AU 2014). UNESCO in partnership with the AU, recently started the Global Observatory of Science, Technology and Innovation Policy Instruments (GO→SPIN), tasked with assessing science policy and the state of research in African countries to enhance institutional management, human capacity and policy frameworks(UNESCO 2012). The GO→SPIN initiative has already completed mapping research and innovation in several African countries, including Botswana, Zimbabwe, Malawi and Rwanda (UNESCO 2013; UNESCO 2014; UNESCO 2014; UNESCO 2015). UNESCO also continues to promote African science in general, through special initiatives such as the UNESCO International years project. For instance, '2015' was 'the year of light' proposed by Ghana, targeting to promote the field of crystallography in Africa. UNESCO continues to partner with different African countries to formulate of national science policy guidelines, and supports African countries with trying to achieve their innovation and research development objectives.

Dr. Vittorio Colizzi of the University of Rome Tor Vergata, was involved in the establishment of a number of collaborations between UNESCO and African research institutions, during his 15 year tenure as the UNESCO chair for interdisciplinary biotechnology in Sub-Saharan Africa. The strategy used by Dr Vittorri team, was one of fostering the establishment of North-South-South collaboration, by providing linkage between institutions in North (developed countries), to those in the South (Africa), while promoting the establishment of linkages between African institutions (South-South). During his tenure, he was involved in the establishment of a number of collaborations in West Africa, as part the efforts to boost research on infectious diseases in Africa, including; The Integrated Research Center Biotechnology in Abidjan, Cote d'Ivoire (CIBRA-Centre Intégré de Recherche Biotechnique d'Abidjan) for studying aspects of HIV immunology; CEBRA- Ouagadougou- Burkina Faso- HBV/HPV (immunology and molecular biology); International Reference Centre Chantal Biya (IRCCB -Yaounde (Cameroun) for research on the immunology and molecular biology of HIV-TB and HBV-HCV coinfections.

Dr Vittori was also involved in various research projects across West Africa, more recently in Sierra Leone, leading to discovery of Ebola virus specific antibodies in both asymptomatic survivors and exposed but EVD uninfected health care workers (HCWs). Further emphasizing the need for enhanced screening for caregivers, HCWs and Ebola virus survivors, given the reports of human-human transmission of Ebola in semen, vaginal secretions, breast milk and other body fluids(Bausch, Towner et al. 2007; Christie, Davies-Wayne et al. 2015; Rogstad and Tunbridge 2015). His works also demonstrated the importance of conducting studies seeking to elucidate intricate aspects of transmission or epidemiology of an emerging infectious disease, in during an ongoing outbreak. A gap in knowledge gap exists on the animal reservoirs of Ebola virus, and on the mechanisms of viral reactivation in survivors of the disease. These are interesting questions which could be answered by African researchers.

Merck's Partnership with Africa

"Africa is always producing something new- and we are proud to be a partner in the successful future Africa is shaping for itself." Karl Ludwig Kley- CEO Merck KGaA, Darmstadt, Germany.

Merck KGaA is the oldest pharmaceutical and chemical company in the World, established in Darmstadt Germany in the late 17th century. It has recently embarked on an ambitious plan to expand its operations and presence in Africa through the Merck Capacity Advancement Program (CAP). The five year program has 7 signature initiatives, namely- the 'Universities program', 'Diabetes Awareness and Prevention campaign', 'More than a mother Campaign', the 'Cancer Access Program', 'Africa Supply Chain Forum', 'E-health Initiative' and in partnership with UNESCO- the Merck Africa Research Summit (UNESCO-MARS). Dr Stefan Oschmann, the Vice Chairman of the Executive Board and Deputy CEO of Merck KGaA, stated the company now had an expanded portfolio which included different production arms in biopharmaceuticals, life-sciences and performance materials businesses, making the company a science and technology company. Dr. Oschmann revealed that Merck KGA was motivated to start the summit for young African researchers because of two factors- 'Demographics' and 'economics'. According to the revised World Population Prospects report 2015, the World's population will hit 9.7 billion people by 2050 if the current growth rate of 1.18% is maintained(United Nations 2015). Majority of the global population growth will occur in Africa, if the continent maintains the current growth rate of 2.55% per year. Africa's population would then hit 2.4 billion people in 2050, making every 4 out of 10 people on the globe then, African(United Nations 2015). The projected growth in Africa's population will likely open up new economic opportunities in research, labour or services. This makes Merck's investments in Africa very timely, and suitably positions the company to be part of Africa's promising future.

The Current Status and Challenges Facing Health Research in Africa

In recent years, Africa has made remarkable progress towards overcoming some of its traditional health challenges, mainly due to improvements in healthcare provision, increases trained healthcare personnel and improvements in health infrastructure across the continent. However, there are areas which need great improvement for quality and universal health provision to be attained in Africa. These would be greatly aided by sustained political stability and the positive economic growth taking place across Africa. The continent still has the heaviest burden of disease, yet invests the least in health research. Africa also has the lowest per capita of trained health professionals and health infrastructure in the World (WHO 2015; WHO 2015).

1. Africa's high burden of disease

A. Infectious Diseases (Communicable Diseases)

Africa continues to bear the greatest burden of infectious diseases globally, with the highest disability-adjusted-life-years (DALY) at 71%, and the highest years of life lost (YLL) at 50%(WHO-AFRO 2014). The highest contributors to Africa's infectious disease burden are: HIV (25.8 million or approximately 70% of all infections)(UNAIDS 2015), Tuberculosis (7.2 million or 90% of all infections)(WHO 2015) and Malaria (188.2 million or 88% of all infections)(WHO 2015). These diseases were also the leading causes of mortality on the continent in 2014(WHO-AFRO 2014). The good news was in the reduction of incidences for all three diseases owing to increased coverage of key interventions for HIV, TB and Malaria(WHO-AFRO 2014). For instance, by the end of 2014, 15.8 million people were receiving ARVs, up from 690,000 in 2000, accompanied with declines in HIV incidence from 520,000 to 220,000 in children and 4.7 million to 2.1 million in adults, between 2000 and 2012(UNAIDS 2015). Currently, 68% of children in Sub-Saharan Africa sleep under an ITN (Insecticide Treated Nets) compared to less than 5% in 2000, consequently the Malaria incidence has declined by 37% globally(WHO 2015). The increased rates of detection of TB from 38% to 63% and higher treatment success (85% or higher) through the Directly Observed Treatments (DOTS) program in the period after 2007, led to a 1.5% reduction in TB incidence on average across all regions globally(WHO 2015). Overall, great progress has been made in reducing the prevalence of these infectious diseases including parasitic and respiratory infections, which fell from 12.1 million in 2000 to 9.5 million globally in 2012(WHO 2015).

