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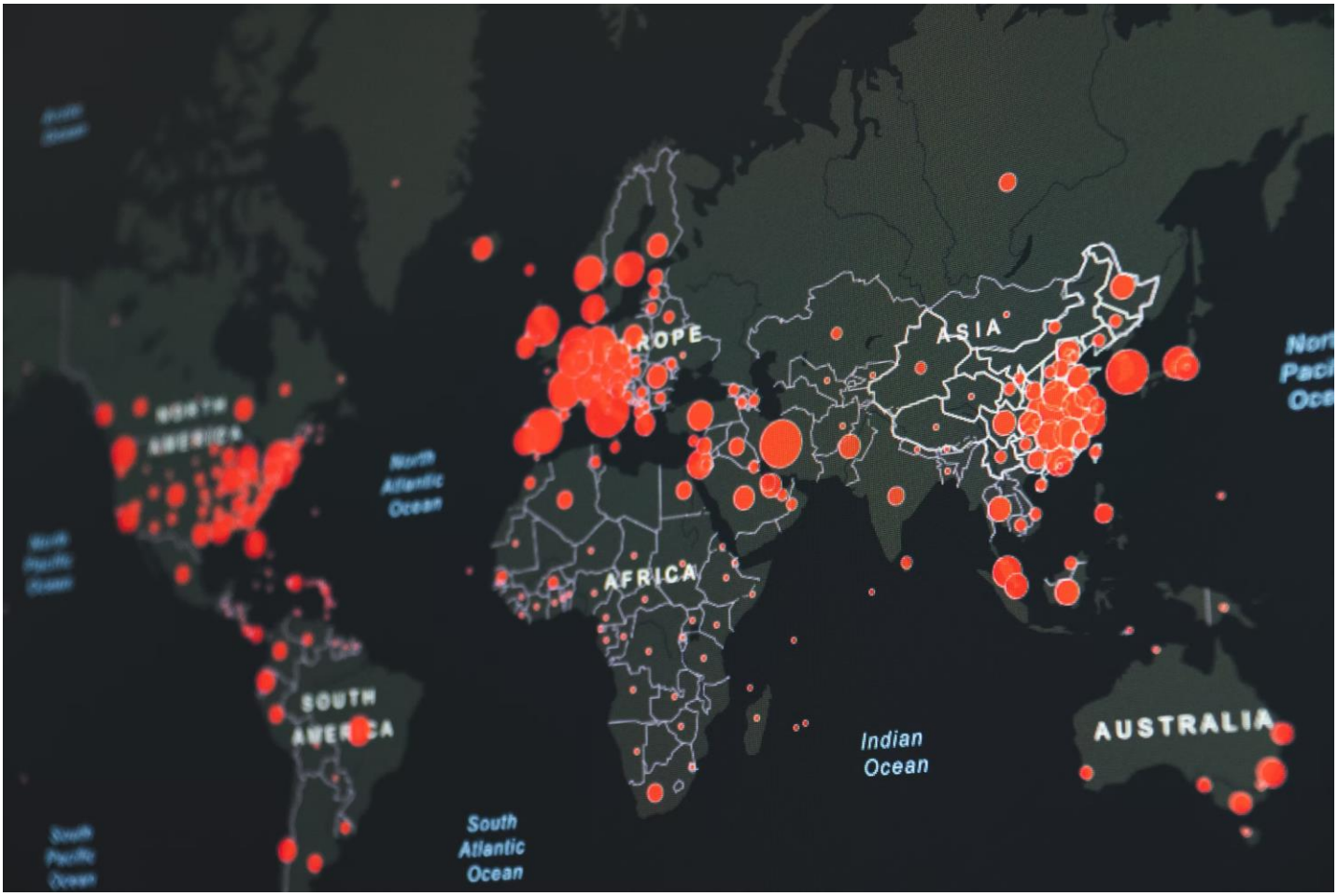

Global Health Strategy Group: Digital Health & AI for Health

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The Digital Health and AI for Health work is chaired by **Darlington Akogo**, Founder and Director of MinoHealth AI Labs, and **Saleem Sayani**, Director of the Aga Khan Development Network Digital Health Resource Centre. This Group brings together global experts who draw off the skills and enthusiasm found in both the global North and global South.

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Acronyms

AI	Artificial Intelligence
AMR	Anti-Microbial Resistance
FT	Financial Times
G7	Group of Seven
HSDN	Health Services that Deliver for Newborns
HSU	Health Systems Unit
ICUs	Intensive care units
ITU	The International Telecommunications Unit
FG-AI4H	The International Telecommunications Unit World Health Organization Focus Group on AI for Health
KNUST	Kwame Nkrumah University of Science and Technology
KEMRI	Kenya Medical Research Institute
NCDs	Non-Communicable Diseases
LMICs	Low-and-middle-income countries
LSHTM	London School of Hygiene and Tropical Medicine
LIFE	Life-Saving Instruction for Emergencies
OiB	Oxford in Berlin
OUCRU	Oxford University Clinical Research Unit
SDGs	Sustainable Development Goals
UHC	Universal Healthcare
WHO	World Health Organisation

Section 1: Introduction

This section details the rationale and previous engagements of the Oxford in Berlin group, and the objectives of the Global Health Strategy Group for Digital Health and AI for Health.

1.1 Background

The World Health Organisation defines digital health as "a broad umbrella term encompassing eHealth (which includes mobile health), as well as emerging areas, such as the use of advanced computing sciences in big data, genomics and artificial intelligence".[1] Such tools have huge transformative potential for global health, but also pose many challenges.

OiB global health initiatives has organised numerous workshop sessions focusing on health data, and digital health and Artificial Intelligence (AI) tools. A launch meeting in October 2018 covered, amongst other things, AI applications in healthcare and the role of global health networks. A brainstorming meeting "Data in Health" held in June in 2019, covered topics including AI applications to healthcare and the role of global health networks, big data, machine learning, deep medicine, digital health, value-based healthcare, data in health care management and prevention, sustainable Europe-wide and global data-sharing platforms. In October 2019, a large gathering in Berlin held to explore "Healthy Planet–Healthy People" brought together over 80 participants globally with sessions that included One Health, human-animal interactions, infectious disease emergence, spatial modelling, and pandemic preparedness. Oxford in Berlin has therefore already brought together hundreds of colleagues from Oxford, Berlin and globally to engage in in-depth discussion of the issues pertinent to digital health and AI for health. To capitalise on the enthusiasm and momentum generated by this prior activity, the Global Health Strategy Group for Digital Health and AI for Health was set up in mid-2021.

