TouchFoundation

Early Thoughts on Potential of COVID-19 to Promote Digital Health in Africa

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Executive Summary

Touch Foundation's mission is to save lives and reduce human suffering. We strengthen healthcare in sub-Saharan Africa, providing better access to care and improving the quality of local healthcare systems.

While most of our work is devoted to implementing specific programs that have direct impact, one of the ways in which we deliver on our mission is to produce white papers that provide our perspective on specific issues, given the knowledge we have developed from our work within Africa, that others can use to help inform actions that they can take.

In this spirit, the first section of this paper will provide some early thoughts on how the COVID-19 pandemic could impact African healthcare in the near term. The second section sets out how the COVID-19 pandemic has the potential to catalyze action in helping Africa address its infectious disease burden in the medium and longer term and describes the role that Digital Health could play in such an effort.

Each of these two sections is summarized in the next few pages.

1 – COVID-19 ADDS URGENCY TO NEED TO ADDRESS AFRICA'S INFECTIOUS DISEASE BURDEN

In the near term, the world's interest in how COVID-19 will affect Africa is a straightforward humanitarian concern. Africa, with over 1.2 billion people, has long struggled in managing the health issues of its population. Diseases ranging from respiratory illnesses like the flu, to HIV/AIDS, to malaria, to tuberculosis, to cholera are among the infectious diseases that plague Africa.

Africa is estimated to have some 25% of all the health issues in the world but has only 4% of the world's healthcare workers (despite having made major strides in producing more skilled medical personnel over the last twenty years). By any measure, Africa has particular challenges dealing with infectious diseases. Infectious diseases are by far the leading cause of death in Africa and account for approximately 60% of all annual deaths (i.e., over 5 million deaths a year).

Even without the added burden of COVID-19, these are staggering numbers.

Having said this, through help from the world's governments, the global health sector, and most particularly by the African nations themselves, tremendous progress has been made over the last 20 years in managing infectious diseases. The United States Agency for International Development (USAID)/The President's Emergency Plan For AIDS Relief (PEPFAR) program and The Bill & Melinda Gates Foundation are particularly noteworthy in the fight against infectious diseases.

Many African nations, using their own resources, and assistance from other governments and the global health sector, have been increasing healthcare spending at rates that are as much as twice as fast as GDP growth. The resulting progress can be demonstrated through many measures, including vaccination rates, improvements in HIV/AIDS, malaria, and tuberculosis mortality rates, lowered maternal and newborn death rates, and the total number of healthcare workers in service, among other indicators of progress.

However, despite this progress, African healthcare systems are far less well prepared than developed countries to be able to handle COVID-19.

As of this writing, it is too soon to understand the full impact of COVID-19 on African health. Early indications are that the disease is rapidly spreading in sub-Saharan Africa but, due to limited testing capacity, the extent of transmission, the number of cases that will become serious, and the number of those that will die is extremely uncertain.

One important wild card in predicting the impact of COVID-19 on Africa is that a very large percentage of the region's entire population have been vaccinated, at birth, with a 100 year-old vaccine called BCG (Bacillus Calmette–Guérin). This is a vaccine that has long been used to protect against tuberculosis. Although most Africans have never received booster shots, which are necessary to provide lifetime benefits, there is some evidence from various nations around the world, that populations who were vaccinated with BCG experience lower infection and mortality rates from COVID-19. While the variation in deaths are undoubtedly due to many

factors, including when transmission started, timing of lockdowns, differences in treatment rates, differences in accuracy of deaths counted, the death rates in countries with BCG vaccinations and those without are striking. For example, Japan, South Korea, Czechia, Croatia, Slovenia, where the populations all received BCG vaccinations, have much lower rates of infection and death than nations such as the US, Italy, France, Spain, Belgium, Netherlands, and Switzerland whose citizens were not so vaccinated. Particularly interesting is Portugal, whose population was vaccinated with BCG, and which has half the case load and one fifth the death rate per person of Spain, whose population was never vaccinated with BCG.

Absent such an ability of BCG, or some other unknown factor, to mitigate the impact of the disease, the prognosis for COVID-19's impact upon Africa is grim. Despite the progress made over the last two decades, if the healthcare systems of rich countries like the US, UK, Italy, Spain, and France have been struggling to handle the demands upon their health systems, African nations clearly have insufficient capacity to handle the volumes of cases headed their way. This would be true even in a "best case" scenario where BCG provides mitigating effects. Indeed, it can be argued that most African nations have insufficient capacity to handle their existing infectious disease burdens even before considering the impact of COVID-19.

For African nations, "flattening the curve," in an effort to curb the spread of the disease to keep the peak below the capacity of the healthcare system, seems like an unrealistic aspiration.

And, given that much of the African population have serious, pre-existing conditions and malnutrition since birth, they would seem to be much more vulnerable than populations in Europe or the US.

What would a "best case" versus a "worst case" look like?

Given the uncertainties, predicting the eventual deaths from COVID-19 in Africa is purely speculative. For example, it is not clear at this point whether or not the disease will ever be eliminated or will instead be with us for decades. This may be particularly true in sub-Saharan Africa which is still burdened by many other infectious diseases that have largely been eliminated in the developed world. So, should you estimate the impact over the next year or over the next ten years?

In Africa, with a population of 1.2 billion, and an annual mortality level just from various respiratory diseases that approaches 1 million people, the numbers who die from COVID-19 could be very large even in a "best case." Even if only 40% of the population became infected and the death rate was 0.5%, about 2.4 million excess deaths would occur. On the other hand, with 67% infected and a death rate of 1%, the number of deaths would soar to over 8 million.

Sadly, one of the realities is that we may never know how many people die from this disease in Africa. Given that many of those that die from the disease will never be tested, and will never reach a hospital, it seems likely that we will only be able to crudely estimate the full impact of the disease by, for example, estimating "excess deaths."

One special consideration for African healthcare systems in this pandemic is the need to protect the on-going capacity of African healthcare systems for the future. While every effort needs to be made to mitigate the impact of COVID-19, it shouldn't be done at the risk of damaging the long-term capacity of the system as whole.

2 – POTENTIAL TO USE COVID-19 AS MOTIVATION TO DEPLOY DIGITAL HEALTH AT SCALE IN AFRICA

In the medium and longer term, however serious the disease turns out to be in Africa, it seems possible that this pandemic could become a catalyst to enable dramatic improvements in African healthcare– particularly in regard to infectious disease.

In the developed world, the vast amount of spending on healthcare is for individual health which includes the detection, diagnosis, and treatment of health issues from the perspective of the individual and the provider or providers serving that person. Far less money is spent upon taking actions that improve the health of the entire population.

The world has received a massive wake-up call on the weaknesses of our underinvestment and lack of focus on population health. Specifically, COVID-19 has exposed our need to be better prepared for pandemics.

It should now be very clear in the midst of this pandemic, that the public at large should be willing to pay for better population health (without compromising their own abilities to receive personal healthcare), even if it means consuming less goods and services.

Or, as Bill Gates has famously noted, the pandemic has taught us "we should not be reluctant to spend tens of billions of dollars when the economic costs of this pandemic are going to be in the trillions of dollars."

Everyone in the world should also now have developed a profound understanding that all of us have a compelling interest in not just our own nation's abilities to handle infectious diseases, but also in every other nation's ability to handle them as well.

All of us should be concerned with how to prevent future pandemics and that means that we should all be interested in helping Africa do so. Unfortunately, Africa is one of the most likely places for novel infectious diseases to emerge. While over the last 20 years, SARS and COVID-19 originated in China, HIV/AIDS, Ebola, and Zika originated in Africa. There is a real chance that the next pandemic could be worse than COVID-19.

Moreover, given the level of infectious disease in Africa, the world should want to help these nations deal with their infectious disease issues even if that motivation comes purely from a straightforward humanitarian perspective.

Assuming that COVID-19 does become a catalyst to energizing a medium and longer term focus on reducing Africa's infectious disease burden, this note will argue that there is an opportunity to use Digital Health approaches to dramatically leverage the impact of such new investment.

In this note, Digital Health is defined as using data management technology and other digital technology (e.g., using mobile devices for telemedicine), to improve both the effectiveness and the efficiency of healthcare delivery.

Massive investment is already being made in moving in the direction of Digital Health. Going forward, the levels of investment should become even more accelerated. However, it should be noted that most of this investment, to date, has been focused on improving individual health.

This report argues that Digital Health has an equally important, or perhaps even greater, potential to improve population health than it does in improving individual health.

However, there are many obstacles to using Digital Health to address population health issues in the developed world. While there are few technology barriers, there are major difficulties in sourcing, aggregating, and making ready for use the required population level healthcare data assets and the related permissions for using the data. Many of the issues are related to the inadequacy of data regulation. Data privacy information in the developed world is overbalanced to protect data privacy for the presumed benefit of individual, payers, and providers relative to the need to use the data for the benefit of population health.

But, where does Africa fit into this picture?

This note argues that African nations can take advantage of all of this investment accelerating the movement to Digital Health to re-think the future evolution of their own healthcare systems. As independent nations with pressing population health needs, particularly related to infectious diseases, they should be less burdened by the political and other related issues that get in the way of developed world governments using data to improve both individual and population health.