At the summit, Dr Peter Faussett of UNAIDS presented a progress report on the global campaign to halt the HIV epidemic, which has made remarkable advances in recent years nearly halting the 40-year-old pandemic. The rates of new HIV infections have declined, while the life expectancy of infected individuals increased owing to the significant increases in use of antiretroviral therapy (ART), resulting in reductions of disease morbidity and mortality resulting from HIV/AIDS. The reductions in new infections cannot be attributed to a single factor, but have been largely associated with the expanded use of antiretroviral therapy (ART) in recent years, coupled with the expansion of prevention tools for limiting the spread of the virus. Yet more needs to be done to end the pandemic by 2030 as targeted under the newly released SDG 3.3(WHO

2015). Africa has not been left behind in the war against HIV/AIDS. Majority of the tools currently used in preventing new infections, and the recent improvements in clinical management of HIV/AIDS, have arisen from research conducted by Africans. For instance African researchers demonstrated the protective effect of medical male circumcision (Auvert, Taljaard et al. 2005; Bailey, Moses et al. 2007; Gray, Kigozi et al. 2007), and discovered a number of novel uses for HIV antiretroviral therapy (ART) in pre- and post- exposure prophylaxis (Abdool Karim, Abdool Karim et al. 2010). More importantly, there are many lessons to be learnt from the measures taken in dealing with the HIV/AIDS pandemic which could be useful for the management of emerging infectious diseases such as Ebola. The knowledge gained from the extensive and broad range research conducted in the search of a HIV vaccine, produced as a spinoff great advancement in the fields of immunology, vaccinology, virology and microbiology, and resulted in great improvements of research technologies and infrastructure across Africa. Some of this knowledge and technologies, have been used to rapidly understand the biology or to develop interventions against emerging infectious diseases.

I. Emerging Infectious Diseases

The discovery of antibiotics and vaccines against a number of deadly pathogens, created the perception that mankind was finally winning the war against microbes. This was following massive outbreaks of infectious diseases in the early part of the 20th century which killed millions of people and severely impacted the economic and social aspects of life in affected countries. However, the discovery of newer and more deadly infectious diseases changed all this, starting with Ebola (1976), HIV (1983) and the identification an additional 1470 new pathogens between 1970 and 2007, the majority or 70% of which were zoonotic in nature (Mathis M. 2015). Majority of the speakers at the summit, spoke on the Ebola outbreak in West Africa, as such the discussion following will focus on the recently ended and previous EBOV outbreaks.

Ebola (2014)

The recent Ebola outbreak in West Africa was the first in the region. It was also the longest, largest, deadliest and most devastating outbreak in the history of the disease. The recent Ebola outbreak is one of an old disease occurring in a new context, exhibiting a more rapid and invisible spread in the early phase (UNDP 2015). The last WHO report of 11th May 2016, indicated that 28,616 confirmed cases and 11,310 deaths had been recorded in the 2014 outbreak, compared to 2232 cases and 1503 deaths in the period between 1976-2012 (WHO 2015). The West African outbreak viral strain was more virulent compared to the Central Africa ones, with a 2.5 times faster rate of replication based on mathematical models (Chowell and Nishiura 2014). Previously, the outbreaks frequently occurred in rural parts of Central Africa, in countries with equally weak health systems. Repeated outbreaks in Central Africa, allowed countries in the region to develop efficient outbreak detection systems, accompanied by improvements in health infrastructure to deal with such events and better sensitized their citizens. Delays in identification and positive diagnosis of suspected cases in the recent outbreak, resulted in continuous invisible spread of the virus in rural areas, allowing the virus to spread into urban centres where continuous visible chains of transmission were later established. The early and rapid uncontrolled spread of the disease in rural parts of Guinea, Sierra Leone and later Liberia, allowed the disease to spread into larger urban centres like Conakry, Freetown and Monrovia. The urban spread of Ebola stretched the weak and already overburdened health systems in the affected countries, to the extent of limiting the capacity of health workers to provide life-saving services to infected individuals, and later causing a public anxiety which further hampered the efforts to trace contacts of infected persons. All worst affected countries, had recent histories of political unrest, internal conflict or were in the process of recovering from the effects of wars that had destroyed public infrastructure, affected distribution of people and other resources.

Historically, the people of West Africa are highly mobile, and perform certain cultural practices or rituals which may have enabled the spread of EVD. Unfortunately, some of the prevention strategies instituted during the outbreak eroded some of these practices along other longstanding cultural values, negatively impacting communal behaviours, burial rights, care provision to infected family members and enhanced mistrust in communities.

The economic impact of the West African Ebola outbreak of 2014-2015, was estimated at \$500 million in the short-term, and \$2.6 Billion in the long-term by World Bank. The outbreak brought overwhelming challenges to almost every sphere of life in Sierra Leone, Liberia and Guinea, where movement of people and goods was greatly impeded. As a result the economies of the three countries contracted, with projected growths declining from 4.5% to 1.3% in Guinea, 11.3% to 6% in Sierra Leone and 5.9 % to 0.4% in Liberia (Bank 2014). The down-turn in economic prospects for the three countries, had spillover effects to the neighbouring Niger, Cote d'Ivoire and Mali, where livelihoods were lost, trade reduced or in-flows of foreign investments, affected by due by border closures, pushing more people into poverty (UNDP 2015). The socio-economic impact of the EVD during the West African outbreak was immense, resulting in lowering of indicators of development, and this may affect the attainment of the SDGs if unmitigated.

People aged between 15-44 years and young children were the most impacted, and women were affected more than men in the West African outbreak (UNDP 2015). The impact on women was evident by the changes in women's health seeking behaviours witnessed, especially for services offered to women at health centres where majority of the EVD cases were managed. These included; contraceptive services, immunization and safe delivery of children by trained health professionals. For instance, in Sierra Leone, safe delivery of children by health professionals dropped from 52% to 38%, while hospital deliveries which dropped by 30%. The primary caregiver role played by women, often assisting infected family male members and children, enhanced their risk of getting infected.

Enhancing Africa's Capacity to Deal with Emerging Infectious Diseases

At the summit, attention was directed at the key areas of equipping African countries with the appropriate tools for dealing with emerging infectious diseases. The success of any future efforts to rapidly contain outbreaks of infectious diseases like Ebola in Africa, will depend on increasing the efficiency of health systems in the countries that are most at risk of Ebola, especially with regard to rapid detection and management of suspected cases of Ebola (UNDP 2015). Through:-

i) Proper Training of African Health Professionals

Future outbreak preparation efforts in Africa will require well-trained health professionals, who will be able to competently diagnose pandemic causing pathogens, and efficiently execute health protocols and containment procedures for highly infectious pathogens. Proper training of health professionals will require the creation of programmes offering basic knowledge on emerging infectious diseases, outbreak preparation, and training on management of procurement and logistics, and strategies for coordinating relief efforts. The trainings should be coupled with the establishment of outbreak coordination systems, and appropriate logistical systems for handling supplies and medications. Efforts to train health professionals on pandemic preparation, should be supported by efforts to increase health researchers on emerging infectious diseases, who in turn will contribute to the processes of developing solutions for the constantly evolving challenges in the setting of an outbreak.

ii) Improving Outbreak Detection and Diagnostic Capacity:

Dr. Ian Goodfellow, of the University of Cambridge shared his experience working in Makeni- Sierra Leone to establish a diagnostic laboratory, during the West African Ebola outbreak. He was the leader of a team of volunteers tasked by Public Health England to establish and manage a diagnostic lab for detecting Ebola virus at Makeni treatment facility in Sierra Leone. The establishment of a diagnostic lab in Makeni- Sierra Leone by Dr Goodfellow and his team, reduced the average time taken to make a proper diagnosis of Ebola from 4-10 days at the peak of the outbreak in October 2014, to under 24 hrs by December 2014. The Sierra Leone experience, made Dr. Goodfellow appreciate the importance of in-country real-time genetic sequencing capacity in Ebola prone regions, as a means enhancing disease detection capacity, and for monitoring viral evolution to facilitate development of epidemiological maps of human to human transmission. The lab in Makeni processed nearly 1600 samples, and generated 600 full genome sequences of the Ebola virus with approximately 75% genome coverage, in turn-around times of approximately 24 hours per sample. Real time sequencing of Ebola was a useful tool for identifying the sources of orphan cases of Ebola. For example, Dr. Goodfellow's team was able to trace the source of EVD infection in a 16 year old girl from Makeneh, to a survivor from a different village based on Ebola virus sequence data. Consequently, Dr Goodfellow's team established the UniMak Infectious Diseases Research Laboratory which in addition to being used for research on the disease will be used for training Sierra Leone researchers in the future.

African countries in regions prone to Ebola also need to establish early detection systems, supported by well-equipped laboratories for screening of suspected blood samples. In the case of Ebola, real time-polymerase chain reaction (RT-PCR) machines could be useful for detecting viral RNA in blood from suspected cases. It is equally important to streamline the operations between sample collection points and diagnosing laboratories, to reduce the time taken to make a positive diagnosis, which would then allow for swifter activation of different outbreak response elements. The proper functioning of an outbreak detection system also requires proper management of specimens, beginning at the point of collection, followed by transportation and eventually ending in laboratory testing or storage. Integrating clinical information with data management systems prior to outbreaks, offers better support for sharing of epidemiological and clinical data between clinics, field sites and laboratories. In turn, this will enable constant monitoring of epidemiological and viral sequence data, both of which are a crucial for understanding the dynamics of transmission and viral evolution.

iii) Establishing channels for disbursing emergency response funds during outbreaks

Efficient, sufficient and timely disbursement of funds during outbreaks of emerging infectious diseases is a critical aspect of the outbreak response. Emergency funds like the African Public Health Emergency Fund created by WHO in 2010, was critical for mobilizing, managing and disbursing resources from member countries during events of public health concern, like the H1N1 pandemic of 2009. In the West African Ebola outbreak, AU and ECOWAS set-up 'stop Ebola' fund to boost the Ebola response activities. In spite of this, the provision of funds to local governments was often delayed or encumbered by challenges in prioritizing or harmonizing the usage of funds, between governments of affected countries and international organizations. In the future, establishment of proper and transparent mechanisms for allocating and prioritizing the usage of such emergency funds would be greatly assisted by enactment of the necessary legislation or institution of appropriate policy instruments.

iv) Integrating regional and national prevention strategies for optimal results

An integrated approach to West African EVD outbreak, involving national, regional, continental and international prevention strategies, contributed to the successful containment of the disease. The areas of collaboration included contagion control, epidemiological data sharing, care provision and social support to infected individuals or families. National governments and international organizations collaborated to ensure peace and security, through actions by various agencies of the UN, AU though AU support to Ebola outbreak in West Africa (ASEOWA), ECOWAS together with AU which committed to set up a regional centre for disease control. The ECOWAS centre will be mandated to focus on health research activities in Africa, complementing other regional and continental efforts.

v) Engagement of Community and National Leadership during outbreaks, matters.

During the West African Ebola outbreak, local governments played an important role in reducing social anxiety during outbreak, which was crucial for the mobilization of residents in the affected countries and communities to participate in outbreak response activities. Both local and national governments should be engaged at all stages of the outbreak, before, during and after.

vi) Need to strengthen health systems in countries surrounding those affected by Ebola.

The health systems in West African countries neighbouring those affected by the Ebola 2014 outbreak, were just as vulnerable and could potentially be exposed to future similar outbreaks. However, West Africa countries that had relatively stronger health systems like Nigeria and Cote d'Ivoire, were able to rapidly and efficiently halt the spread of Ebola in spite of encountering a few cases of Ebola during the outbreak. The contrasts between the two sets of countries, serves to illustrate that strengthening health systems in African countries which are most at risk of Ebola, is essential. Efforts to strengthen health systems may include increasing budgetary allocations to the health sectors in countries with weak health systems, in line with the Abuja Declaration of 2001. Additionally, the institution of the necessary preventative measures, investment in risk reduction and improvement of health management systems, will all contribute to the strengthening of health systems in the countries concerned. The process of strengthening health systems could also be through devolution of health services like in Nigeria and Senegal. This allowed local health authorities to act more promptly and independent of the central government during the 2014 outbreak, leading to rapid and effective containment of Ebola in the two countries.

vii) Protection of vulnerable populations during outbreaks is essential

The Ebola outbreak in West Africa demonstrated that women as primary caregivers were more vulnerable to emerging infectious diseases. Future interventions and pandemic preparation strategies should be viewed through gender lenses, with women and children being incorporated into recovery plans to restore kinship links ensuring proper care to all affected individuals.

Overall, important lessons were learnt and systems developed during the EVD outbreak in West Africa. These should be used broadly as guides for future Ebola pandemic preparation, avoiding the overlap in the strategies, program and infrastructure in management of future outbreaks of other diseases.

b) Non-communicable Diseases (NCD)

Globally, approximately 38 million (68% of all deaths) deaths occur annually due to NCDs, 30 million (or 80%) of these are in low to middle-income countries. The prevalence of NCDs globally declined between 2000 and 2012, masking the increasing number of NCDs in Africa and the Middle-East Region (Di Cesare, Khang et al. 2013). The rise of NCDs in Africa in contrast to declining patterns observed globally, obtained prominent mention during the UNESCO-MARS summit 2015. Cardiovascular diseases (CVD) (17.5 million), cancer (8.2 million) and diabetes (1.5 million), are the leading causes of death among the NCDs. The major risk factors associated with these diseases include unhealthy diet, sedentary lifestyles, tobacco use, lack of physical activity, rising air pollution among other factors. Given that the UNESCO-MARS conference focused on infectious diseases, we would like refer readers interested in obtaining more information on NCDs in Africa, to the recently published WHO- NCD progress monitor report in September 2015 which gives a country by country account on the steps being taken to reduce NCDs (WHO 2015).

c) Neglected Tropical, Waterborne and other Diseases

Africa also bears the heaviest burden of neglected tropical, waterborne, helminth and vector diseases. The amount of money allocated to research and development of new medicines, vaccines and medical supplies for neglected tropical diseases, is still very low at 1% of the global total committed to research and development in 2010 (Rottingen, Regmi et al. 2013).

2. Africa's has weak health systems

The African countries faced with the greatest burden of infectious diseases, also tend to be the ones with weakest health systems, greatest health inequalities, limitations in health infrastructure and lowest proportions of health professionals. The weakness of the health systems in Guinea, Sierra Leone and Liberia, became evident soon after the 2014 Ebola outbreak began. The strength and optimal functioning of a health system is dependent on the health workforce, health research, health financing, health governance and health policies present in-country.