The last two years have added even more urgency to the need to improve data for international health emergencies. Recent events have reminded us that analysing the problems we face must go hand-in-hand with scaling up practical, implementable, solutions, and that instead of being merely passive observers we need to focus on action, and for that we need a "strategy" with priorities and timelines. To this end, the launch meeting of the Global Health Strategy Group for Digital Health and AI brought together 34 individuals representing nearly 20 institutions from around the world, with intent to increase its inclusive coverage even further over time. Quotes from participants and speakers at the meeting have been included in the hope of capturing the rich discussion that took place.

1.2 Objectives of the Global Health Strategy Group for Digital Health and AI for Health

- To create a platform where global health experts can discuss and explore the global health potentials, challenges, and important future domains of digital health and AI for health.
- To clarify the relative priorities, impacts, and inter-dependencies of the key challenges faced in utilising digital health innovations and AI for health effectively and equitably.
- To develop a network of global health experts who are tackling global health issues through digital and AI tools that will encourage partnerships, innovation and knowledge sharing.

[1] WHO Health Topics, Health Topics, Digital Health
https://www.euro.who.int/en/health-topics/Health-systems/digital-health

- To advocate for an action plan that reflects the steps required for a globally cooperative, equitable, implementation of digital health innovation and AI that promotes global health and well-being for all.
- To provide a supportive environment for building digital health and AI ventures across many actors from initial concept to scaled-up delivery.

1.3 Groups Engaged in the First Meeting of the Global Health Strategy Group for Digital Health and AI for Health

1.4 Chairs and Speakers

Saleem Sayani,
Aga Khan Development Network Digital Health Resource Centre,
Director

Darlington Akogo,
minoHealth AI Labs,
Founder and Director

Wilfred Njagi,
Villgro Africa,
Co-founder and CEO

Wilm Quentin,
Department of Global Health Management
Technische Universität Berlin,
Senior Research Fellow

Timothy Tutti,
University of Oxford,
Post-doctoral Researcher

Jacob Mcknight,
University of Oxford,
Post-doctoral Researcher

Naomi Muinga,
KEMRI/Wellcome Trust Research Programme,
Research Officer

Andrew Jack,
UK Financial Times,
Global Education Editor

Roland Eils,
Digital Health Center, Charité Berlin,
Founding Director and Chair

Louise Thwaites,
Oxford University Clinical Research Unit (OUCRU) Group,
Associate Professor and Clinical Researcher

Chris Paton,
Global Health Informatics Group, University of Oxford
Head;
LIFE, Principal Investigator

David Clifton
Clinical Machine Learning, University of Oxford
Professor

Thomas Wiegand,
Technical University Berlin,
Professor; International Telecommunications Unit Focus Group on AI for Health, Chair;
Fraunhofer Heinrich Hertz Institute, Executive Director

Section 2: A framework for engaging with Digital Health and AI for Health

To guide global action, the world community has agreed on a framework, the Sustainable Development Goals (SDGs). Arguably all of the SDGs matter for human health. The Chairs of the Strategy Group identified three SDGs in particular to frame the activities of the Group, and proposed that all subsequent meetings would check off activities against these three Goals.

2.1 Sustainable Development Goal 3

Digital health and AI tools are an opportunity to "Ensure healthy lives and promote well-being for all at all ages". This provides the Group with a vision of equity, fairness, and common humanity. In particular, digital and AI tools offer opportunities for improving quality of health and health-related services to people who ordinarily would not have access to good quality healthcare because of their low income or poverty, or because they live marginal lives—as the homeless or migrants, or in informal settings—or who live in hard-to-reach areas. SDG3 is about more than medical treatment. It is about ensuring health and well-being in all areas of human existence, including from interactions with the planet and of individuals with other individuals and with the rest of society. Digital and AI technology alone is not enough. Success requires transdisciplinary and interdisciplinary thinking that bridges life sciences and medical sciences, social and political sciences, humanities, and many other subject areas too, and the development of implementation science, which requires a better understanding of the users and recipients of digital and AI technology, and their health and well-being at all stages of their lives. Digital health and AI tools can also play an important enabling role in achieving Universal Health Care (UHC), a priority of the global health community, and therefore of this Strategy Group.

2.2 Sustainable Development Goal 9

Digital and AI technologies have great potential to "Build resilient infrastructure, promote inclusive and sustainable industrialisation, and foster innovation". The Global Health Strategy Group for Digital Health and AI for Health has a particular interest in strengthening research capacities and domestic technological development in low-and-middle-income countries (LMICs), and especially in very-low-resource settings, where the poorest 2 billion of the world's people live. The Strategy Group heard of several case studies where the low-resource nature of a setting became, indeed, the very stimulus for innovation in digital (and, increasingly, AI) solutions. Such solutions have the potential to make health systems more resilient and cost efficient, and offer lessons to be shared with the global north.

Building and strengthening capacity in such settings will reduce dependency on others, enable local solutions for local problems, and build local as well as global resilience. This relates also to resilient data systems for health emergencies which, for sure, will need all parts of the world to strengthen their local capacities.

At the same time, the voices from the global south members in the Global Health Strategy Group are extremely keen to engage with the initiatives and institutions of global northern members. The Group envisions an "innovation umbrella", embracing north and south, of digital health and AI

groups, lifting barriers so that local solutions can be scaled up globally, including from south to north ("reverse innovation") as well as from north to south. Rather than a preferential focus on the south, they want equality: There is huge expertise, knowledge, and entrepreneurialism amongst those in the global south working on digital health and AI for health, but frequently it is not supported enough by funders and financers. Global initiatives, shaped in the north, often overlook and undervalue it. This Group will help to create a more level playing field, new funding mechanisms and mechanisms for sharing expert advisory support to innovators drawing on the expertise of members of the Group and their home institutes, with a focus on translational research and scaled up applications with impact.

2.3 Sustainable Development Goal 17

This refers to the need to "strengthen the means of implementation and revitalise the global partnership for sustainable development". Rather than trust in one's own strengths, more than ever we recognise the need for the many to work together, and the power of collaboration for dealing with global health challenges. As one of the Strategy Group Chairs put it, the goal of the Group should be to use its "collaboration to create a really imaginative future", and there is a "great opportunity to learn from each other and implement our solutions in very meaningful ways given the many unique institutions within the Group drawn from across the world". The Strategy Group wishes to see greater partnerships between north and south, and south and south to foster science, technology and innovation, and in the process build new research and innovation capacity.

"This is a great opportunity to learn from each other and implement our solutions in very meaningful ways given the many unique institutions within this Global Health Strategy Group drawn from across the world."