Indeed, if sufficient investment is made by global public and private funding sources, and by the African nations themselves, it may be possible to launch robust Digital Health initiatives in several African nations. If so, the potential to use Digital Health to improve health can be demonstrated — not just to African nations but to developed world nations as well. And, once a few countries show the way, many others will follow.

What kind of effort should be considered?

To answer that question, this note concludes by laying out a "clean sheet rough sketch" to serve

as a straw man to illustrate how an African healthcare system could be rethought using Digital Health approaches.

Some of the elements of this "clean sheet rough draft" could include:

1. Rethinking how primary healthcare is delivered by using Digital Health approaches to re-organize, country wide, how community health workers use technology both to interact with the broad population and with the broader healthcare system.
2. Building an individual and population health data management capability.
3. Building out an extensive, digitally based, Point of Care diagnostics and disease testing capability.
4. Building out a transport and logistics system to ensure the effective movement of patients to where appropriate care can be provided and also to ensure the flow of needed supplies, drugs, and vaccines.
5. Redefining the role higher level centers (i.e., large specialty hospitals and related medical universities) play in providing leadership to the entire redesigned healthcare system.
6. Rethinking and redefining the role of government, given how the redesigned new Digital Health based system is intended to work – includes re-thinking all aspects of how healthcare is delivered, ranging from how the payer system will work to regulating how healthcare data can be used.

The note expands on what is meant by each of these elements.

Section 1 – COVID-19 Adds Urgency to Need to Address Africa's Infectious Disease Burden

In the near term, the world's interest in how COVID-19 impacts Africa is a straightforward humanitarian concern.

Africa, with over 1.2 billion people, has long struggled in dealing with the health issues of its population. Infectious diseases ranging from respiratory diseases like the flu, to HIV/AIDS, to malaria, to tuberculosis, to cholera, among others, all plague Africa.

Africa is estimated to have some 25% of all the disease states of the world and only 4% of the world's healthcare workers (despite having made major strides in producing trained medical workers over the last twenty years).

As with almost all numbers used to estimate the conditions of African health, any numbers anyone uses should be viewed as estimates, despite the best efforts of many organizations to produce reliable numbers. The numbers used in this report were hand calculated by the author using underlying numbers after looking at a number of different sources (e.g., WHO, Africa Check, CDC, The World Bank, Institute for Health Metrics and Evaluation, etc.).

One of the consistent themes in efforts to address the infectious disease burden in Africa is the lack of sufficient, current, accurate population health data. The lack of sufficiently good population health data is a problem everywhere in the world but the inadequacies of such data are particularly severe in Africa. Given the increased digitation of the world economy, there is no reason why this needs to be a permanent state of affairs.

However, by any way of counting, Africa has particular challenges dealing with infectious diseases. Infectious diseases are by far the leading cause of death in Africa and account for approximately 60% of all annual deaths (i.e., over 5 million infectious disease deaths a year).

Even without the added burden of COVID-19, these are staggering numbers.

To put the burden from infectious diseases in Africa into perspective, the infectious disease death rate per 100,000 people in Africa is approximately 10 times that of the United States. Infectious diseases account for about 8% of US deaths. If COVID-19 turns out this year to increase the number of deaths from infectious diseases in the US by 100,000 additional deaths, the infectious disease death rate in the US would go up to only about 11% of total deaths this year.

One of the major complications in fighting infectious diseases in Africa is that infectious disease mortality rates are high throughout the region because many of the patients have had multiple infectious diseases, often at the same time. For example, many people are infected with not just HIV/AIDS but also have malaria and the combination is often fatal.

Having said all that, through help from the world's governments, the global health sector, and most particularly by the African nations themselves, tremendous progress has been made in improving healthcare delivery in many African countries over the last 20 years including in managing infectious diseases. The USAID/PEPFAR program and the investments of The Bill & Melinda Gates Foundation are particularly noteworthy in the fight against infectious diseases.

Many African nations, using both their own resources, and from contributions from other governments and from the global health sector, have often been investing in healthcare delivery at a growth rate that is as much as twice as fast as GDP growth. The resulting progress from such increased investment can be demonstrated through many different measures including vaccination rates, improvements in HIV/AIDS, malaria, and tuberculosis mortality rates, lowered maternal and infant death rates, the total number of healthcare workers in service and so forth.

Indeed, to anyone who has visited the same hospitals and healthcare centers in Africa at different times over the last 15 years, the progress that is being made is visible to the naked eye.

However, despite all of this progress, African national healthcare systems are not well prepared to handle COVID-19.

As of this writing, it is too soon to understand the full impact of COVID-19 on Africa health. Given that, let's describe what is likely to happen.

One important wild card in predicting the impact COVID-19 has on Africa is that there have been analyses that indicate that the severity of COVID-19 outbreaks may be affected by whether or not the people exposed to the disease had received at birth a vaccination called BCG (Bacillus Calmette–Guérin). BCG, which is a 100-year-old vaccination, may have an ability to mitigate the impact of the disease. BCG has been widely used throughout Africa and most of the rest of the world (excepting the US and Western Europe) to provide some immunity to tuberculosis. Researchers in the Netherlands and elsewhere have pointed out that nations where this vaccine has been widely used, such as South Korea, Japan, Czechia, Slovenia, and Croatia have so far experienced much less transmission and death from the disease relative to what would be expected based upon experience in US and European countries where the vaccination is not regularly administered. While the variation in deaths are undoubtedly due to many factors, including when transmission started, timing of lockdowns, differences in treatment rates, differences in accuracy of deaths counted, the death rates in countries with BCG vaccinations and those without are striking. It is particularly noteworthy that this seems to be true between Spain and Portugal on the Iberian Peninsula where BCG has continued to be used in Portugal, but not in Spain and Portugal has half the case load and one fifth the death rate per person of Spain.

This also seems to be true within Germany between West Germany, where the BCG was not widely used, and East Germany, where everyone received the vaccine prior to re-unification.

The vaccination rates of BCG in most sub-Saharan African nations are a very high percentage of the population, so if BCG has a mitigating effect on COVID-19, this is very good news for Africa.

It should be noted that to be most effective in adults, BCG usually requires booster shots. However, almost no African nations require boosters of the vaccine. And, it should be noted that BCG is not a silver bullet given COVID-19 is still spreading, if at much slower rates and with less virulence, in counties that have maintained widespread BCG vaccination programs.

In countries that have not vaccinated their populations widely, like the US and most of Western Europe, there is hope that BCG vaccinations could help mitigate the disease until a new COVID-19-specific vaccine becomes ready. Indeed, clinical trials are underway in the Netherlands, Australia, and the US to test BCG's efficacy in providing immunity to healthcare workers receiving the vaccine. It should be noted that BCG, even if it proves to have some ability to mitigate the disease in countries where most of the population was vaccinated with it at birth, may not be very helpful in mitigating the current COVID-19 outbreak in the US and Western Europe. This is because the vaccine is believed to have limited efficacy when given to adults.

However, if the vaccine is even somewhat effective in providing some population-wide immunity, because most of their populations were vaccinated at birth, it may be that African countries escape the worst of the pandemic if they take other actions to mitigate the disease's spread (e.g., wearing face masks, social distancing).

Africa also may benefit from having a very young population (Africa has a median age of about 20 versus a median world age of about 30). One of the most striking characteristics of COVID-19 is that it hits the elderly much more heavily than the young. Having said that, the disease has hit younger people heavily in some geographies (e.g., Ecuador) and among some racial demographics. Of particular concern for African nations is the early evidence from the US that African Americans, even younger ones, are being hit harder by the disease than other races. While this is undoubtedly due to many factors, it would seem to indicate that a younger population, by itself, may not be sufficiently protective.

Absent such an ability of BCG, or having a younger population, to mitigate the impact of the disease, the prognosis for Africa seems grim.

In terms of the capacity of the African healthcare system's ability to handle this crisis, it seems

apparent that, despite the progress that has been made over the last two decades, they are poorly prepared to deal with a widespread COVID-19 pandemic. If the healthcare systems of rich countries such as the US, UK, Italy, and Spain have been struggling to handle the demands on their healthcare systems from the pandemic, it is clear that African nations' healthcare systems will have insufficient capacity to be able to handle the volumes of cases that may be headed their way. Indeed, the shortages of Personal Protective Equipment (PPE) for healthcare workers in Africa are bound to be far greater than in the developed world. Moreover, there is a much greater shortage of hospital beds, healthcare workers, oxygen supplies, ICU beds, respirators, and ventilators than in the developed world. Moreover, the availability of testing to confirm who has the disease will also be far more limited.

For African nations, "flattening the curve," in an effort to curb the spread of the disease to keep the peak below the capacity of the current health system, seems like an unrealistic aspiration if community spread of the disease becomes widespread. Indeed, it can be argued that the disease burden in African nations is already overcapacity even without the new disease. In nations where clean water is in short supply, frequent hand washing at the desired level is unrealistic. And, stay at home orders, if issued, would seem to be difficult to maintain for very long given very few in the population can work from home. Indeed, most of the rural populations and informal workers who live in cities have to work every day to feed themselves. Moreover, in these nations, the urban poor live in poor housing with dense concentrations and must use buses or other public transport to move around their cities. So, it seems inevitable that when widespread community transmission begins, large numbers of people will become infected relatively quickly.