A. Africa needs to expand its Health Workforce

Efficient functioning of a health system is dependent on the size, competence, distribution and performance of the health workforce. According to the WHO, the main challenges in developing health workforce capacities in most middle to low income countries include: under-investment in education of health professionals, distribution inequalities, outdated education systems, resistance of health professionals, associations and institutions to adopt new models of care such as ICT backed systems, homecare and task shifting (WHO 2015). In 2013, WHO passed resolution WHA 66.23 which sought to transform education of health workforces as means of helping countries realize universal health coverage. Currently, health workforces can be evaluated based on: - i) Availability- the presence of well-trained health professionals and the capacity to train health professionals. ii) Accessibility- the ease by which people can reach health professionals. Sub-Saharan Africa contributes only 3% to global health workforce, and currently spends the least in training health professionals when compared to the other continents. This fraction excludes a significant number of highly skilled Africa medical health professionals who continuously leave the continent in the form of 'brain drain'. As a result, the scientific output of the continent has remained very low at just 0.5% of the total global output. This is in spite a vast of majority of researchers with origins in sub-Saharan African being extremely productive, unfortunately, majority do not work in Africa.

WHO proposed a Global Strategy on Human Resources for Health, Workforce 2030, to the World Health Assembly in May 2016 (WHO 2015). This strategy emphasizes the importance of job creation in the health and social sectors (public, private and other), as a means for enhancing economic growth (de Francisco Shapovalova N 2015; WHO 2015). According to Dr Fausset, timely investments in health research and infrastructure, could potentially stall the further loss of health professionals, and result in increased research and scientific output in Africa.

B. Health Research is needed in Africa

The last 50 years have been characterized by an explosion of knowledge in life and medical sciences, tremendously increasing the life span of humans as a result. Dr Maciej Nalecz, the Director of Basic and Engineering Sciences at UNESCO, stated that discoveries in life sciences, health sciences and associated industries, have contributed greatly to human socio-economic development, making individuals live longer, better and more productive lives. The disparities in

health research funding globally, act as a major challenge for the attainment of sustainable economic development, and often affects the functioning of health systems in Africa.

The news on Africa by non-African media often tends to be negative. The negative focus on Africa by foreign media, has hoped to inspire positive change to address the challenges facing the continent. Unfortunately, a by-product of this has been the development of negative stereotypes and skepticism on Africa, which often blinds non-Africans from seeing the positive progress taking place on the continent. The socio-economic and political situation in Africa has been improving, as Africa moves forward with broader peace and stability. The majority of African countries have recorded impressive growth rates in recent years, and the positive growth is visible in research and development taking place on the continent due to a number of new medical and life sciences initiatives. Yet more still needs to be done. Efforts to promote research and development, must be reinforced and accelerated by building greater capacities for training and retaining researchers, in Africa. This requires greater investments in research and education infrastructure, increased research funding and the creation of conducive research environments and policy frameworks. More importantly, African researchers should take up leadership role in building effective institutions that can address the continent's most pressing health priorities.

Challenges facing Health Research in Africa

Prof Rose Gana Fomban Leke of the Biotechnology Centre at University of Yaounde, spoke on strengthening the Capacity for Health Research in Africa, shared her personal experience with some initiatives instituted to strengthen research in Africa, and their corresponding outcomes. In her view health research strengthening should be a continuous process, rather than a 'one-stop fix'. Frequently, the global community has responded to health crises in Africa by increasing investments in health research in a hope that such investments would translate into increased engagement of African institutions and scientists in research to address the challenges facing the continent, increases in innovation and better health for Africans. This worked in some instances but not always. Often, the research conducted in Africa was not focused on addressing the most pertinent issues facing the local populations.

Some of the persistent challenges of conducting health research in Africa, are highlighted below:-

i. There is little or no alignment between research strengthening efforts, national priorities and developmental agendas in Africa

Research is yet to become a priority in most African countries, evidenced by the low budgetary allocations for research by African governments. Currently, majority of health research work in Africa is funded by non-African agencies, that often have their own agendas and priorities which do not always match those of recipient African countries. Future research capacity strengthening efforts in Africa should be accompanied by increased funding opportunities for health research, and these should be in harmony with the broader national health, innovation and developmental agendas. In 2007, AU heads of states and government committed to allocate 1% of their nations GDP to STI. Unfortunately, in most countries this was not honoured partly due to a failure by the African research community to provide evidence for the benefits accrued from the limited resources already allocated for research.

ii. Africa has very few research opinion leaders and solutions to local health problems

Africa has very few renowned research leaders whose opinions and experience can steer the scientific discourse, direct the development of research policies, who can act as idea filters or mentors to the next generation of African researchers. This lack of leadership has resulted in a paucity of local champions to lead the processes for finding solutions to local health problems. Frailties in human research capacity building and training efforts can partly be blamed for the continent's failure to produce scientific leaders. Training in most African academic institutions, is by lecturers who are not active in research. Consequently the curriculum used is often outdated, leading to the transfer of outdated knowledge to successive generations of African trainees.

iii. Africa has extremely slow uptake of research findings and translation into policy or practice

Knowledge translation is the process of dynamic synthesis, dissemination, exchange of knowledge obtained from research into ethically sound health practice (Canadian Institute of Health Research definition). Timely dissemination of research findings to stakeholders enables the development of appropriate policy reforms. Usually the findings generated by research, is disseminated into peer reviewed journals, which are rarely read by policy formulators or implementers. A disconnect in knowledge translation arises, resulting in failures to translate beneficial research findings, into health practices. There is need to ensure that knowledge generated through research in Africa, is translated into positive practices,

products or solutions, which can improve the lives of those who need the research most. Some of the factors that cause poor translation of research are, high costs or lack of funding for KT, intellectual property conflicts, weak research communication, delays in analyzing research findings, among others.

Honourable Sarah Opendi, Uganda's Minister of Health and chief guest at the conference, reiterated the need for policymaking informed by sound scientific evidence.

The AU's scientific, technical and research policy panel identified three pillars needed for effective research translation (**Table 1** and **Figure 2**). Dr. Ahmed Hamdy, AU head of science, innovation and ICT, presented the two-step model adopted by the AU to promote knowledge translation in Africa (Figure 2). In this model, African countries are encouraged to conduct a thorough assessment of the challenges limiting knowledge translation in their countries. The process begins with a preliminary policy analysis involving stakeholders of research translation, who should identify the pillars and sub-pillars needed from effective research translation. These pillars could include; an enabling research environment- defined by the existence of support in the form of research policies, strategies or intellectual property systems; research infrastructure; technical and professional competences (**see Table 2**). The stakeholders in the research to be engaged in this process include, research professionals, local authorities, policy makers, regulatory bodies, industry, funders and researchers/educators and all of whom make contributions to the research in one form or another. Study participants in health research, usually make invaluable contributions by donating samples, personal information or by dedicating time to studies, but are often left out of knowledge translation process.