Section 3: Perspectives & Viewpoints

3.1 The first meeting: Key themes

The first meeting of the Global Health Strategy Group for Digital Health and AI for Health, heard from a selection of its members about their work. This shapes the content of this report. Subsequent meetings will hear about other activity across the Group. The report is based on discussions during the meeting, chat messages left during the meeting, speaker presentations, feedback and insights provided before and after the meeting by members of the Global Health Strategy Group for Digital Health and AI.

Key themes that emerged in the first Group meeting:

- *Using digital and AI tools as instruments to boost the value of human health as an asset and the health of the planet as an asset, to prevent as well as to fix human health problems, with particular attention to primary care, the community level, ageing populations, and preventing as well as fixing pandemics.*
- *Creating an "innovation umbrella" of digital health, AI and machine learning groups from the global north and global south, lifting barriers so that local solutions can be scaled up globally, and making the huge expertise and knowledge amongst those in the global south in the fields of digital health and AI clearer to funders and financers.*
- *Supporting efforts to strengthen implementation science, for better understanding the users and recipients of digital and AI tools*
- *Focusing on human-centered design and local "intelligence" such that health systems are continuously learning and improving, and innovation in digital health becomes a natural outgrowth of patient care, leading to more rapid adoption of findings and improved quality of outcomes.*
- *Creating quality and efficacy bars for evaluating and regulating digital and AI technologies that are as rigorous as for any other healthcare interventions*
- *Employing the power of standardisation and long-term inter-operability, shaped by patients' and service providers' needs and constraints, to accelerate digital and AI for health applications in resource-poor settings.*
- *Improving the sustainability of the activities of many digital and AI innovators especially in low-resource settings by achieving better balance between the private and public sectors and their respective extraction, holding, and use of data, tackling data silos which weaken the value of data and harm the collective good, and finding new ways, including as part of UHC, to demonstrate value, reimburse, and finance when the potential beneficiaries of digital health and AI for health are poor.*
- *Championing health data as a global public good, and creating a trustworthy and trusted international data system for health emergencies, applying best practice and lessons learned from data-sharing and digital and AI tools developed in response to COVID-19 as components of future pandemic prevention and response mechanisms.*

This report discusses in greater detail the ideas, and themes about the potentials and challenges of Digital health and AI for health that emerged during the meeting. What follows is not a comprehensive list of all possible issues; just what came up in the flow of discussion on the day; future meetings will explore many further issues.

3.2 Health is an Asset and a Healthy Planet is an Asset

A healthy planet is an asset, and digital and AI tools can be designed to enhance the value of this asset which, in turn, boosts human health. Human health is also an asset, the value of which needs to be protected, and digital and AI tools are critical means for doing this.

Medicine and healthcare go back hundreds of years. To the Egyptians, the science of medicine was the "necessary art". They treated disease with pharmaceuticals, had doctors who specialised in certain specific areas, and understood the need for cleanliness when treating patients. China's medical systems date back at least 2,200 years, with long traditions of acupuncture and Chinese herbal remedies. Africa has a long tradition of nature-derived medicine use, well before modern pharmaceuticals, based on plants and fungi. The Europeans worked out the germ theory of disease, operated on the body before and after the invention of anaesthesia, and build a thriving drugs industry. In comparison, the digital and AI revolution is very recent indeed. The tendency is to try to attach new digital and AI tools, as an addition or add-on, to current medicine and healthcare practices without questioning these practices. Some in the Strategy Group quickly argued that it is better to treat the advent of digital and AI tools as an opportunity to reset our mindset, to think of digital health and AI as a new frontier, as more than about solutions to problems but as about creating new ways to foster good life and healthy living by investing in, and boosting the value of, human health and the health of the planet as assets that generate returns over time and, indeed, across generations.

Furthermore, more attention needs to be put into how digital and AI tools might put power into the hands of citizens to manage their own health. In parts of the world suffering from a lack of healthcare workers or where populations are ageing, digital and AI tools could prove an extremely valuable resource. Instead of just looking at the supply side—what can a healthcare system do?—this means looking at the demand side, preventing people from needing to go into hospitals and from needing healthcare in the first place, because they are healthy or better manageing their own conditions. The extension of this logic to preventing health emergencies seems obvious. Additionally, with ageing populations in many parts of the world, healthy ageing will involve innovation in digital and AI applications applied to devices, living conditions, energy use, transport, and independent living, to create healthy environments and communities that support healthy life for longer.

"Given this power, we need to check we are not just trying to answer questions…but that we are in fact asking the right questions."

Perhaps the most value will come from working out how our current ways of living harm us (and the planet and thereby us), then using digital and AI technology to maintain health and avoid ill health, and only then using such technologies in healthcare settings when all else has failed and we get ill. Our current mode of doing things—and investing in and using digital and AI technology—is completely the other way around.

One Group member pointed out that compared with other new technology platforms, digital and AI technology has the potential to have radical and extensive impact but that "Given this power,

we need to check we are not just trying to answer questions…but that we are in fact asking the right questions". Another added that we need to "highlight the importance of questions and where they come from" so we are not "beholden in the headlights of our current modes of thinking, including those coming from within academia itself". In particular, it is useful to think of digital and AI tools as means for boosting the value of human health as an asset, and the state of the planet as an asset.

3.3 Collaboration, Communications, Funding Platforms, and Funding of the Global Health Strategy Group for Digital Health and AI for Health

The Chairs of the Global Health Strategy Group for Digital Health and AI for Health, as well as some of the speakers, identified funding opportunities that the Group could apply for together or in smaller collaborative groupings.

Oxford in Berlin as part of its service for those working in global health, has started to put together a platform for sharing such opportunities and, in due course, will put together a communications platform for all of Global Health Strategy Groups to share. As well as the opportunities identified, the sustainability of the Global Health Strategy Group itself, which currently has no funding to keep itself going, is a high priority. OiB is working on a number of human resource strategies to help support the work of the Group. Others in the Strategy Group put their interests on the table; for example, London School of Hygiene and Tropical Medicine (LSHTM) is interested in developing technology-enabled solutions for anticorruption as well as projects on NCDs. Oxford in Berlin has been working with others on the vision for a "Life Sciences for Global Health" global network, engaging funders to create financial mechanisms to support life science activities that have a potentially large global health impact; digital and AI tools for global health would be part of that broader vision.

3.4 The Need for Implementation Science and Human-Centered Design

Because some intervention sounds like it is based on cutting-edge science, it can be tempting to naively presume that it is bound to work. The LSHTM noted that in their non-communicable disease (NCD) activities, digital platforms don't always work, and we need to explore the reasons why. Similarly, the Oxford-KEMRI group noted that the record of digital health funding in LMICs is poor. Digital tools (app-based or otherwise) should address real problems, be well designed, and come with a long-term model for their own sustainability. Often this is not the case.