And, once infected, given that much of the African population have serious, pre-existing conditions of many kinds, they would seem to be more vulnerable than populations in Europe or the US. Indeed, studies have long shown that populations in sub-Saharan Africa already have higher levels of mortality from infectious disease than those in any other region in the world.

One challenge that seems inevitable is that even in a "best case" the disease will still be bad enough to put an unbelievable strain on the entire healthcare system. Such a strain will inevitably lead, as it has already been shown around the world, to a lowered ability for African healthcare systems to deal with all the other existing health issues they face. Indeed, given the heavy infectious disease burdens of African nations, this strain is bound to lead to increased mortality due to malaria, cholera, tuberculosis, and HIV/AIDS as the various nations fight to contain the impact of COVID-19.

Even in a "best case" where the BCG vaccination has a large mitigating effect, it seems likely, that given all of the challenges facing African nations in fighting this disease, the mortality rates in Africa will be much larger than in Asian and European nations whose populations have also been vaccinated with BCG. With a population of 1.2 billion, if a "best case" meant that only 40% of the population was infected and if the mortality rate was "only" 0.5%, there would still be nearly 2.4 million deaths. On the other hand, with 67% of the population infected, a death rate of 1% would mean more than 8 million people would die from the disease.

Sadly, one of the realities is that we may never know how many people die from COVID-19 in Africa. Given that many people who die from the disease will never be tested, and will never reach a hospital, and given the high death rates that already exist from other respiratory diseases in Africa (such diseases already account for nearly a million deaths a year), the mortality from COVID-19 in Africa may never be known.

Given all that, African nations have for the most part been working hard to get ready for the disease.

One potential advantage for African nations is that they have had a little more time to prepare given that they have been able to watch what first Asian countries and then European countries and the US did to mitigate the disease. The community transmission of the disease in Africa, except for South Africa, seems to be at least 8 weeks behind Italy and Spain. Many African countries have used this time to shut down international travel at an earlier stage of the disease progression in their

country than did Italy or Spain. They were also quick to isolate and quarantine such travelers as well as anyone who had been exposed. In addition, African countries may, for example, benefit from the expanded ramped up global production of PPE, tests kits, respirators, and other equipment and supplies. If the timing of when their curves accelerate is sufficiently delayed, their escalating needs may coincide with many developed countries reaching the other side of the "apex" of their curves, thus reducing their demand and making more supply available. They also may benefit from learnings in the developed world about which therapies work.

Having said all that, COVID-19 appears to be spreading rapidly in Africa, although the numbers reported seem to be spotty. As is true in other parts of the world, even the numbers reported seem to be significantly undercounted due to inadequacy of testing and the very significant numbers of asymptomatic cases and the difficulty of attributing death to COVID-19 versus the flu or cardiac arrests.

However, the real "worst case" is not the number of people who die in the next year or two from the disease. The "worst case" is that COVID-19 becomes a new, severe, persistent disease that adds to the already persistent infectious disease burden faced by African populations. If it, like the flu and HIV, mutates sufficiently so that vaccines don't provide lasting immunity, the suffering and loss of life over time could be even greater than whatever the impact the disease has over the immediate future.

Only time will tell whether Africa experiences a best case or a worse case as this disease progresses.

In all of this, one special consideration for African healthcare systems in this pandemic is the need to protect the on-going capacity of African healthcare systems for the future. It has taken years of hard work and very significant investment to make the progress described earlier in improving African healthcare systems. While every effort needs to be made to mitigate the impact of COVID-19, it shouldn't be done at the risk of damaging the long-term capacity of the system as whole. Africa will remain full of healthcare challenges long after COVID-19 has been vanquished and it will need to have a healthcare system that can constantly be gaining capability rather than one that has to recover from a major setback.

In particular, the skilled professional healthcare worker population of Africa needs to be protected. For example, specialist doctors who provide the knowledge and the leadership needed to train other medical professionals in their specialties are in incredibly short supply. In some nations, there are literally only one or two doctors in many medical sub-specialties.

Even doctors without specialty training are in very short supply. After years of investment, the number of doctors per 10,000 people in an average African nation is often less than 3 FTE, while the average in the developed world is more than 25. Losing significant numbers of these relatively few, highly skilled healthcare workers, due to lack of PPE and overexposure to the disease, as has happened in countries such as China, Spain and Italy, would not only be tragic in its own right but it could also set back the healthcare systems in affected African nations for years.

For these reasons, African nations should perhaps be considering treating COVID-19 patients, as much as possible, in segregated health facilities (e.g., field hospitals).

Section 2 – Potential to Use COVID-19 as Motivation to Deploy Digital Health at Scale in Africa

While the near term impact of COVID-19 on African healthcare could be very significant, and possibly incredibly tragic, it seems possible that this pandemic could, in the medium to longer term, become a catalyst to enabling dramatic improvements in African healthcare delivery – particularly in regards to infectious disease.

This will be partly due to the increased global focus, and a generally greater willingness to invest in improving healthcare. And, in particular, it may also increase the willingness of the rest of the world to focus on, and invest in, reducing infectious disease risks and in preventing future pandemics.

But the real payoff will be if this increased interest in African health can be leveraged through applying Digital Health approaches to improving population health – in particular by using it to improve approaches to reduce the impact of infectious diseases.

However, doing so will require conscious, decisive action. Specifically, it will require African nations to re-think and redesign, using Digital Health approaches, how their health delivery systems operate.

But, if African nations are able to do such a redesign, there is great potential, in the medium and longer term, for these nations to significantly reduce the impact of infectious diseases upon their populations.

The last section of this report will provide a very "rough sketch" on how African health systems could possibly be re-thought and re-designed, using Digital Health approaches.

But, before describing such a "rough sketch," let's first describe why the pandemic is likely to lead to much greater global public health investment in managing infectious diseases and why the acceleration of the movement to Digital Health offers so much potential to make such increased population health investments effective.

INCREASED INVESTMENT IN MANAGING INFECTIOUS DISEASES GLOBALLY

The world has received a massive wake-up call on the weaknesses of our approaches to population health and, in particular, on our need to be better prepared for pandemics.

Specifically, the pandemic has exposed the challenges of primarily taking an individual healthcare delivery perspective, rather than also focusing on population health, in a world which is exposed to large scale pandemics. Payers, whether they be public or private, which are primarily focused on responding to individuals as they demand healthcare, are focused on containing the immediate costs of delivering those services. Not surprisingly, such payers, which control the vast bulk of spending on healthcare, have not been focused on preparing for unknown threats to population health or on improving the health of people which fall outside the populations for which they pay for healthcare.

However, it is now very clear in the midst of this pandemic, that the public at large should be willing to pay for better population health (without compromising their own abilities to receive personal healthcare), even if it means consuming less goods and services.

Or, as Bill Gates has famously noted, this pandemic has taught us that "we should not be reluctant to spend tens of billions of dollars when the economic costs of this pandemic are going to be in the trillions."

With 20/20 hindsight, this lack of focus on population health has manifested itself in underinvestment in being prepared for pandemics no matter whether the healthcare is being delivered primarily through public payers or private ones.

For starters, this lack of focus on being prepared for large scale outbreaks of infectious diseases manifested itself in insufficient stockpiles of PPE, respirators, and ventilators, not to mention a shortage of available hospital beds. We have also not invested in sufficient stockpiles of potentially therapeutic drugs and vaccines to have them available for use at scale if they prove to be effective

against a new disease. We have also underinvested in the spare manufacturing capacity needed to scale up production of such equipment, drugs, and vaccines. We have underinvested in building the capacity needed to scale up production in new vaccines, once they have proved to be effective. We were clearly not prepared, in advance of the need, to hold accelerated clinical trials on all manner of potential therapies.

The pandemic has also exposed all of the vulnerabilities in the developed world's healthcare delivery systems, created by these systems' primary focus on delivering care as demanded by individuals and by the providers that serve them when determining how healthcare spending is allocated. In systems where the public is the payer, such as Italy and the UK, where the focus is on providing as much healthcare to people as the government can afford, the vulnerabilities have appeared in the form of rationing healthcare and, in this pandemic, to triage in determining who will live and who will die. In private systems, where the ability to pay limits who receives what level of healthcare services, the vulnerabilities in this pandemic have appeared in the form, for example, of seeing much higher mortality amongst people who combine pre-existing conditions with lower incomes.

It seems likely that the result of these, and other lessons learned, will lead to some fundamental, but at the present, highly unpredictable, changes in how different developed nations deliver, and pay for, healthcare.

However, while global economic integration will probably go into reverse in the near term, as nations want to self-contain and diversify their supply chains, increasing integration of global public health activities is likely to increase. While finger pointing between the US, China, and the WHO will receive a lot of attention, at the end of the day, the reality is that, hopefully, even the most nationalistic nations will recognize that pandemics do not respect borders.