Table 1: The Conclusions of an Ebola Research and Development Summit for stakeholders from different sectors (government, industry, scientific, agencies, NGOs and civil society)

Lessons learnt as derived from the work relating to Ebola, were:
<ul style="list-style-type: none"> • Need for new R&D funding models which would support the development of products where the market is inconsistent, unknown or unreliable.
<ul style="list-style-type: none"> • Future R&D must encompass more than just vaccines, drugs and diagnostics.
<ul style="list-style-type: none"> • Establish standards for evaluating the efficacy of targets compounds in the intra-epidemic period
<ul style="list-style-type: none"> • Need to develop broader road maps for identifying prioritizing interventions for evaluation in the setting of an ongoing outbreak.

Table 2: Pillars of Knowledge (research) translation

RESEARCH TRANSLATION PILLARS		
Research Infrastructure	Technical/Professional Competences	Enabling Research Environments
Strengthening R&D	Science workforce-M.Sc and PhDs	Financial support for knowledge translation
National research institutions	Technological transfer	Advocacy and communication
Private sector R&D research facilities	Knowledge exchange	Intellectual property systems
Academic institutions (universities, institutes or colleges)	Innovation and entrepreneurship promotion	Research policies and strategies
Science/Innovation Parks		

*Adapted from Dr Ahmed Hamdy's presentation at UNESCO-MARS 2015.

Text Box 1: Accelerating access to interventions for severe emerging infectious disease in Global health-A blueprint- Presented by Dr Cathy Roth-Assistant Director

WHO realized soon after the Ebola outbreak (2014) began, that very wide knowledge gaps in the natural history of Ebola, immunopathology, basic aspects of immune response, limited of knowledge on routes of transmission of the virus, intra-host and population transmission dynamics, a fundamental lack of knowledge on environmental survival of the pathogen, and the absence of suitable interventions, or knowledge on how to design interventions to stop the spread disease. Similarly, there is a dearth in countermeasures for dealing with other severe emerging infectious disease. This accompanied with the risk of social unrest, anxiety and which often have heavy impacts on the economic activities in affected regions. Usually this is precipitated by a lack of scientific knowledge, partly due the sporadic and unpredictable nature of most emerging infectious diseases. Consequently, it is very difficult to evaluate interventions for such severe infectious diseases, with the only opportunity to evaluate interventions against a disease like Ebola is during an outbreak. This limits the ability of researchers to prepare and conduct research to test interventions against such diseases due to the very unpredictable nature of outbreaks of these diseases.

These outbreaks often occur in countries with poor health and biomedical infrastructure, which often makes such countries feel vulnerable to the consequences of such events. Often such events are accompanied with logistically headaches of dealing with thousands of researchers, journalists, global health officials and other interested parties, who stream in, to take part in researching on the disease or covering the outbreak. Therefore it is important to assist such countries in Africa to develop the capacity to organize and manage the scientific research activities, media, health practitioners and other interested parties during such outbreaks. This considering, it is difficult to know when, what or how, the next outbreak of an emerging infectious disease will be like and what kind of response it will require. All this underscores the importance of pandemic preparation, and overall the proper functioning of health systems supported by suitable health and research policy frameworks.

These challenges arising from the recent Ebola epidemic, became evident once it was realized that the size and scale of the epidemic, was unprecedented. This necessitated rapid implementation of mechanisms for rapid detection, ensuring the safety for health workers and volunteers and eventually the effective containment of the viral spread. It took months to implement these measures, partly due to the need for massive coordination due to the arrival of different groups with varying interests, to the affected countries. This also created the challenge of ensuring research work being done was on scientifically credible, interventions and the process of obtaining the authority to carry out such research in the setting of poorly structured, limited or completely absent scientific guidelines or policies to regulate the conduct of such research. Mechanisms of actively engaging the affected communities in the ongoing research, was initially not well established. This was a major limitation to carrying out behavioural research, which was equally as important as the biological research work seeking to develop an Ebola vaccines or therapeutic continued. Finally, there were challenges around securing and allocating money to research conduct on the areas that needed it the most.

A number of studies were conducted without best practices for conducting preclinical screening of candidates for Ebola vaccines or therapeutics, either in vitro or in vivo, coupled with the absence of a suitable animal model. There are a number of animal models which are currently in use, but it is uncertain to what extent they do or do not recapitulate the human disease. Majority of the results arising from these studies were not rapidly shared among other researchers as a means of avoiding duplicity and accelerating the progress toward identification of suitable interventions or therapeutics. There were situations where results were shared in the Ebola research community, but in certain instances important results were not shared between researchers, potentially affecting public outcomes and leading to repetition of studies. Critical studies were also delayed,

Prioritization of studies posed a major challenge due to, difficulties in selection of study sites considering there were only a few sites where preclinical studies could be conducted, challenges in selection target compounds for testing- for instance the choice when choosing between candidate compounds with preliminary evidence showing weak versus those with strong efficacies; and limitations in supply of test compound- for some instance certain interventions were only available in limited doses. Other challenges included the selection of protocol designs for use in the preclinical studies- either statistically perfect or single population, competition for sites between study teams, dwindling patients and poor communication between researchers.

WHO policy body dealing with all this is called the World Health Assembly, made up of ministers of health from all the member states (194). The executive board demanded for the design a blueprint to accelerate research and development for epidemics and other emergencies that there are no or insufficient curative or preventative solution. This was echoed by the ministers of health from G7 countries, who recommended that progress should be made lead candidates, pre-establish protocols and enhance capacity building, where the capacity needs to be built in countries with the most at risk populations. The meeting also highlighted the need for a more comprehensive. applied and translational approach in partnership with at risk countries, and the importance of collaboration between the 35 countries and the health research funders Finally, a call for innovative funding to help support research endeavours in the very challenging environment of ongoing outbreaks with emerging infectious diseases.

iv. Limited support for communicating research findings in Africa

'Publish or perish' is the scientific mantra. Most researchers work tirelessly towards sharing their research findings in high impact peer-reviewed journals, but often forget to share their findings with the study participants, local practitioners, communities or policy makers, who often contribute the most to the research. Fortunately, a number of research funding agencies, now require research dissemination plans and knowledge translation components to accompany grant applications for funding, which will hopefully improve the situation.

v. Too much focus knowledge generation

Bulk of the research conducted by researchers in Africa is on knowledge generation, for instance 'the prevalence of this' or 'the resistance to that', often the impact of the knowledge generated is ignored when the research is being conducted. There is a need for African researchers to go beyond the culture of 'knowledge generation', and adopt an 'innovation' culture, that would potentially result in the development of novel drugs or vaccines. African countries also need to develop strategies of financing health research and innovation. In the words of Dr. Armany Asfour 'Innovation is not just about new findings, but it's about doing things differently in a more sustainable and effective way'.

vi. Limited career options for young African researchers

Upon completing their PhD degrees, most young African researchers look for employment at local universities with the primary intention of developing a career in academia owing to the limited employment options or opportunities (**Figure 2**). Africa needs to create opportunities for her younger researchers, in order to build a critical mass needed to bring about a technological transformation in Africa's health research sector. One of the ways to accomplish this is by providing funds to young Africa investigators to enable them establish their careers, accompanied with proper mentorship frameworks to help them realize their full potential. New initiatives to address some of the challenges include, African Research Excellence Fund (AREF) for supporting early career African scientists and the Alliance for Accelerating Excellence in Science in Africa (AESA) - which runs two initiatives the DELTAS and Grand Challenges Africa.

vii. There is an uneven geographical distribution of existing and future research capacity building programmes

Presently, the geographic distribution of capacity building programmes or research activities in African countries is uneven between the regions. A higher concentration of research programmes is evident in Eastern, Southern and Western African in Anglophone Africa, as compared to Central Africa, Francophone and Lusophone Africa. The research environment in Africa is fragmented along colonial lines. The diversity of African languages has limited the interaction, sharing of ideas and the establishment of collaborations, between researchers across the continent. Africans need to capitalize on the opportunities presented by the information/technological era to create platforms which would ease the interactions among African researchers, thereby debunking the research silos and enhancing collaborations beyond language barriers.