Improving health data in LMICs hospitals means building local "intelligence" in terms of skills and the organisation of people to meaningfully use such data, and health systems that are continuously learning and improving. Discovery in digital health, as in any other area of medical intervention, then becomes a natural outgrowth of patient care, leading to more rapid adoption of findings and improved quality and outcomes. Often, good innovations are not being used as a result of constraints elsewhere in the system or within society. To understand why this is so, we need to focus on the techniques of health system implementation science and tackle those constraints so that proven effective interventions can be matched with knowledge on how to deliver them. Such research requires a multi-disciplinary systems lens, one that looks also at unintended consequences of innovations for the broader system and for different stakeholders.

The design of digital health tools needs to be human-centered. Most digital health innovations fail after they have been developed, not because they are technically deficient but because they do not fit workflows or help those providing, or receiving, care in their day-to-day activities. They have no value to users even if they have a logical value for the system. They solved the problems outsiders imagined, not the problems that insiders knew existed. Perspectives shaped predominantly by academic approaches may not fully reflect local context and on-the-ground realities, which are often much better understood by local practitioners and innovators with years of experience in those settings. Tackling "pilot-itis"–the inability to go beyond endless piloting of interventions demonstrating efficacy in only very small and targeted population samples–requires the right research networks, and embedded long-term collaborations. It was noted that bringing these Global Health Strategy Groups together is potentially extremely fruitful in all directions, as policy makers, service providers, local innovators, and patients in routine settings become partners in a digital-health and AI learning enterprise. Only this way can we go beyond the hype swirling around much AI-based healthcare in LMICs.

Digital and AI tools extend, as some of our case studies illustrated, to supply chain issues. Medical and public health sustainability, especially in resource-poor settings, can be greatly strengthened if data is better garnered from the whole supply chain and if local AI capacity is strengthened to make timely use of such data.

Beware hype over AI-based healthcare in lower income countries
Financial Times Opinion Artificial intelligence
Ajay Aggarwal.

"This sounds like a new form of technological colonialism: 'We have the solution and just need to be allowed to make a difference."
"It may fail to work; not improve the effectiveness of care; be unaffordable or impossible to scale; and ultimately waste scarce resources better used elsewhere to improve patient outcomes."

"The key to success will be to ensure that technology is developed in conjunction with local partners, and tailored to their needs and the constraints of their health systems. It should not be seen as global or falsely described as Africa's solution."

Source: https://www.ft.com/content/f4dd834c-4835-4ec0-8737-ff98626fa010

3.5 The Perils of "Move Fast and Break Things" and the Role of Standardisation and Interoperability Standards in Digital Health and AI for Health

For a while, "move fast and break things" seemed the technology saying de jure. More innovation was always good—the more disruptive, the better. The race was always on to get products into the hands of users. It is increasingly recognised—indeed by industry leaders and regulators—that this was never good in the worlds of social media and online activity, and has led to much social misery and societal destabilisation. Applying the "move fast and break things" mantra to digital health is perilous. For example, there are over 350,000 consumer-facing apps on the marketplace related to health and social care, but the evidence behind most of them is extremely questionable at best, and downright dangerous at worst. App stores are littered with failed digital-health apps. As a community, we need to hold digital health tools to the same rigorous standards as any other

healthcare interventions, and not operate a double standard that sees medical treatments held to a high bar and digital-health tools treated much more as a free-for-all. There are only a few randomised controlled trials generating evidence, but there are ways, as exemplified by the work of several members of the Global Health Strategy Group involved in the ITU/WHO Focus Group on "Artificial Intelligence for health" (FG-AI4H), to create a quality and efficacy bar.

The situation in AI is not much better. A recent systematic review identified 2,212 papers and preprints published between 1 January 2020 and 3 October 2021 describing new machine learning models for the diagnosis or prognosis of COVID-19 from chest x-ray or computerised tomography images. Of these, 415 were included after initial screening and, after quality screening, 62 made it into the systematic review. Even for the few papers that made it, the review found that "none of the models identified are of potential clinical use due to methodological flaws and/or underlying biases."[2] As Derek Lowe put it in a Blog entry for *Science Translational Medicine*: "In all AI/ML approaches, data quality is absolutely critical. "Garbage in, garbage out" is turbocharged to an amazing degree under these conditions, and you have to be really, really sure about what you're shovelling into the hopper".[3]

We are now living through a digital revolution, and we need something similar in public health. Common data standards and long-term inter-operability, shaped by patients' and service providers' needs and constraints, are critical for accelerating applications in resource-poor health settings. A strong focus of some in this Global Health Strategy Group is to bring standardisation to this field having previously witnessed its power across other fields. The impact of standardisation and common rules and protocols could be immense, for example in terms of extending the scope of practice of nurses by the application of AI, and of getting affordable digital technologies that truly work into the hands of the bottom two billion people on the planet, and ageing populations everywhere. There is huge potential "bang for the buck". This is going to need a concomitant revolution in global education, in particular in foundational literacy and numeracy,[4] if the poorest members of society are to truly benefit from hands-on access to such technologies.

At the moment, even if some consumer health apps have benefit, many do not (they are even 'naff' and 'dangerous' in the phrasing of several in the Group). For example, different self-testing apps, with menus for symptoms that lead to an eventual diagnosis, proffer very different advice based on identical data entry. Such apps need proper validation mechanisms if they are to reap their potential and not do harm. This would offer the opportunity for scaling up worldwide. This Strategy Group might offer a pipeline for doing this. In the wording of one of the Chairs of the Group "Standardisation offers the potential of exponential growth and scalability".

3.6 Sustainability

Very many in the Global Health Strategy Group for Digital Health and AI for Health identified sustainability as a highly limiting factor of their work.

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[2] Roberts, M., Driggs, D., Thorpe, M. *et al.* Common pitfalls and recommendations for using machine learning to detect and prognosticate for COVID-19 using chest radiographs and CT scans. *Nat Mach Intell* **3,** 199–217 (2021). https://doi.org/10.1038/s42256-021-00307-0.
https://www.statnews.com/2021/06/02/machine-learning-ai-methodology-research-flaws

[3] Derek Lowe, 'Machine Learning Deserves Better Than This', In the Pipeline, 2 June 2021.
https://blogs.sciencemag.org/pipeline/archives/2021/06/02/machine-learning-deserves-better-than-this

[4] Girindre Beeharry, The pathway to progress on sdg4 requires the global education architecture to focus on foundational learning and to hold ourselves accountable to achieving it, International Journal of Educational Development, Volume 82, April 2021, https://doi.org/10.1016/j.ijedudev.2021.102375

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"Most of the time we all rely on grants and our work revolves around grants and once they end, we have to wrap up the project…As digital health and AI leaders, we need to think about not only getting a grant but about how we can provide a sustainable level of service once grant funding has ended."