Part of the likely response will be major increases in investment in global public health capabilities. Given the funding will be coming from the US, China, European governments, and private charities, it is unclear how this investment will be coordinated.

But, in any case, the total investment in preventing future pandemics is likely to be massive.

Indeed, Bill Gates may be underestimating the global will to invest in mitigating future pandemics. It seems likely that the investment response could be in the trillions of dollars, rather than in the tens of billions range he has estimated. Investments at such levels seem particularly likely if you include a probable public desire to increase aggregate healthcare spending on population health on their own populations, as a percentage of GDP, throughout most of the developed world.

Moreover, it seems highly likely that the developed world will "over invest" in stockpiles of PPE, respirators, ventilators, drug inventories, etc. not to mention hospital beds that can be mobilized rapidly if the need arises. There will also be far greater investment in discovering means of rapidly scaling up, and rolling out, testing, vaccine discovery, therapy discovery, etc.

At a global level, there will probably be greater investment in building up rapid global response capabilities to outbreaks including the ability to swarm any indication of a new infectious disease. After post-mortems, hopefully there will be new agreements, signed by all the nations of the world, that define the obligation of any country experiencing an outbreak to trigger immediately a global response as well as define the global mechanisms that would then be put into action.

And, there will likely be investment in early warning systems that use data to indicate an outbreak is occurring anywhere in the world.

Much of the investment needed will be on becoming able to detect and swarm new outbreaks anywhere they occur in the world. It will require investment in the healthcare systems of the emerging nations of the world, particularly in sub-Saharan Africa. If community transmission of a disease becomes widespread in any African nation, it is everyone's problem. If you want to protect the world from pandemics originating in Africa, the region's capabilities to prevent, detect, and treat infectious disease must be improved.

Finally, there should be a much greater focus on protecting the world from a variety of different kinds of pandemics. The next pandemic may not be a respiratory disease. Instead it may be a much worse

disease, like smallpox once was, that had a mortality rate of 30%.

Our global public health system response to COVID-19 was hampered by assumptions that the disease was "flu like." This was perhaps not surprising given that the global health community had done most of its contingency planning based upon flu pandemics. But, this made it more difficult for the global public health community to identify, early-on, the differences between COVID-19 and a flu as well as the related implications of those differences.

For example, there was an under appreciation, despite early-on evidence, that unlike the flu, many of the cases and transmission occur among people who do not yet have symptoms (or will never have them). This led to bad advice by the WHO, for example, which until late March, downplayed the value of mask wearing to slow transmission and to reduce viral loads even if transmitted. This also led to an overestimation of the rates of both serious forms of the disease, and mortality rates, relative to the total infected population (i.e., the rates were overestimated because the denominator did not reflect all of the people who had so few symptoms of the disease that they never asked to be tested or were denied tests because their symptoms were not serious).

There was also an under focus early on, that unlike the flu, there is a great need to find existing drugs not to treat the virus itself but rather to prevent overreaction of the immune system as it became clear that this overreaction was the source of many of the cases that became serious.

But, having said all that, it was still a source of strength that the global public health community had at least thought through, in advance, how to deal with a respiratory disease.

One question that should be raised, however, is "how well would the world be prepared if the next pandemic is not a respiratory disease?"

We need to expand the range of the kinds of diseases for which we need to undertake scenario and contingency planning. In particular, we need to think what needs to be done if potential diseases have even higher transmission and mortality rates than does COVID-19.

What would we do if we had an outbreak of a highly infectious polio-like disease? A more extreme Ebola-like disease? A smallpox-like disease? An HIV/AIDS-like disease?

Unfortunately, Africa, with the greatest population facing tropical health issues, and the world's largest infectious disease burdens, may be a more likely incubator of such diseases than China or other regions.

ACCELERATION OF DIGITAL HEALTH'S ABILITY TO HELP MANAGE POPULATION HEALTH

Another highly likely development in the aftermath of the pandemic is an acceleration of the global movement to use Digital Health techniques for population health purposes – in this case, to reduce the impact of infectious diseases.

The movement to Digital Health is a worldwide phenomenon that has been underway for well over a decade as incredibly large volumes of diverse health related digitized data have become widely available. The reason why this movement to Digital Health is so important to Africa is that it should be possible for African nations to piggyback on the investments being made in the developed world in this arena. If so, there is the potential for Africa to make dramatic strides in improving their abilities to improve the population health of their people.

Some early ideas on how to take advantage of this movement will be discussed in the last segment of this note.

But first, before describing why Digital Health offers so much potential to African nations, let's first define what is meant by Digital Health and why the pandemic is likely to accelerate the use of it for population health purposes globally.

Different people have offered different definitions for what Digital Health embraces. For the purposes of this note, it will be defined as the use of data management, and other digital technology such as telemedicine, to deliver better healthcare, more effectively and more efficiently. The intent of Digital Health is both to improve access to healthcare and to increase

the effectiveness and efficiency of diagnosis and treatment, through using digital technology, while lowering the costs of delivery.

The fundamental driver of all Digital Health approaches is the expanded use of digital data to improve the detection, diagnosis, and treatment of health issues.

Until now, most of the attention to Digital Health has been focused on its application to individual health – that is the application of Digital Health approaches to enable individuals to improve their own health.

At the individual level, in the US, for example, it embraces services such as WebMD, the Apple Watch, and Abbott's Free Libre glucose monitoring. More and more people want to self-direct more of their own healthcare. Specifically, they want to take more and more responsibility for having direct access to their own diagnostic information, want multiple points of view rather than relying on a single doctor, and are willing to take more and more personal responsibility for self-directing the management of their own health.

But, even individuals who still want to primarily use doctors are seeing the benefits of using telemedicine approaches. Due to COVID-19, many of us have discovered that telemedicine can be very effective and that we do not always need to see a provider face-to-face. Indeed given how effective telemedicine has proven to be, you can even start asking questions about whether, for primary care services, you are best served by a single provider located near you or being served remotely by a team of providers?

For example, would you be better served, and probably at lower cost, by having access (including on nights and weekends) to a cadre of qualified doctors, each with access to all of your medical records as needed, who operate out of multiple, geographically disbursed (regulation permitting), telemedicine call centers? How much is having access when you need it worth versus having "your own doctor" whom you can only see through scheduling appointments around their availability rather than your own needs?

But, as important as Digital Health will be in changing how care is delivered to individuals, the potential to use Digital Health approaches for improving population health are even greater. Indeed, the world is only beginning to realize the potential to use Digital Health to improve the health of the entire population.

Touch Foundation has undertaken two programs that fall within the broad definition of using Digital Health for population health purposes.

One effort is the M-Mama program, which we developed in Tanzania in collaboration with Vodafone Foundation and The ELMA Foundation. M-Mama is a population health initiative that helps women experiencing difficult births to get care (e.g., a Caesarean section). Anyone in the community can call a toll-free number using their cell phone. They are connected to a 24/7 dispatch center where dispatchers use an application on a tablet to collect information and dispatch a community driver or ambulance to transport them to receive appropriate treatment — which can often then save the life of both the mother and her child. The program is in the process of being rolled out to other African nations. However, despite the success of this program, at every step of the way we have had to overcome data limitations (e.g., not being able to understand the mother's medical condition before arriving at the health facility, not being able to track outcomes easily, etc.).

A second effort, funded by PEPFAR and USAID, that is being applied in Tanzania by its government, uses data, and a software tool that Touch developed called POA (Prioritization and Optimization Analysis), to determine where best to allocate scarce healthcare workers given the existing level of services accessed in different geographies and given existing staffing levels of primary health facilities in the country. Again, much of the work in undertaking this initiative has been in overcoming data limitations (e.g., how services accessed match with disease burdens in each specific geography).

Such programs are as yet only a start to using digital technology to re-design how healthcare can be delivered from a population health perspective using Digital Health approaches. But, it is clear to us that when you start thinking about how to improve population health, the key requirement is to be able to have better, more granular, data available.

For population health purposes, most of the data used today is derived from separate data collection efforts, based, for example, on surveys or by manually aggregating health facility records and official statistics that do not include actual patient data. If more granular research is done, it is performed on samples rather than through undertaking whole population analyses.

However, if you really want to move the needle on population health, you would want to be building whole population health data assets. A population health data asset is built from the ground up, person by person, that includes all the medical records and other related data, for the entire relevant population.

If you can build such an asset, you can undertake full population analyses, rather than relying on small samples which are always subject to sampling bias and to statistical limitations. For example, would you rather take data from a sample of 500 people, 100 of whom had diabetes, that tested positive for COVID-19 to understand the impact of a combination of COVID-19 and diabetes on death rates? Or, would you prefer to be able to analyze the outcomes on the entire set of people (perhaps hundreds of thousands of people) in an entire country who tested positive for COVID-19 and who also had diabetes?

Such a population health data asset, if built, could be used, not only to help treat individuals, but also to help identify the specific circumstances and conditions of people with a particular disease within that population and to develop intervention strategies that can help both individuals and the entire population. Such population health data assets could also be used to provide access to a patient's complete medical records from multiple healthcare providers (such a capability is useful in a pandemic where often the provider who treats the patient in the hospital will have never met the patient before).