Additional challenges in the management systems of health research in Africa exist in the weak coordination of research activities, often resulting in duplication of research work. Over-dependency on donor funding limits the type and direction of the research work conducted within African countries, often shifting the research priorities to those of donor countries and affects the establishment of self-perpetuating research institutions.

3. Improving Africa's Health Governance and Policies

Health governance refers to systematic actions taken by countries or societies to ensure the promotion and protection of health in a population. Where well-structured governance systems have realistic national health policies, plans and strategies, facilitating a progression towards universal health coverage. The main challenges facing health governance and policing in Africa include;

Increasing complexity of health governance structures: Many countries in Africa have multiple levels of government-national, local and governmental, with each layer of government contributing additional complexity to the management of health system overall. These complexities require extra coordination of health strategies, policies and action plans, and produces the unwanted outcome of inflating national health budgets.

Concerns over financial management: World Bank's Country Policy and Institutional Assessment (CPIA) is a measure of how countries are improving policies and institutions, needed for development. In 2015, CPIA of African countries (including Djibouti and Yemen), revealed that the improvement of financial management in health sectors of most African countries had stagnated (Bank 2015). Some countries had improved CPIA scores, while others recorded declines, cumulatively resulting in a stagnated CPIA score of 3.2 similar to 2014 (Bank 2014; Bank 2015). A wide variation of CPIA scores between African countries was observed, due to differences in economic management systems, structural policies, policies of social inclusion and equity, public sector and institutional management.

4. Limited Health Financing

The arrangements made by any country to finance its health needs, determine the functioning of its health systems and the speed of progression towards universal health coverage. Over the last 20 years, the majority of African countries took steps to improve their health financing systems, to reduce out-of-pocket (OOP) expenditure by their citizens. An estimated 100 million people globally live below the poverty line and many more were at risk of being pushed into poverty by OOP and poor health financing systems (WHO 2010). Majority of these countries are in Africa, where public health expenditure on average represents 44% of national budget. Yet, a large amount of the health expenditures of African countries, is supplemented by high OOP expenditures averaging 35% with great inter-country variability (Bank 2015). Presently, there is no single model that offers the best strategy for financing the health needs of any country. However, there is a convergence of financing health systems using models supported by WHO (Kutzin 2012) and World Bank (Maeda A 2014).

An ideal health financing system model, should facilitate the progression towards UHC, by relying on compulsory public funding of health systems, reducing the fragmentation of funding pools and increasing the direct linkage of health funding to providers who are often more knowledgeable on the health needs of the people. A number of strategies in Africa focus on performance of the health systems so as to ensure efficiency in utilization of the funding, as governments gradually increase funds committed to the health needs of their countries, in the hope of improving the quality of health services (Buckley G.J 2014).

5. Inadequate Medicines and Medical Supplies

Globally, 2 billion people lack access to medicines or health related products they need (Asia 2012). This shortage is precipitated by weak regulatory policies, that allow for the circulation of substandard/spurious/falsely-labelled/falsified/counterfeit medical products (SSFFC), putting the health of many people at risk and destabilizing pharmaceutical markets (Asia 2012). Alternatively, poor diagnosis of diseases resulting in wrong prescription of medicines, has contributed to the rising antimicrobial resistance, particularly in Africa. Still, many people in Africa lack access to essential medicines for treating preventable diseases and NCDs, coupled with the frequent shortages of blood products. A survey conducted on the quality of blood products in 25 low income countries, revealed occasional failures in testing of blood products for either HIV, hepatitis B, hepatitis C or syphilis, putting into question the safety of using such products (WHO 2015). Lowering the costs of essential medicines remains a challenge particularly in LMIC countries, where higher OOP expenditures expose patients to exploitative pricing for the lowest priced generic medications in both public and private sector health institutions (Health 2013). The price of new medicines and vaccines under patent is often prohibitive, limiting their use even in higher income countries. Millennium development goal 8 Target 3E sought to address the issue of essential drug availability, and now the SDG Target 3b aims to support the development of medicines and vaccines for infectious and NCD that primarily affect developing countries (WHO 2015).

Access to Medicines Index was started by Mr Wim Leereveld the CEO and founder of Access to Medicine Foundation who presented at the conference. The index seeks to improve access to medicines by analyzing the steps taken by the top 20 research-based pharmaceutical companies, to improve access to essential medicines to those who need them most. In 2014, the top-20 pharmaceutical companies had 327 molecules under development, most of these were developed by the top 5 companies and only targeted five diseases (Foundation 2014).

The recent Ebola outbreak acted as a reminder of the limitations of the current profit motivated system of drug development, considering there were close to 200 molecules in development for treating Ebola prior to the outbreak. However, there was no incentive to prioritize their further development, a view echoed by Dr. Cathy Roth the advisor to Assistant to WHO Director-General. A number of these were tested during the outbreak, none proved to be completely efficacious, but some provided promising results and have since progressed to clinical trials (for more detail on enhancing drug development during emerging disease outbreaks, see the complete speech by Dr. Roth in **Text Box 1**).

Ebola researchers during the recent outbreak were faced with the enormous challenge of trying to compress the timeframe for generation of new knowledge and drug development, from the typical years, to months or days. A similar

scenario could be replayed in future outbreaks of emerging infectious diseases, where the time frame for drug development would need to be substantially reduced. Therefore, emphasis must be placed on the development of newer or better models for accelerated drug or therapeutics development for emerging and neglected tropical infectious diseases which disproportionately affect low and middle income countries, a view echoed by Mr Leerveweld (Pedrique B 2013). Dr. Cathy Roth, further emphasized the need for developing systems for pre-screening and clinically testing candidate products for Ebola and other emerging infectious diseases using best clinical and laboratory practices for *in vivo* and *in vitro* research, potentially for use in outbreak situations, particularly where suitable animal models are not available. In such shortened drug or vaccine development timeframes, all the components of the R&D work would be conducted in parallel, that is- research, development, candidate product testing and licensure.

Africa's Health Challenges offer Opportunities for Growth

1. Africa can benefit from a robust Life and Health Sciences Sector

The life sciences sector comprising of pharmaceutical, biotechnology and medical technology industries, was a leading creator of wealth in 2012 contributing approximately US\$1.6trillion to the global economy. Unfortunately, Africa did not benefit much from the opportunities in this sector(Deloitte 2013). The key drivers of growth in life sciences industries were health spending and demographics (Unit 2014). The global healthcare expenditures in 2013 amounted to US\$9.4 trillion, and was expected to grow by 5.3% between 2014-2018 hinged on global population growth (Unit 2014). The life sciences sector also provides enormous employment opportunities globally.