This is especially true for primary care, which frequently proves unsustainable once grants end. In the global south and in very resource poor settings, primary care beneficiaries are big losers from this lack of sustainability. One priority proposed was for more cost effectiveness analysis of solutions, of "nice ideas that solve problems, but what is their cost of treating, and would it be sustainable beyond the grant?" This might entail the creation of a subgroup pulling together those with expertise on heath economics to apply that to digital and AI interventions.

A number of members of the Global Health Strategy Group based in Africa were witnessing lots of data being collected by groups trying to figure out how to monetise it to make it more sustainable for themselves. No clear map of how that data was being used was emerging. These members argued that we needed a "line of site" towards thinking "who purchased this data and for what purpose?" and that a Strategy Group like this could be really insightful regarding what data is available and what can be shared and for what purpose, and how to change this process to make for more sustainability. Even if there is no answer yet, "asking the right questions is itself a good anchor."

Yet, how can we define "sustainability" when economic incentives are lacking? If there needs to be a source of payment for technologies to be sustainable, but potential beneficiaries can't pay, does that mean they should not get? Obviously not. UHC also requires us to think beyond just proving that solutions are "economically viable". Traditional approaches to demonstrating value, and modes of reimbursement, pricing, and financing are barriers to implementation, and are also in need of pragmatic innovation. The, often not sufficiently priced, global health impact of innovations need to be incorporated into investment models guiding rewards for innovation in these areas.

Developing and implementing digital and AI technologies at scale needs resources, which means some attention is needed to digital tech finance mechanisms, including Research and Development incentives, science funding mechanisms, and investor markets. How also might governments, as consumers of data, better sustain projects beyond their funding life once improved health outcomes and return on investment has been demonstrated? This is the source of a future much longer discussion. Indeed, once their activities are more advanced, Oxford in Berlin Global Health initiatives is planning to create a cross-cutting economics/finance/investment tools group to serve all four Global Health Strategy Groups.

3.7 Data

Primary care and community-level data are critical to promoting health and treating human health as an asset. Much current medical expenditure—a flow—is to try to restore the value of health once damaged. Much digital and AI technology has so far, in similar fashion, focused on hospital-level and epidemiological data, and the notion of enriching such data as much as possible, to eventually have a medical application. This is good, but to some degree it has been driven by currently-framed incentives, with markets and healthcare systems and research funders incentivised to fix health damage and much less incentivised to improve health assets and prevent health damage in the first place. Digital and AI tools offer the opportunity to improve and prevent as well as to fix, and to integrate these over the life courses of people and populations, but we may

need to change the way we think and the structure of incentives too. And funders and journal publishers may also have to rethink their funding and publishing models.

In the realm of pandemic response, we have seen strong market and political forces acting in response to the damage done by SARS-CoV-2, following very little action and poor incentives to protect health and prevent the damage in the first place (there are huge markets in richer parts of the world for vaccines to fix the pandemic, but no market for the sort of activities that might have saved trillions in lost economic output by avoiding the pandemic in the first place). Digital and AI tools offer an opportunity to put much more focus on prevention.

With the value created in health and planetary assets, investment in such technology needs to be better accounted for in measures of economic activity and in how digital and AI innovation and interventions are evaluated and paid for. It follows that cost effectiveness analysis can't just concentrate on the flows expended but must also consider the stocks of health and planetary assets created.

The Science Academies of the Group of Seven (G7) nations are leading a clarion call for Improving Data for International Health Emergencies, which requires careful attention to governance, operations, and skills development.[5] The Global Health Strategy Group for Digital Health and AI for Health (and the Global Health Strategy Group for Pandemic Lessons and Future Pandemic Preparedness), on behalf of the multiple communities they represent, expressed strong willingness to help the G7, and the new WHO Hub for Pandemic and Epidemic Intelligence to address these sorts of questions.

Launch of the WHO Hub for Pandemic and Epidemic intelligence

"The more adaptable and agile we are the more effective our response will be. None of this is possible without better data, analytics and insights to improve the speed and adaptability of our response."

Source: https://www.who.int/director-general/speeches/detail/dr-michael-ryan-s-remarks-at-the-launch-of-the-who-hub-for-pandemic-and-epidemic-intelligence

The Global Health Strategy Group for Digital Health and AI will champion the cause of health data as a global public good, and of the need for a trustworthy and trusted international data system for health emergencies and, indeed, for health in general. Part of this will involve identifying best practices and lessons learned from data-sharing and digital and AI tools used in response to COVID-19 that might become key components of a future pandemic prevention and response mechanism.

This will need principles-based governance systems for securing safe data-sharing and use of data for health emergencies; the building and implementation of operational systems, infrastructures, and technologies for implementing a principles-based and privacy-preserving approach to equitable use of data for health emergencies; and fostering skills and capabilities at all levels and in

5 Science Academies of the Group of Seven (G7) nations. Data for international health emergencies: governance, operations and skills https://royalsociety.org/-/media/about-us/international/g-science-statements/G7-data-for-international-health-emergencies-31-03-2021.pdf

all parts of the world—from health professionals to the general public—needed for trusted and accurate use of data.

Special Report Future of AI and Digital Healthcare.
We need a new era of international data diplomacy
Rohinton P Medhora

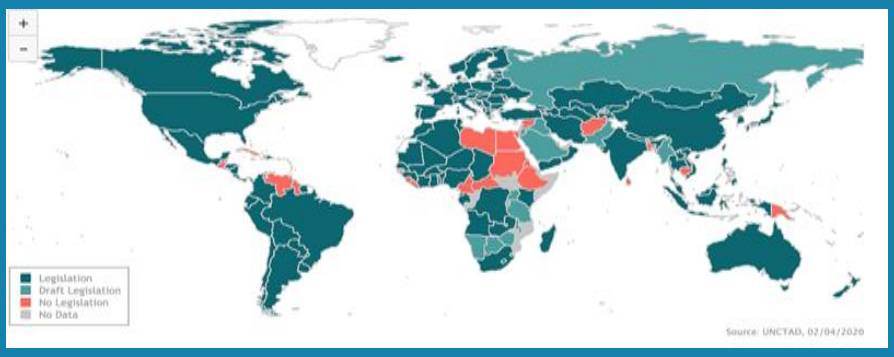
"A starting point could be a technology charter of principles, such as the Universal Declaration of Human Rights. It may not be fully applied everywhere, but it could serve as a beacon of hope—particularly for citizens in countries with oppressive regimes—and could guide the drafting of national and subnational legislation."