Obviously, in order to use this data in such a way, there are a variety of data privacy and data usage issues that must be worked out.

Our society's experience with using data to help manage COVID-19 should legitimize exploring how we can more routinely use population health data to get answers to population health questions. It is not a big step to go from asking "why do minorities have such high mortality rates due to COVID-19?" to such questions as "what specific diet interventions can be proven to be most effective in different kinds of populations (e.g., African-Americans versus Latinos) in preventing Type 2 pre-diabetic people progressing to becoming fully diabetic?"

Having access to good health data to manage population health has always been important. But, now data can be used to manage population health in a way that was never possible before.

What has changed?

It is because over the last decade, incredible volumes and varieties of health-related data, previously available only on paper or in non-digital forms (e.g., test strips) have become digitally available. These include the digitation of patient clinical records, digital laboratory diagnostic test data (e.g., blood tests and MRIs), digital data from an increasingly wide range of wearable and Point of Care devices, as well as the widespread collection of individual patient data (e.g., demographics, genetics). This is not even to mention data from cell phones, digital thermometers, etc.

And, all of this data has now become manageable because of the development of new technologies, based upon distributed, cloud-based computing to manage very, very large (i.e., petabyte-sized) data sets with high levels of data integrity.

The combination of the volumes and varieties of data now becoming available with these new technologies offers the potential to dramatically change how medical care can be delivered both at the individual and at the total population level.

The pandemic has already demonstrated, to some significant degree, some of the potential for how massive data sets can be used to improve population health.

For example, all the world has been able to observe how researchers have used global data on cases, hospitalizations and deaths, combined with modeling, to both understand how the disease is progressing and to predict the future consequences of the disease's progression under different scenarios, including in particular estimating the healthcare system's capacity to handle the resulting disease burdens. Data on

temperatures, collected from digital thermometers, have been used to track where and how fast the disease has been progressing, through symptom capture (i.e., temperatures collected through digital devices), into different geographies. Cell phone data has been used to determine how well people are adhering to social distance guidelines, for contact tracing, and to monitor compliance with quarantine requirements. And, data analysis and data management are foundational to how all the healthcare companies around the world are racing to find therapies and vaccines.

Indeed, almost all the effective responses to the COVID-19 pandemic by both governments and private healthcare companies have been data driven.

Unfortunately, while the data available has been critical to fighting the disease, there has also been a general recognition, and lament, that much more could have been done if we had more, better data available (ranging from more test data to much more granular population health data).

Regrettably, we do not yet know even what percentage of the population has contracted the disease and, of those that have done so, how many are asymptomatic. We also lack any granular data that would be able to reveal the specific underlying characteristics of asymptomatic people versus people that developed symptoms. Nor do we have any data that can help us understand what were the specific reasons why some people's immune systems react properly and why some people's immune symptoms overreact.

If we had already built large population health data assets, we could have been able to quickly undertake research to get insights into such issues. But, as a world, we are only at the very early stages of being able to use such data at the population level to improve population health.

Governments, payers, and providers may in the future be able to build and use total population data assets to help improve the health of whichever populations that most concern them. These aggregated data assets could have in them, for each person in the relevant population, all of that person's health data including each person's own clinical records, personal characteristics (e.g., demographic information), treatment histories, diagnostic data, payment information, etc.

The data in them, built from the ground up person by person, could then be used first and foremost to help treat each of the individuals whose data resided in the asset.

In doing so, given the data would be used to deliver individual healthcare, it is essential to build all the data in such assets with high levels of data integrity. If someone is receiving healthcare based upon data, the costs of bad data are very high. Indeed, one of the challenges in treating people today is that often there are data quality issues in data coming from the existing legacy data management systems used by many large provider systems. The data health workers use are often incomplete, or are missing historical data, or lack data held by different providers. Often records are not properly linked to the right patient.

One major advantage of creating a population health data asset, is that there is now newly available software that can detect and then resolve data integrity issues at scale for the entire population. When combining this software with new processes, you can make very, very large data sets ready for use at both the individual and at the population level.

One critical advantage of creating such high-quality data assets therefore is to improve the care of individuals. But, perhaps as importantly, the resulting data asset could also then be used for population health purposes. As such assets are created, their very existence can remove what is the most significant constraint on improving population health — the lack of high quality, granular data being available at population scale.

Depending on the use case, the data could be used for population health either on an identified or on a de-identified basis. For example, going forward, it should become much easier to identify through analyses of population health data assets, disease pathways for different people based upon their specific characteristics. Such R&D could be done with de-identified data.

However, identified data would be required if that R&D was then used to pinpoint specific at-risk people for targeted interventions with an aim to mitigate the progression of the disease in those individuals.

To date, the movement to use data for such population health purposes has been much slower than many have foreseen. It is not because the technology is not ready for such purposes.

It is much more due to the difficulty of sourcing, aggregating, and making ready for use the required large data sets and having the permissions to use that data.

Much of the issue is related to the inadequacy of data regulation. Data privacy regulation, for example, is overbalanced to protect data privacy for the presumed benefit of individuals, payers, and providers relative to the need to use data for the benefit of population health, with appropriate safeguards.

But there are also non-regulatory barriers that limit the ability to build and use population health data assets. Some of these obstacles to building and using population data assets are due to the limitations that the provider technology systems have, due to their reliance on legacy data warehouse-based technology platforms, rather than using more distributed computing approaches. Some of the obstacles are that the data that is available at scale often have data quality issues that make the use of AI techniques to analyze the data too unreliable by, for example, creating too many "false positives" and "false negatives." Some of the obstacles are due to different providers' unwillingness to make it easy to share data with other providers that serve the same patients. And, in particular, there are obstacles related to the lack of the legal frameworks, and accepted business practices, needed to motivate many of the firms that own or control data to let the data they own or control to be used in combination with the data owned or controlled by others.

However, if sufficient public pressure comes out of the pandemic to use data to help improve individual and population health, not to mention containing and mitigating future pandemics, it may be enough to overcome many of these obstacles. For example, there may be a movement to use data to deliver far better healthcare to disadvantaged populations. There is likely to be enormous public pressure to re-think how both the private and public payer systems can be made to work to enable them to be far more cost effective which could, in turn, lead to a greater push towards data intensive Digital Health approaches.

Even with increased public pressure, obstacles to resolving the underlying political issues are very considerable. Such political issues are very considerable and include health data regulation, government control versus private control over the payer system, and how, within a Digital Health framework, the practice of medicine is regulated.

But, given the stakes, it would seem likely that many of these political issues will be resolved (not necessarily in a manner that makes everyone happy). Over time, it seems likely that different developed countries, at different paces, will find ways to get better alignment on these kinds of issues and, as that happens, the movement to Digital Health will accelerate rapidly.

As regulation, medical practice, and the payer system become better aligned to support the movement to using Digital Health for individual and for population health purposes, it is likely that an avalanche of public and private investment money will be brought to bear to drive this evolution.

But, what has all this acceleration of the movement to Digital Health for population health in the developed world have to do with African health?

The answer is straightforward.

African nations can take advantage of all of this global investment in accelerating the movement to Digital Health, to re-think the future evolution of their own health systems. As independent nations, with pressing population health needs, particularly related to infectious diseases, they in fact should be less burdened by the political issues that seem to get in the way of many developed nations in using data to improve individual and population healthcare.

Indeed, if sufficient seed capital investment by global public and private funding sources can be found, it should be possible to launch robust Digital Health initiatives in several African nations. If so, the potential to use Digital Health to improve population health can be demonstrated not just to other African nations but to developed world nations as well —particularly in the arena of infectious diseases. And, once a few countries show the way, many others will follow.

It makes far more sense for African nations to develop their future health systems based upon Digital Health than trying to follow the paths that have been taken by the developed world to practicing medicine. Frankly, it is impractical for nations with poor populations, and massive population health issues, who have, for example, 3 doctors per 10,000 people, to try to imitate developed world nations' historic medical practices, and payer systems, that have, for example, an average of 25 doctors per 10,000 people. Simply said, most African nations do not have the per capita GDP to be able to afford taking the historic approaches of developed nations, given an alternative to taking a Digital Health path. Digital Health is by far and away a better approach for African nations to take if they want to address the massive population disease burdens they face.

Just as the emerging market countries used mobile telephones to leapfrog the need to build land lines, building their future healthcare systems off of Digital Health can accelerate African nations' ability to meet the healthcare needs of their populations.

And, becoming better at managing infectious diseases would seem to be a good place to start.

"ROUGH SKETCH" THOUGHTS ON HOW TO USE DIGITAL HEALTH TO REDESIGN AFRICA'S APPROACH TO MANAGING INFECTIOUS DISEASES

At stake in the need to embrace Digital Health in sub-Saharan Africa is not just the need to help prevent future global pandemics, but also the more straightforward need to reduce the staggering infectious disease burdens the region already faces.