There is room for growth of Africa's life sciences sector, given that Africa has currently 11% of the global population and shoulders the greatest burden diseases, but only contributes 1% to the total global health and medical expenditure. A report by Deloitte in 2014, indicated that investments made in the life sciences sector by African countries, were likely to pay handsomely in the future owing to the rise in incidence of non-communicable diseases, increases in life expectancy and projected aging of Africa's population. When this is coupled to the technological advancements and innovations currently taking place across the continent, could benefit or reform the health sector.

2. Building upon the foundation laid by HIV research to tackle other infectious diseases in Africa

Over the last 30 years, efforts to combat the HIV/AIDS pandemic have resulted in the formation of important global partnerships, leading to increased research funding and improvements in health research infrastructure across Africa. This period also saw massive improvements in immunological, molecular and equipment in laboratories around Africa, enhancing the diagnostic capacities for diseases associated with HIV infection, such as TB, other viral infections such as HPV, HBV and CMV. More importantly, the desire to end the HIV pandemic that adversely affected Africa increased the research tempo on the continent. A large number of the African researchers have extensive experience based on work done in the fields of Malaria, HIV and TB research in Africa, which could be useful for rapidly setting or scaling up research projects on emerging or re-emerging infections.

3. Harmonized UN sustainable development goals sets a bench for African Countries

In 2000, the UN general assembly adopted the millennium declaration which set eight voluntary goals for countries and development partners to be achieved by 2015(A/RES/55/2 2000). Three of the eight MDGs- reducing child mortality (goal 4), improving maternal health (goal 5) and combatting HIV/AIDS, TB, Malaria and other diseases (goal 6)- were related to health. While other MDGs such as sanitation, nutrition and water, were associated with health. The progress of the 8 MDGs was tracked using 60 indicators with 21 targets. The MDGs have been the most influential tools ever used to set international development priorities, primarily because the MDGs came with set targets that were simple, clear and time bound. This enabled governments, donor countries and international agencies to identify areas of need, and to prioritize resources for addressing them, while measuring the outcomes of initiatives instituted to address the needs. The increased emphasis on measuring targeted outcomes, improved the ability of developing countries to collect and report data, supporting the enhancement of national statistical systems.

Remarkable progress was noted in some health related issues areas, such as, in reduction the global HIV, TB and malaria incidences. While improvements in primary school enrollments allowed more girls go to school, thereby reducing gender disparity in education which could potentially improve maternal and child health in the future. By 2015, 91% of the global population had access to improved drinking water, up from 76% in 1990, while open defecation halved globally in the same period. Much as both maternal and child mortality reduced remarkably, both reductions failed to meet the MDG target by 2015. The attainment and progress made in achieving the targets for the other MDGs was mixed, in Africa, there was great regional and inter-country variability. Most African countries failed to achieve most of the MDGs targets,

chiefly due to lower starting points for most targeted areas, especially in countries with internal strife or with recent histories of internal conflicts. In spite of this, the continent made tremendous progress towards achieving the health related MDGs, by lowering maternal and child mortality, slowing the spread of HIV, and by lowering incidence of malaria and TB.(WHO 2015).

Much as the MDGs drew praise in many quarters, many shortcomings of MDGs were identified(Fukuda-Parr 2013; Higgins 2013). For instance, they failed to take into account the reasons why countries failed to meet the targets. Majority of these, were due to intra-country inequalities arising from the hardest to reach populations who were often marginalized by economic status, education, gender or place of residence. The MDG framework was also blamed for focusing resources on certain goals at the expense of broader and more concerted actions. This was evident in the allocation of resources for health related MDGs at the expense of broader and cross-cutting improvements of health systems. This resulted in fortification and increased functionality in certain aspects of health provision, but overall resulted in some weaknesses in health systems, such as, limited capacities to deal with outbreaks of emerging infectious diseases (the best example being the recent Ebola outbreak in West Africa). The broad targets set in the MDGs failed to take into account the need of individual countries, for instance, the countries that had suffered internal strife stalling development and lowering starting points, thereby affecting the ability of such countries to attain the targets.

On 25 September 2015, the UN harmonized all the different goals of its agencies under new UN SDG goals, themed "Transforming our world; The 2030 Agenda for Sustainable Development" (UN 2015). The new 17 SDGs goals integrated under the 5 "Ps" of sustainable social, economic and environmental development "people, planet, prosperity, partnership and peace". The objective was to complete and build upon the progress made under the MDGs. For instance, under the new SDGs universal goal (No. 3) for health was adapted with 13 targets, supplemented with an additional 4 means of implementing the targets(WHO 2015). The SDGs took cognizance of the relationships between health and other socio-economic determinants of health, with close to a dozen targets in non-health goals that are health-related. For the first time there is a goal that specifically seeks to assist countries to implement the other goals –SDG Goal 17.

Successful implementation of the SDGs will require progress tracking and follow up at national, regional and global levels. Much as country stewardship is necessary for the attainment of targets, cooperation between countries and international agencies will be important for the realization of the more numerous SDG targets in order to overcome some of the persisting global challenges. The recent Ebola epidemic demonstrated the interconnected nature of the world, and affirmed the need for concerted efforts in dealing with emerging infectious diseases. It also served as a reminder of the linkage between health and the economic productivity in any given country. Improvement of health systems in Africa fosters capacity building for science and health research, as a mean for sustainable development.

3. Increased focus on efforts to improve STI by African Governments

In June 2014, the AU Heads of State and Government adapted the STISA2024, which is designed to accelerate the transition of African economies into innovation and knowledge based economies in tandem with the AU agenda 2063. In 2012, African Science Ministers met in Kenya to discuss ways of improving Africa's Science Technology and Innovation, as a means of creating employment for the youth, development and economic growth. The forum noted that the future capacity of African countries to compete in the global market, would depend on the ability of Africans to innovate and productively apply the latest technologies to health, education, agricultural, industrial and other sectors. Therefore, investments in STI, education and improved research policies, will increase Africa's global competitiveness, create employment and increase productivity within the continent. It was also noted that investments in research done in Africa, would help meet the continent's most pressing needs, while ensuring sustainability of ongoing and future research programmes. To this end, the ministers agreed that there was a need for African governments to channel more resources to higher education and research, now more than ever. A second forum of African Sciences Ministers was held in Morocco 2014. The deliberations from this second forum further reinforced the messages arising from the first meeting. Ambassador Godia reiterated that, for Africa to achieve research excellence, concerted efforts of African governments, private sector, institutions of higher learning, industries and research community, would be needed. Through such collaborations it is possible to promote the development of local solutions to the continent's most pressing challenges.