Source: https://www.ft.com/content/66f1ff42-fe49-4376-aafb-3943a9f04a1c

Several members of the Digital Health and AI for Health Group took part in the launch meeting of the Global Health Strategy Group for Pandemic Lessons and Future Pandemic Preparedness, and they have plans for sections of their future meetings to look at practical applications of digital and AI tools to help bring the pandemic to a close.

United Nation Conference on Trade and Development (UNCTAD) Data Protection and Privacy Legislation Worldwide

"Big data holds great promise in improving health outcomes. But it requires norms and standards to govern collection, storage and use, for which there is no global consensus."



"19% of countries (in orange) have no legislation for data protection and for the collection, use and sharing of personal information to third parties. There is a need and Potential Ways to Form a Global Consensus."

Source: https://unctad.org/page/data-protection-and-privacy-legislation-worldwide

Health information systems are critical to effective performance measurement and management. Within Europe and globally, there are great opportunities for integrating and interrogating data at scales linked to respective health problems, including health emergencies, and improving evidence-based decision-making. As one Strategy Group member noted, the reality is that the human race does not have global governance or practice. We might have one "common" body, but the approach, organisation, and coverage of health and medicine are not common or even treaty-based

issues. Digital and AI technologies offer a huge opportunity to build across those barriers. They might also play a critical role in any future pandemic preparedness treaty.

Part of the problem is the continued creation of data silos—which are often invisible to the naked eye—despite years of talking about the need to avoid them. Data silos, in both the public and private sectors, weaken the value of data and harm the collective good.[6] Most social enterprises to tackle public health problems, even if they end up with solutions, do not feed their data back into the healthcare system that supposedly contributed towards the provision of such data in the first place. The continuing danger of data silos exacerbates the sustainability problem. Meanwhile, many small digital entrepreneurs find themselves trying to answer questions when the data they need is held by mostly private entities "whose sole purpose is profit". In marketplace apps in Africa, private companies dominate and create their own data silos. If sustainability is defined by market forces—which is the norm in the unregulated environment that most LMICs face—it ends up creating data silos that are even invisible to health policymakers and frontline workers.

As well as feeding huge inequalities, who owns data changes the competitive landscape for those trying to innovate.
Low-resource settings can often be very rich in human resources, even if other physical and financial resources are lacking. Data silos stop those human resources from reaching their full potential.

"The same population who were marginalised in historic colonialism appear to pay the heaviest price under this new data colonialism."

"Low and middle-income countries will find it difficult to renegotiate terms of trade for health data flows with such powerful groups."

[6] Nick Couldry and Ulises Ali Mejias. Special Report Future of AI and Digital Healthcare. Big Tech's latest moves raise health privacy fears. December 07 2020 https://www.ft.com/content/01d4452c-03e2-4b44-bf78-b017e66775f1

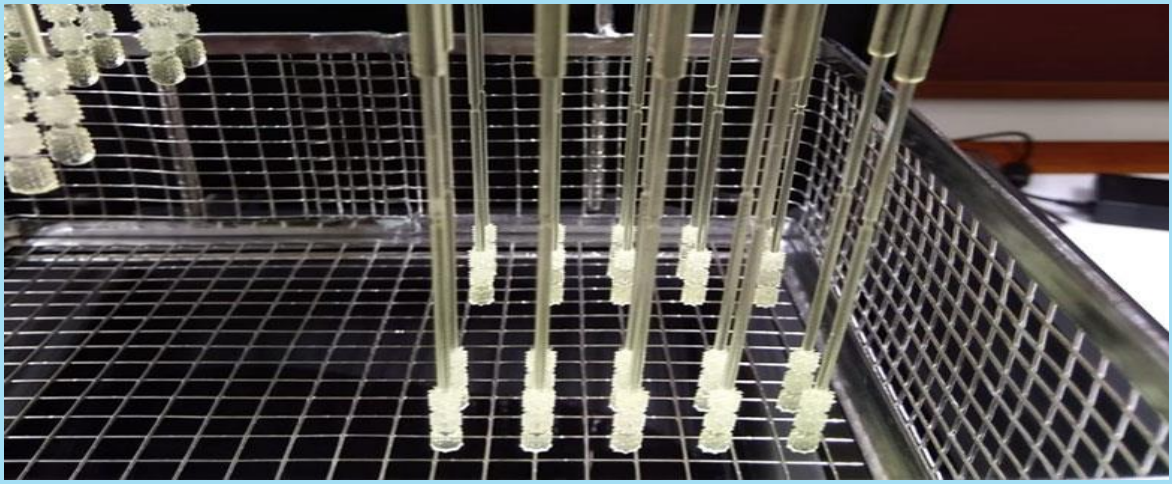
Section 4: Case Studies

In this section, this report briefly describes digital health or AI for health projects which were presented during the meeting. Future meetings will give opportunity form many more organisations and innovations to be presented and showcased.

4.1 Aga Khan Development Network Digital Health Resource Centre

When SARS-CoV-2 first hit Pakistan, supply chains quickly broke and critical medical interventions were not getting through. In response to a shortage of testing kits, especially nasal swabs, the Aga Khan Development Network Digital Health Resource Centre turned to its 3D printing lab, designing its own swabs and printing them *in situ* in Pakistan. A quick clinical trial for a month made sure they worked before they were used across Pakistan. Swabs were thus more readily available without need for import. They proved also to be very cost effective. If this could work in Pakistan, it "can work anywhere in the world in low resource settings", noted those leading the initiative.

Aga Khan University News
University completes clinical trial on 3D printed nasal swab
Professor Zahra Hasan



"The 3D printed swab will reduce the need to import swabs for respiratory sampling. This can help increase COVID-19 diagnostic capacity across Pakistan."

Source: https://www.aku.edu/news/Pages/News_Details.aspx?nid=NEWS-002379

4.2 minoHealth AI Labs and Runmila AI Institute

Before SARS-CoV-2 struck, minoHealth AI Labs and Runmila AI Institute in Ghana were running digital and AI hackathons with local public health stakeholders, for other medical conditions. They began to mobilise in the direction of COVID-19. One challenge identified early on was that, though African data was starting to appear in global trackers and portals, there was a lack of aggregated COVID-19 data in Africa. They put together a team across Africa, collecting and making available online data from across their countries, and started to do analysis and forecasts of the dynamics and patterns.

When COVID-19 started in Africa, the case numbers were initially negligible, and there was a sense in some quarters that Africa's young population would be protected from it. In the face of a lackluster approach in the early days, the Ghana digital and AI group was able to show the exponential danger. After the Africa CDC and WHO started building the tracker, the Ghana group moved its attention to using medical images and CT scans to detect damage related to COVID-19.