Let's assume for the rest of this note that some combination of the US, China, European nations, global public health charities, and tech companies are willing to invest significant amounts of money to help some African nations use Digital Health to redesign their approaches to managing their infectious disease burdens. The objectives of different investors would vary from enlightened self-interest in the mitigation and prevention of future pandemics, to altruism, to discovery of population health approaches that could be used in the developed world, and, in some cases, to a desire (particularly from tech companies) to make money.

How could this investment be made?

The starting point for any potential investor, or set of investors, would be to identify which African nations with whom to work. The reality is that almost every sub-Saharan African nation could be viewed as a candidate for investment given the high infectious disease rates across the region. As a first thought, it would seem to make sense to pick among those nations, the ones that are most willing and able to embrace the use of Digital Health approaches to address their infectious disease burdens. These nations could then serve as learning beds and the proof of concept for the rest of the region.

Of course, the way in which Digital Health was used to re-design their approaches to healthcare delivery would vary by the specific characteristics of each nation's population, infectious disease burdens, and existing healthcare systems. Moreover, the design decisions would inevitably be made by different countries given their own particular circumstances and own political leadership.

Different investors would, in reality, decide to work in different countries and would probably work separately on different aspects of Digital Health.

However, for the purposes of this note, let's assume all of the investments being made in a country were undertaken in a coordinated, holistic approach.

Given this assumption, let's lay out some first thoughts on a "clean sheet rough sketch" to serve as a straw man to illustrate how a healthcare system could be redesigned using Digital Health.

Before I lay out this thinking, I would like to make clear that the thoughts in this note draw upon thinking of many other leaders in the global public health community, such as Bill Gates, the WHO, and the Global Fund. It also draws upon work I have personally done over the years with healthcare clients including both providers and healthcare product companies. The thinking also draws on reading many thought pieces written by a wide variety of people but, in particular, by drawing upon thinking, and engaging in discussions with

my former colleagues at McKinsey & Company. It also includes thinking I have done in partnership with the leadership of Tresata, a new tech company, which I've invested in, and on whose board I sit, whose software enables extracting intelligence from very large data sets using the latest advances in AI and cloud computing. This includes joint thinking on how these new technologies can be used to build very large population health data assets. And, most importantly, my thinking has been significantly derived from all the program work done by Touch over the years and, in particular, by drawing upon the thinking and knowledge of Touch's program staff led by Massi Pezzoli.

The resulting rough sketch that is discussed in the rest of this note brings together thinking that has been evolving over the last several years. The underlying need that has been driving this thinking has been the quest to find approaches that could move the needle on African health issues given the magnitude of the challenge. The COVID-19 pandemic has served to accelerate and catalyze this thinking which is why this note is being written now rather than sometime in the future.

Before describing these first thoughts, it needs to be pointed out that these ideas are conceptual and need to be further evolved and refined over time before they can be put into practice at scale. Like many other endeavors, such as developing new therapies or new vaccines, some kind of stage gate process is required to navigate through all the inherent uncertainty and complexity involved in putting such conceptual ideas into practice.

Touch Foundation's experience in Africa has been that in order to make new ideas work on the ground, you need to first undertake a rigorously defined proof of concept. Then, based upon lessons learned from that proof of concept, you need to undertake a large-scale prototype effort to see if the ideas work at scale and then to refine the ideas based upon that experience. Such prototyping is required, in particular, to learn how the economics work in practice, including the costs versus the benefits. Only then, can you be prepared to scale the ideas across a nation or across multiple nations.

We have taken such a stage gated approach, for example, in working with Vodafone Foundation and The ELMA Foundation in developing the M-Mama program and also with PEPFAR and USAID in developing the POA tool described earlier, used to determine how to assign scarce healthcare workers.

Moreover, by using stage gating, you can match the right parties to fund each stage with the risks that need to be managed and the funding that is required, since the risks and benefits, and the funding required for each stage, are different. For example, the proof of concept effort for each of the elements of this rough sketch might be best funded by global health focused foundations, perhaps in combination with private, profit-seeking companies such as tech providers. Prototypes, using the learnings from the proof of concept, might be funded by very large public foundations, perhaps in combination with assistance from non-African governments (e.g., US, China, European) as well as by the local African governments themselves.

In our experience, much of the work in the proof of concept and prototyping are in thinking through how to make the different roles of different people who need to do the work in the new approach to be as simple, and as clear, as possible. This includes defining how each role is supposed to interact with other roles. It also requires thinking through how the performance of each individual worker, in each role, will be measured and to develop reward systems that re-enforce those metrics.

However, while funding for proof of concepts and prototyping can come from others, there is no alternative but for the funding needed to do the heavy lifting of scaling the effort to come from the African nation itself. Scaling a Digital Health system to the national level will require funding largely through that particular African nation's own resources (perhaps supplemented by some outside assistance). On the scale being described in this note, it would certainly include re-working how the nation's payer systems, and the allocation to funding from taxes, are used to support the scaled introduction of a new, digitally based, healthcare system.

But, further discussion of what should be done to put the ideas into operation is beyond the scope of this note.

The rest of this note will be focused on providing first thoughts of what a clean sheet rough sketch redesign of African healthcare delivery aimed at reducing the disease burden in Africa could look like.

Some of the elements of this clean sheet rough sketch redesign could include:

1. Rethinking how primary and infectious disease care is delivered by using Digital Health approaches to re-organize and re-design, countrywide, how community health workers use technology both to interact with the broad population and to keep connected with the broader healthcare system
2. Building an individual and population health data management capability
3. Building out an extensive, digitally based, Point of Care diagnostics and testing capability
4. Building a transport and logistics system to ensure the effective movement of patients to where appropriate care can be provided and also to ensure the flow of needed supplies, drugs, and vaccines
5. Redefining the role that higher level providers (e.g., specialty hospitals) and medical universities play in providing leadership to the entire re-designed healthcare system
6. Rethinking and redefining, given how the new Digital Health system is intended to work, the role of the nation and governments in overseeing and managing the system

Let's look at these elements one at a time.

1. *Using Digital Health to Redesign How Community Health Works*

The bulk of the populations of most African nations are rural and are usually dispersed over wide geographies. Rural communities are often distrustful of people outside their communities. Moreover, given their low incomes, it is difficult and expensive for people in such communities to afford the costs of traveling to get to the nearest clinic or hospital, or to pay for services, once there, even if the healthcare center is properly staffed (which often they are not). These difficult to reach communities, however, are the ones where most of the infectious disease burden resides.

For these reasons, the first line of defense in rural Africa (including the care of many people in semi-urban areas as well) are community health workers. Community health workers are usually lightly trained, or untrained, workers who serve communities. Usually they are not formally paid and rely for their income on contributions from the people they serve. In general, these workers come from the communities themselves and are most effective when they personally know the people they serve but in many areas there are so few of them, relative to the people they are serving, that such personal knowledge of all of them is not practical.

There has been a global public health community campaign underway, led by organizations such as the WHO, the Global Fund, Amref Health Africa, the Bill & Melinda Gates Foundation (and others) that have been attempting for decades to find means of increasing the number of these workers and to improve their training. It has been variously estimated that Africa needs from 1 to 2 million or so such workers (versus the few hundred thousand or so today) that would provide, depending upon your assumptions, one community health worker for every 500 to 1,000 people.

An even greater problem than the sheer number of community health workers available, is the reality that most of them are often not very effective. Many are poorly trained, and some may not be literate. Many, if not most of them, are not even connected to the formal healthcare system. Moreover, they don't have the skills to diagnose many infectious diseases and often do not have access to the drugs needed to treat them. They certainly aren't well prepared to identify novel diseases.

The thought is to improve their effectiveness by formalizing the connection of such workers to the healthcare system through using Digital Health approaches. It also implies recruiting workers who have the appropriate intrinsic skills and literacy, training them, and retaining them by paying them appropriately. These would be good jobs, but the pay and training requirements would be far less than those of nurses or doctors.

For example, you could envision a "hub and spoke" system where each community health worker was provided a mobile device that could be used to

connect them to a designated health facility staffed by a trained nurse or nurses. For disease challenges beyond their skill set, the community health worker could enable, through telemedicine, the nurse to interact with the patient as necessary to help diagnose the issues, determine which diagnostic or disease test to take, and determine appropriate treatment and next steps. If a drug therapy was needed, the nurse could prescribe it and have the medicine delivered to the community health worker (who would be responsible for the patient's adherence to taking whatever drug was prescribed).

If the patient's needs required a doctor, the nurse would have the ability to bring in, again by telemedicine, a doctor as needed. The same community health worker would work to ensure that the members of the community being served were all vaccinated as required by the nation's protocols. They would also be responsible for ensuring the input of each person's data (e.g., clinical records from interactions with a patient, results of diagnostic tests, etc.) to the appropriate data management systems.

The core idea, simply said, would be to use telemedicine as the backbone of a new system connecting an army of skilled, well-trained, community health workers both to the population and to nurses and doctors in nearby clinics and hospitals. The intent would be to put the "boots on the ground" needed to treat the infectious disease burden of the entire population and to give them, through digital support from more highly trained healthcare workers, the ability to diagnose and treat infectious diseases.