4. Opportunity to improve quality of education using modern technologies

Globally, the trend in higher education institutions is one for greater collaboration rather than isolation. Therefore, education systems in Africa which play an important role in human capital development can maximize on the improvements in technology to enhance the training of the continent's workforce, next generation of researchers and innovators. The Pan African University was established through collaboration between African countries, which sought to create centers of excellence in learning across the continent for training of high level professionals to conduct research on

the continent. The Pan African University promotes networking between institutions of higher learning in Africa through development of programmes in centres where high quality research can be conducted in the five geographic regions of Africa- North, West, East, South and Central. Each sub-region hosts a specific thematic research component- for instance Jomo Kenyatta University of Agriculture and Technology (JKUAT) in Kenya currently hosts the institute of basic sciences. Graduates from these programmes are expected to utilize the knowledge they receive to develop creative solutions for the challenges facing the continent.

Furthermore, it is important for African scientists drawn from different fields, to form networks and engage in useful discussions on how to mitigate the negative consequences of brain drain. Enhanced networking and data sharing using modern technologies, will allow African researchers to exchange ideas, collaborate and to share knowledge on ways to improve research on continent, a departure from the current silo-mentality. Many talented Africans have left the continent due to a lack of an enabling environment for scientific research. It is equally important for African governments to institute labour policies which specifically attract or tap on the expertise of African researchers currently working in the Diaspora. Although in recent years the foreign remittances of Africans working in the Diaspora, has contributed to a significant portion of the direct foreign exchange earned by African countries, Ambassador Godia believes the 'Brain drain' can actually be turned into 'a brain gain'.

5. Innovative Financing

For Africa to become an international hub of science, technology and innovation, the continent needs to find innovative methods of financing its research. This would allow the continent to set its own research agenda that would promote more involvement of local communities in research activities and focus on addressing local challenges.

The Alliance for accelerating excellence in Science in Africa (AESA) was formed in September 2015 through a collaboration of African Academy of Sciences and NEPAD (The New Partnership for Africa's Development), is a research funding platform that seeks to develop science strategies and to increase funding for early career African researchers. Dr. Kevin Marsh, a senior advisor at African Academy of Science, said the new initiative seeks to improve the quality of Africa's scientific output and support research on the most pressing diseases afflicting the continent, such as HIV/AIDS, Malaria and Ebola. Scientists funded through this framework will work towards creating, new vaccines, and products for diseases that primarily affect Africans. It also targets drawing increased funding from African governments to setup centres of scientific excellence on the continent. The DELTAS programme was formed through collaboration between Wellcome Trust, AESA and other partners. It seeks to support early career African researchers to establish leadership skills, by strengthening scientific training, fostering mentorship and by promoting professionalism. The AAS recently announced a round of grants amounting to \$70 million to support researchers working on issues such as mental health in Zimbabwe, HIV and TB in South Africa and Malaria in Mali.

6. New Technologies can enhance Knowledge Translation, Scientific Advocacy and Scientific journalism in Africa

New technologies, like mobile phones and the internet, have recent years enjoyed increasing usage in Africa, provide additional avenues of research dissemination. These can augment the more traditional and well-established research dissemination channels such as, publishing in peer-reviewed journals, print or broadcast media. Science journalism has been on the rise in Africa, and the quality and quantity of scientific materials published on research being conducted in the continent, has also improved.

Dr. Steven Smith, a medical doctor who founded a program which airs on BBC radio called 'The Naked Scientist', spoke on what motivated for starting the program. In his words, "to strip down science to the bare essentials to make it fun and interesting, while at the same time being scientifically rigorous and educational". The Naked Scientist overcame challenges such as timing and reach, faced by most radio programming by shifting its broadcasting platform to internet, which allowed for the creation of downloadable content such as podcasts while immensely increasing the dissemination of their programming material. Currently, The Naked scientist's website has a global reach and constant online traffic for its digital, audio, visual, written and audio-visual content. The Naked Scientist example, illustrates the potential of integrating traditional forms of communication with newer platforms in scientific journalism.

7. Africa can capitalize on scientific and technological innovation to spur economic growth

The efforts by African researchers to innovate and increase the continents output, can be greatly assisted through structured support from national governments and private sector, targeting to empower African researchers to compete with their contemporaries from other continents. A number of speakers at the UNESCO-MARS conference spoke on the topic of research innovation in Africa. Sir Richard J Roberts, a Nobel laureate, biochemist and molecular biologist, offered some

invaluable advice to the 100 young African researchers to seek paths to innovation, by sharing the journey leading to his Nobel prize. The most memorable advice he gave the young researchers, was that, 'Usually people don't make important discoveries when they set out to look for them, because the unexpected discoveries, usually turns out to be the big ones'.

Dr Amany Asfour, the Chair of Human Resources, Science and Technology of the AU, and who is also a professor of paediatrics, entrepreneur and civil society advocate for research and women empowerment, spoke on empowerment of Africa's researchers and innovators. She presented the "three Ps" of empowering Africa's innovators. The most essential component of empowerment is the people, representing the first "P". People can be empowered by policies and strategies that seek to support innovation, this includes empowering African researchers, women or transforming education systems for better training of the next generation of health workers or researchers. Policies and procedures, represents the second "P". These included policy frameworks implemented to empower the African research centres public or private sectors, for the process of innovation or discovery. The last "P" represents the product; all research efforts target to develop a product, guided by the most pressing health priorities and needs (See **Figure 3**).

Dr Asfour summarized the pillars for Africa's innovation strategy, which seeks to economically empower researchers and innovators using the 10 "in"s which include; indigenous capacities and human resources; internal policies and reforms; increased productivity and upgrading the value chain; innovation; information and communication; infrastructure; financial investments; integration; industrialization; and international markets for African products (**Figure 3**). These pillars were factored into a strategy paper on strengthening pharmaceutical innovation in Africa, sponsored by AU, the Coalition for Health Research for Development (COHRED) and the New Partnership for African Development (Berger 2009).

Conclusion

The first UNESCO-MARS summit held in Geneva-Montreux, Switzerland, brought together researchers from across Africa to discuss strategies of building Africa's health research capacity, by enhancing policy environments to support life and health sciences, and to showcase some innovative research taking place on the continent. The 2014 Ebola outbreak in West Africa, demonstrated the risk posed by infectious diseases in a highly connected World. Its far-reaching impact was felt globally through travel restrictions, border closures and by contractions of entire country economies in the region affected by the outbreak. The magnitude of the Ebola outbreak in West Africa was unprecedented, and it was one of an old disease occurring in a new setting. The undetected spread of the virus was facilitated by weaknesses in national health systems, inexperience of health workers with EVD and insufficiencies in existing health infrastructure. Efforts to strengthened health systems in Africa, through increased, through increased health financing, improved governance, better management of health systems and growth in health research, will best serve to prepare Africa for outbreaks of emerging or re-emerging infectious diseases in the future. The participants of the summit agreed that increasing Africa's capacity to conduct research through an approach focused on addressing the continent's most pressing needs, would hopefully result in improved health of Africans and further strengthen the health systems on the continent. However, in order to meaningful improvements in the health of Africans to be realized, the gap between knowledge generation through research, and translation of the research findings into tangible solutions, would need to be bridged. Moreover, the recent increase in research activity in Africa will hopefully stall the massive brain drain of continent's top researchers, by increasing the employment opportunities and improving the career prospects for young African researchers. The maintenance of a critical mass of African researchers, if supported by local governments, would be a key driver of scientific discovery and innovation on continent.

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