4.3 Villgro Africa

Villgro Africa, an incubator and investor hub pioneered five years ago to promote innovation across the African continent, has supported 30+ start-ups and invested over $1M in seed funding. Of the multiple successful innovations, Digital and AI tools have been utilised by innovators to tackle health problems including malaria, childhood jaundice, and critical care.

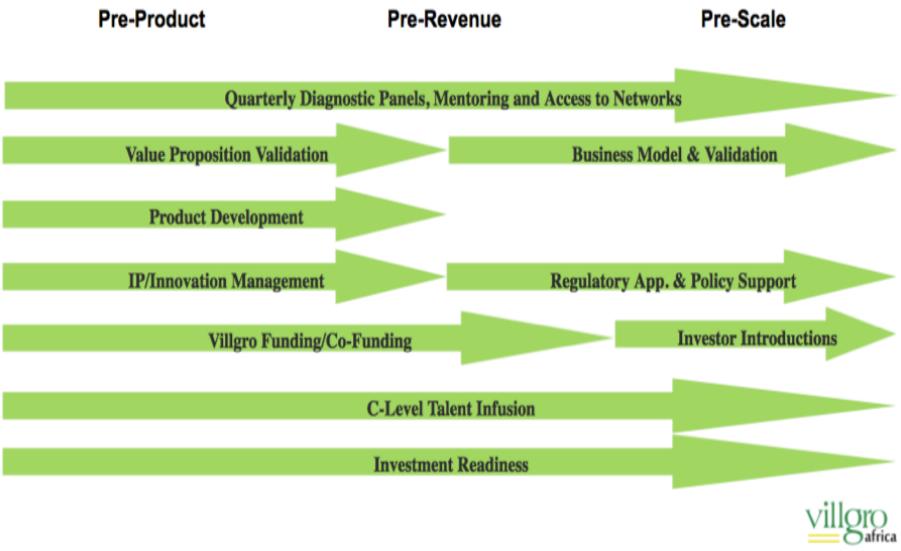


Figure 1: Villgro Africa's Support Model

In response to the COVID-19 pandemic, with the support model in figure 1, Villgro Africa accelerated 12 COVID-19 response innovations from East Africa, deploying $350K to innovators delivering health solutions including Nonpharmaceutical COVID-19 Interventions, Emergency response, Critical care, Maternal Healthcare, and Non-communicable diseases. Villgro Africa are engaged in building the healthcare ecosystem, interlinking government and the private sector, including industry.

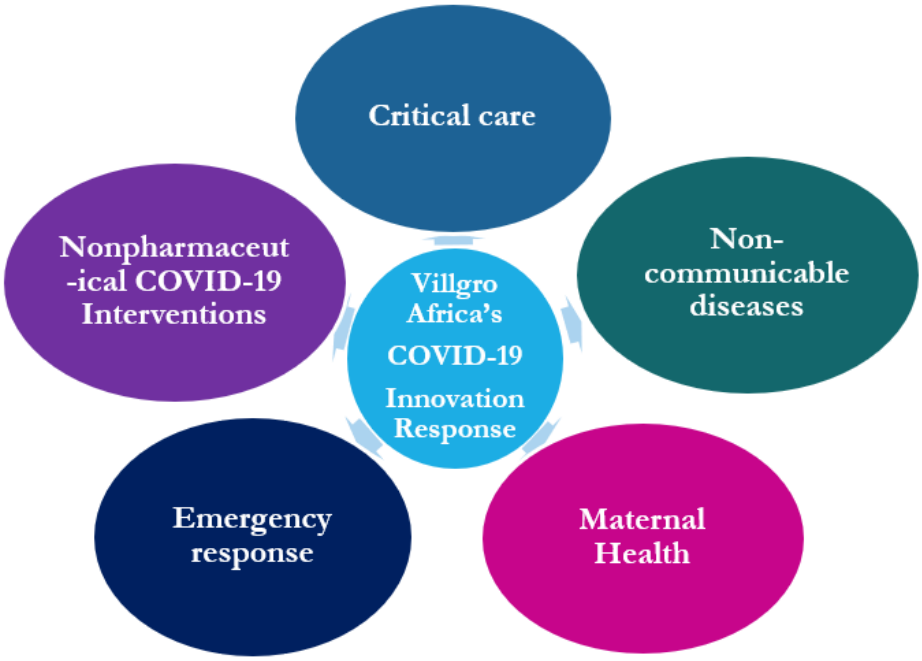


Figure 2: Global health Solutions tackled through Villgro Africa's COVID-19 Innovation Response

They are launching a life scientists fund. Their team includes those with business, molecular biology, and AI expertise which enables them, if partners have priority areas, to identify startups to support with money and technical assistance.[7]

4.4 Ethiopia COVID-19 Response Team

The Ethiopia COVID-19 Response Team–A Voluntary Organisation consisting of Ethiopians in the Diaspora–helped develop a suite of open-source mobile applications to tackle the emerging and prominent challenges posed by COVID-19. Working together with the Ethiopian government and other public health entities, they developed seven apps that support everything from track and trace to sharing data and patient information among health workers, which have been instrumental for the rapid dissemination of information primarily in urban areas.

However, Ethiopia, like so many other countries, has infrastructural limitations. The apps, for instance, have been most useful in the cities, where internet access is greatest, but have had low adoption and usage in rural areas where connectivity is low.

This case study demonstrates the potential impact that health information systems, technology and AI can play in contexts like Ethiopian cities but also underscores the need for ever more innovative ways to reach populations that have no or very limited connectivity.

4.5 Global Health Management at Technische Universität Berlin

The Berlin Centre for Health Economics—one of five similar centres in Germany—collaborates with the Charité to study the cost effectiveness of interventions in Germany and internationally. They have a strong focus on health technologies, in particular medical devices where methods for assessment are less developed than in the field of pharmaceuticals. They have supported the German government in developing a digital framework; Germany is one of the first countries in the world to allow public health insurance funding to pay for mobile apps. This involves a focus on the regulation of digital health, and of how regulations can be adjusted to facilitate the integration of digital technologies such that the benefits outweigh the risks.