Such a system would also provide the means to create early warning alerts for infectious disease outbreaks. It could be to ensure rapid communication to the global public health community of the emergence of new infectious diseases as well as the reemergence of hot spots of existing diseases.

The community health worker in such a system, would, of course, also help with other primary healthcare issues such as helping women and their babies get the care they need for both typical and emergency maternity issues as well as infant care.

2. *Building an Individual and Population Health Data Management Capability*

Another critical need in fighting infectious diseases, and for that matter almost all individual health issues, is the ability to provide healthcare workers with the personal health data they need to treat a patient. The needed data at the individual level includes clinical records, medical histories (e.g., vaccinations, disease history and disease progression over time, disease outcomes, etc.), diagnostic and disease specific test data, demographic information (e.g., age, gender, residence location), and other similar data.

Even in the developed world, such single patient data is often not usually easily available digitally, in patient aggregated form, given that it often resides in the records of many different providers —even if they are part of the same hospital system (although such aggregated records for individuals will increasingly will become available as Digital Health progresses).

Currently, this kind of data is not even collected routinely for most Africans, let alone available in any aggregated form.

This need for data is amplified if a community health worker, who is in physical contact with the patient, needs to work remotely through telemedicine, with the nurse or doctor diagnosing the disease and prescribing treatment. Everyone involved in such individual treatment, including the patient, needs to have access to the same data.

The first challenge in developing a health data management capability is that much of the data needed is not yet even being collected. Or, if it exists, it is in paper form or is on a strip-based diagnostic test where the results, even the data (from a point of care test, for example) used by a provider or seen by a patient, are not ever recorded. So, both more data needs to be collected and that data needs to be collected and stored in digital form. This in turn requires not just a one-time collection effort but rather also a continuous ability to add new data (e.g., clinical records, changes to weight, blood pressure, residence, diagnostic and disease test results, etc.) as it becomes available. This means that in the design of the new system determining how to efficiently and effectively collect and input patient information, digital data is a fundamental requirement.

Once collected, the data then need to be managed. Managing data includes not just data storage but also getting the data ready for use which includes ensuring the data is accurate and that all the data is properly linked to the right person. This is not a trivial issue in economies where the processes of keeping track of people are informal. Indeed, both to ensure that the data is properly linked to the right person and to ensure, later on, that the right payer is making the right payments for services to the right person, it may mean that some form of national digital ID system, like the one now used in India, may be required. The good news is that, once collected and stored, most of the heavy lifting needed to get data ready for use at scale can be done by software.

Once the data is ready for use, further effort is required to enable the data to be accessed by appropriate people while also denying access to others (i.e., maintaining data security). In turn, applications that provide access to the appropriate people need to be built (e.g., so the community health worker, the nurse, and a doctor can all be looking at the same data through their respective mobile devices or computers).

All of this requires using world class tech firms, with advanced technology skills, to design and put into production all the related software and infrastructure required. For both performance and cost reasons, this, in turn, requires deploying 21st century technology, based upon distributed computing and cloud-based approaches.

This should be an obvious point but it should be noted that most of the developed world's providers still use data management approaches that are largely based on 20th century technology (e.g., data warehouses) rather than the 21st century technologies needed to build the described capabilities. It is one of the most important reasons why using Digital Health for population health purposes is far less advanced in the developed world than it should be.

The data needs to be organized so it can be analyzed both for individual and population health using AI analytic techniques. For example, for an individual, you would want to be able to use AI to identify for similar people (as identified by their health data) with similar health issues, what were the outcomes of different therapies and which one is likely the best fit? For example, for population health, you would want to build in the capacity to use AI to identify, at a granular level, the progression of how an infectious disease is spreading amongst a population and to predict, given that spread, what are the best combination of containment and mitigation strategies.

The technology effort, and investment, required to build out a technology platform able to handle the volumes and variety of data in a fully built out population data asset would be very considerable. Specifically, a data asset containing all the health data in a national population, in a nation of 50 million people, would create a need to manage tens, if not hundreds, of petabytes of data (i.e., in the same range as the data that needs to be managed by a large global bank or a global healthcare products company).

3. *Building out a Digitally Based Point of Care and Disease Testing Capability*

The ability to remotely, and conveniently, undertake Point of Care diagnostic testing, is critical to enabling healthcare workers to make on the spot healthcare treatment decisions. This is true not just to know whether someone has contracted a specific disease, or has developed antibodies for it, but also for more basic information such as whether or not a woman who is about to deliver a baby has high glucose levels and is therefore diabetic.

Point of care diagnostics reduces the need to rely upon physically transporting diagnostic tests, and the results, to and from laboratories. Moving data physically creates extra costs but more importantly delays when the provider and the patient see the results. In some cases, the time delays can affect treatment and can have adverse health effects (including death).

Moreover, doing so digitally, so that the data can become part of the patient's medical records, can enrich the ability to use that data, in combination with other data, to track a patient's progress over time and when to change treatments. And, being able to include such data in patient data can powerfully improve abilities to use a population health data asset to understand such issues as which treatments work best with different kinds of patients, when in the progression of a disease different therapies work

best, which kinds of patients are most likely to have adverse side effects from different treatments, etc.

Over the next few years, given the R&D being spent on them, the technologies inherent in digital Point of Care diagnostic and disease testing are bound to get better and they should become ever more cost effective. If so, at some point, every community health worker may wind up carrying portable point of care testing devices where the data, once collected on the spot, is also simultaneously input digitally into each patient's health records.

Of course, there are some tests which cannot be easily done with Point of Care devices, particularly those requiring large blood samples, so there will always be a need to do laboratory-based testing. Of course, such laboratory results also should be included in each patient's medical records.

4. *Building a Health System Wide Transportation and Logistics System*

While Digital Health can overcome many of the limits of physical geography, there is still a real need both to move patients with serous conditions to facilities where they can receive appropriate treatment and to provide the flows of supplies, drugs, vaccines, etc. to patients convenient to where they live.

Most patients with serious non-infectious disease health issues, or with infectious diseases which have progressed to become serious, will require treatment that cannot be handled by community health workers. This means that such patients will need to be moved from where they are to where that care can be provided (usually to a clinic or hospital). In particular, there is a need to develop systems to provide transport for a range of emergency transport related health issues. These include ensuring mothers get moved to where they can deliver their babies safely, particularly if experiencing difficult births. They also include injuries due to trauma (e.g., vehicle accidents) and even to heart problems (which are becoming more of an issue in Africa as life expectancy increases and per capita income grows). Similarly, children who develop severe pneumonia may need to be hospitalized to prevent their death.

In our experience, this emergency transport need is not just about adding more ambulances, given the logistical difficulties of sending them from central locations to remote areas, but rather is how to mobilize private transport (e.g., taxis), in addition to ambulances, to get people picked up and moved to the right healthcare facility quickly. Private transport, particularly in rural areas, can get to patients far quicker and more effectively. However, for some emergency conditions (e.g., severe trauma), private transport may not work.

However, using either private transport or ambulances requires determining everything from how a community health worker can work with dispatchers to order transport to pick up a patient, to ensuring proper PPE for the driver if the patient has an infectious disease, to creating mechanisms to pay the drivers if private transport is used.

The logistics issues of moving healthcare products throughout the system also need to be worked out. The logistical challenges that already exist within most African nations to ensure clinics and hospitals are properly supplied are already very difficult to manage. If the need becomes also providing additional tens of thousands of community health workers, operating in remote geographies, with supplies, drugs, and vaccines, the logistical issues become far more challenging.

This is true even if the community health workers physically pick up the products from a health center, let alone if the supplies need to be delivered directly to the communities they serve. Such movement of supplies also adds to the related costs of the system. And, the widened distribution of supplies to tens of thousands of additional healthcare workers also requires development of control processes so that what is being moved around doesn't get stolen.

Determining how to move people and physical healthcare items around the system is a requirement, not an option, if you want to deliver effective telemedicine-based healthcare. In Africa, relying on the broad population to overcome, individually, barriers created by physical distance will only mean that most of that population will receive far more limited care than they require. Therefore, finding cost effective solutions to overcoming these logistical challenges is a key requirement in making a system based upon Digital Health workable.

5. *Redefining How Higher-Level Healthcare Centers (e.g., Specialty Hospitals with Co-Located Medical Schools) Work in a Digital Health Driven System*

Over the years there has been a debate in the global public health community between those that have advocated for more investment in community health workers versus those who advocate for more investment in doctors and higher levels of healthcare (e.g., specialty hospitals). At Touch, we believe that this is a false choice since both are required to build an effective healthcare system in Africa. Digital Health makes this debate even more unhelpful since while you need more community health workers, you also need to connect them effectively to the entire system—this is particularly true if your objectives are to improve population health and to reduce the burden of infectious diseases.

Within a well-functioning healthcare system, the higher you go up the system, the hospitals generally are bigger, have more capabilities, and become more specialized. For example, doctors with scarce specialized skills (e.g., surgical) are at higher levels of the system so that those skills can be supplied to patients arriving from the broadest number of referring institutions.

Those same big referral hospitals (e.g., sometimes called tertiary hospitals) are often co-located with healthcare worker training capabilities. Indeed, most of the best, biggest hospitals are paired with medical schools. This co-location of medical schools with large hospitals provides ample numbers of patients for the clinical training of medical doctor and nursing students. In the developed world, many of these specialty hospital/medical schools (i.e., teaching institutions) become centers of medical research since they combine being able to have the same world class specialized doctors who are treating patients, and teaching, to also provide leadership for medical research.

In the African Digital Health "rough sketch" being described, much of the role these institutions play in the healthcare system would remain the same. However, their role would be expanded in order to use the brainpower available in these institutions to undertake research, using the population health data assets being created, and to develop interventions using that research to improve the health of the relevant population.

The scale, variety and granularity of the data that would be in one of these population health data assets provides for opportunities for robust population health analyses and interventions.

The research and intervention approach being proposed in this note are different from the kinds of medical research usually being done. For example, most medical research is done on large, specialized databases which have been created to undertake research on cancer, Alzheimer's, cardiovascular disease, etc. Such data assets are being used to help researchers understand, for example, how diseases progress in order to determine disease pathways and to discover potential intervention strategies to be explored. If this research then leads to the development of new vaccines or drugs or other therapies, then efficacy is determined through clinical trials.

The research being proposed in this note is different. The research is to be done for an actual population of people whose health you are trying continually trying to improve. Moreover, rather than just doing research to understand disease pathways and to discover treatment approaches, you would be doing the research to understand what targeted population interventions should be made and, once made, how well they worked in the relevant population.

For the most part, the interventions used to improve population health would not be using new, untried interventions. While the data in the population health data asset could be used to do research on new vaccines or therapies, that research would presumably be done on a de-identified basis, and if that research led to new vaccines or therapies, then undertaking clinical trials etc. to test their efficacy would be appropriate before treating patients.

What this note is highlighting, rather than to find new vaccines or therapies, is the opportunity to do research that would be exploring, amongst the portfolio of possible already medically accepted interventions, which ones work best in the specific population given the different circumstances of the different people making up that population.

For example, if you had a population data asset for a major region of a country, you would be able to identify everyone in the population who had been diagnosed for malaria during the previous week. You could identify, as they appeared, specific geographic hot spots of community malaria infection. Wherever you found a hot spot you could then put in place an immediate, targeted malaria surveillance and elimination program for that community. This could include working through the appropriate medical centers and community health workers to do targeted preventative interventions in those communities ranging from ensuring use of insecticide treated bednets to spraying insecticide indoors. You could re-communicate within the affected community the importance of getting treated as soon as the first symptoms develop (with malaria delaying treatment by a single day can make the disease much more serious). You could get all the under-5 population in the community vaccinated with the new malaria vaccine (which in clinical trials has shown to prevent 4 out of 10 cases). And, you could have the relevant community health workers pro-actively check in on all of the patients who had been diagnosed and treated for malaria in the previous week (and who had not been hospitalized), report their conditions, and identify anyone thought to be at risk.

Being able to analyze the actual health data on a population of people whose health you are trying to improve is therefore different than doing normal medical research. You are trying to get a better understanding of how different infectious diseases spread in that population and how the infectious disease pathways vary for different kinds of people within that population. As targeted preventative measures and treatments are taken, the same people doing the research can also then oversee the efforts being made to interrupt the progression of the disease in the different segments of the population. Then, as those preventative measures and treatments are implemented, and as it became possible to see how effective these measures actually turned out with actual patients, the strategies could be refined as more experience is gained.

Over time, through refining such measures through trial and error, it should be possible to develop intervention strategies at a scale sufficient to have major impact in reducing the entire population's infectious disease burden.

6. *Rethinking the Role of Government in Such a System*

The current way in which African countries operate their healthcare systems is idiosyncratic to the different nations.

But no matter how countries operate their systems today, if they were to move in the direction of the kind of Digital Health system being outlined above, they would probably want to do a major re-think of how they wanted their healthcare system to work to accommodate this new direction. This would include rethinking the role of national and local government relative to the private sector in delivering individual and population health. And, given the costs of providing Digital Health on the scale being envisioned, a rethink would be needed on how the payer systems would work and what role taxation should play in paying for it.

The governments should also do a rethink of the roles of healthcare providers at all levels in this new system (from community health providers to the director generals of the largest hospitals). For example, which people within the system are accountable for population health and the economics of the entire system versus the performance and economics of individual healthcare institutions?

A related issue is the need to do a rethink of the training and education requirements for every role in a Digital Health based system. What is the role of a nurse, for example, in overseeing the work of community health workers and prescribing treatments? What are the levels of compensation for different roles? Do governments, for example, require that formal payments are made to anyone providing health services while simultaneously banning informal payments?

And, given the role that data would play in delivering healthcare in this model, all the issues related to data privacy, data ownership, and data use regulation would have to be re-thought. This would include thinking through the regulations, laws, frameworks, and protocols for collecting, aggregating, and using the data including all the related liability and data protection issues related to using the data ethically.

This would include working through such issues as how do you protect the individual's rights to data privacy relative to the needs to use data for population health purposes?

COVID-19 is just the latest infectious disease to burden sub-Saharan Africa. Even if the pandemic in Africa only lasts for a year or two, the toll of the disease in terms of increased suffering and death will be appalling. If it becomes a persistent disease, like the flu and malaria, it will add immensely to the already compelling need to address Africa's staggering infectious disease burden.

Given the scale of its existing infectious disease challenge, let alone the need to fight COVID-19 if it becomes a major new, persistent, severe infectious disease, Africa needs to change its fundamental approaches to addressing these issues.

Africa has little hope of addressing this challenge by following the historic approaches taken by developed world countries. Those approaches are not only too expensive but, even more importantly, they are not based upon the opportunities to use Digital Health to make population-based interventions like those outlined in this report. Indeed, if some African nations were to succeed in such Digital Health based interventions, they could provide lessons, not just for other African nations, but for the developed world as well.

The COVID-19 pandemic is terrible. It has all the makings of the worst global tragedy in the last 75 years.

However, perhaps, in its aftermath, it can serve to motivate us to use Digital Health approaches, at scale, to address Africa's infectious disease burden. If so, the resulting digitally enhanced primary care system could also be used to gain traction in managing Africa's other population health issues (e.g., maternal and newborn health, non-infectious diseases) as well.

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Author Biography

Lowell Bryan led the effort to found Touch Foundation in 2004 and served as its President until May 2020 when he transitioned to become Chairman of the Board. Since its founding, Touch has been focused on finding approaches that can lead to making meaningful progress in relieving the healthcare burden of African populations.

Lowell led the founding of Touch while he was still a senior consultant at McKinsey & Company. McKinsey has provided significant assistance to Touch from its inception.

Lowell worked as a consultant at McKinsey & Company for 36 years and served as a Senior Partner for 27 of those years. He helped found and lead both the Financial Institutions practice and its Strategy practice. He wrote six books on banking, capital markets, globalization, strategy and organizational topics and has had numerous articles and editorials appearing in publications such as The Wall Street Journal, Harvard Business Review, and McKinsey Quarterly.

Of more relevance for the authorship of this note, is Lowell's experience in health care, in data management, and in Digital Health.

While at McKinsey, beginning in the mid-1990's, continuing until today, he has served major healthcare providers, pharmaceutical and medical product companies. After founding Touch, he became an active member of McKinsey's Global Public Health practice until his retirement from the Firm.

Since the founding of Touch, Lowell has led its efforts to apply his McKinsey-developed problem solving techniques to help address African public healthcare issues. He personally led the research for the first two research papers produced by Touch. The first one was focused on the shortage of skilled healthcare workers in Africa and the requirement to improve the supply as a first step in addressing African health issues. The second report focused on what specific steps needed to be taken to accelerate the training of such workers in Tanzania by identifying what needed to be done in 37 different sites throughout all regions of the country.

Since then, he has led the efforts of Touch's program staff, now headed by Massi Pezzoli, almost all of whom were either former consultants or are medical doctors. Over time, these efforts have ranged across almost the entire spectrum of the challenges that limit the effectiveness of healthcare delivery in Africa, including the lack of skilled healthcare workers, the difficulties of reaching rural populations, the lack of supplies, the logistic challenges, and the lack of management capabilities and systems. A particular focus has been on how to get the most productivity from whatever funding is available.

Since leaving McKinsey in 2012, in addition to leading Touch, Lowell also served as an independent consultant. Much of this consulting work was in areas related to this note.

In particular, one of his primary clients has been Tresata, whom he has served as an investor, adviser, and director. Tresata is a software company whose software is designed to use 21st century digital technologies, based upon distributed computing and artificial intelligence, to manage and get value from all varieties of digital data at vast scale. One of Tresata's software offerings enables the management of very large population health data sets.

Lowell's other primary client since 2012 has been a major healthcare company, whom he has served on many issues. Over the last several years, much of his advisory work at this client has been focused on advising top and senior managers on opportunities to use 21st century technologies to overcome the limitations of their legacy technology platforms. More recently, much of his work at this client has involved developing strategies to use these technologies to pursue Digital Health opportunities.

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