Because they are growing in the field of global health, they just secured funding for the German West African centre for global health and pandemic prevention. Amongst other things, they will

[7] Villgro Africa Support for Innovations Addressing the COVID-19 Pandemic
https://villgroafrica.org/villgro-africa-support-for-innovations-addressing-the-COVID-19-pandemic/

be looking at digital technologies and how they can contribute to future pandemic preparedness. They also have a major project just starting looking at how to increase health resilience in big African cities through UHC. This aims to develop a mobile-phone-based wallet in Ghana to pay health insurance premiums to facilitate payment for informal sector workers and to evaluate this intervention for insurance coverage in Ghana. They have established an e-health research partners group in Ghana doing research in telemedicine, and they have a long-standing relationship with Kwame Nkrumah University of Science and Technology (KNUST) in Kumasi, Ashanti, Ghana, where they have supported a Master's programme in health systems management which they are now expanding to the wider west African region. The new global health and pandemic prevention center in west Africa is being jointly led by Kwame Nkrumah, with the school of public health and Kumasi Centre for collaborative research, the Charité and the university of Bonn, Germany. They are also working with partners from Africa CDC, WHO, and the Carter network in a consortium for advanced research training in Africa based at the Africa Population and Health Research Center in Kenya.

A recent proposal put together for a major call of German ministry of education and research seeks to fund the establishment of German African research networks. A proposal to fund a network on digital UHC will support interventions that can contribute to achieving UHC. This will build on their network of partners across Ghana, Madagascar, South Africa, Kenya, and Rwanda. This Global Health Strategy Group will enable them to gain better overview of actors and innovators and digital people working in this space, to network and come together to develop joint proposals and future projects.

4.6 Financial Times United Kingdom and Lancet Commission "Governing Health Futures"

The Financial Times (FT) does original reporting and opinion pieces, special reviews, conferences, and convenings to disseminate findings and to encourage debate. They have a particular focus on technology. The FT has joined the Lancet medical journal in a commission "Governing Health Futures", that focuses on AI and digital health, and questions of equity and access. They have the support of Foundation Botnar and others. They have drafted a report, currently going through peer review, to be published by the Lancet in the autumn. Andrew Jack's remit is to broaden coverage from the sometimes slightly theoretical, to what is happening in practice. Bluntly, there is a lot more hype around AI in general, and for health in particularly, than there are rigorously tested examples of its impact in practice. This is even more the case when going from high-tech richer settings like the US to the reality in, for example, Ghana, Malawi or Nepal, etc.

The Commission has already produced a number of articles and a magazine. In autumn 2021, to follow on from the official publication in the Lancet of their report, they will look at tangible examples of technology applications that are delivering, at their potential but also at barriers to uptake, and indeed to identify cautionary tales, where technologies are being misapplied or not necessarily delivering on their promise. Where are the bottlenecks? How could policy makers and others work to ensure that there is fairer access and that the needed new regulatory systems at national, regional, and international levels are being put in place?

In the coming months, the FT will be keen to hear more about our projects and those of others, our thoughts on what the gaps are and real, evidence-based, actions that are making a difference. The FT is very interested to work with the Global Health Strategy Group for Digital Health and AI for Health going forward. The FT is following the activities of all three of the Global Health Strategy Groups with great interest.

4.7 The International Telecommunications Union World Health Organisation Focus Group on AI for Health

The aim of the International Telecommunications Union (ITU) / World Health Organisation (WHO) (ITU/WHO) Focus Group on AI for health (FG-AI4H) is to develop a standardised assessment framework for the evaluation of AI-based methods for diagnosis or treatment of medical conditions.

So far, they have generated more than 1000 pages of documents, and they are in the process of producing open-source software to go along with those documents, that reflects the entire AI-for-health development process. They are working with regulators so that someone can turn to this open-source software anywhere in the world, develop their AI-for-health software tool, and submit it for FDA-style clearance. They are also running a benchmarking platform that evaluates AI for health. A key result will be to establish best practices in data sharing across the world.

They have two types of subgroups. One type, of which there are about 20, work on AI for specific health-use cases. Another type deals with aspects that are common to all these groups. They iteratively explore the whole process from data acquisition through to data annotation, training, testing, benchmarking, clinical evaluation, and recommendation. Additionally, they work extensively on data and methods solution assessment and handling, on data sharing and on good data exchange. Their ethics work is led by the head of ethics of WHO, and the group for regulatory considerations will present their document on AI for health at this year's World Health Assembly. If anything, COVID-19 has sped up not slowed down the work of these groups.

They are in the process of creating two major new activities. One is webinars, which attract typically 3000-4000 listeners each, for which they are soliciting speakers (and they hope that some members of this Global Health Strategy Group might engage on specific topics). Second, they are organising AI-for-health challenges and hackathons. They have the engagement of Harvard medical school, the Charité, the WHO and ITU, and now Oxford in Berlin. The ITU has organised challenges for other areas, such as machine learning for 5G, and had thousands of participants. The results are interesting but also a great way of recruiting young people, or just working together across the globe.

4.8 Life-Saving Instruction for Emergencies (LIFE) Project

LIFE is a scenario-based mobile and virtual reality gaming platform that will teach healthcare workers to identify and manage medical emergencies using game-like training techniques to reinforce the key steps that need to be performed in order to save lives. LIFE was designed by a Kenya-UK collaborative team to be applicable in LMICs. It is a new smartphone app that uses 3D simulation training to teach healthcare workers around the world how to save lives. LIFE is built to work on low-cost phones without constant internet connection and is available on both android and iOS platforms.

It is designed based on the principles of immersive simulation training, and supplements existing face-to-face training where available. LIFE provides safety-critical decision-making under realistic time constraints and for life-saving management of emergency conditions. Healthcare workers can download LIFE scenarios to their mobile phones and play them wherever they want. The mobile app uses novel approaches to mobile learning to keep learners engaged and to efficiently convey the key knowledge they need to know to manage a medical emergency. The app behaves as a simulation tutor, responding to reinforce correct actions and provide feedback on wrong answers.[8]

[8] Life-Saving Instruction for Emergencies (LIFE) Project
https://oxlifeproject.org/

Section 5: Conclusion

Digital Health and AI for health tools hold huge potential for tackling key global health and development challenges. However, key issues around standardisation, sustainability, and data sharing could potentially hinder this impact if not addressed in a strategic and timely manner.

The use of digital and AI tools as instruments to boost human health should be guided by standardisation principles that ensure that interventions are equitably-distributed and easily operated by end-users. There is also a need for creation of learning groups that will foster sharing of ideas, data, and innovation across sectors and regions. This learning is especially critical for tackling issues that could affect the scaling-up of practical solutions to global health challenges such as sustainability and data sharing in the field of Digital Health and AI for Health.

Implementers need to design practical solutions that are cost-effective, and policymakers are called to consider greater use of data for decision making and investment in digital health and AI tools for health. Finally, researchers need not only to provide the evidence but also to support and advocate for greater investment in digital and AI tools for health.

Appendix 1: Profiles of Chairs and Presenters

The Annex presents the profiles of the chairs and those who presented in the first meeting.

Global Health Strategy Group Chair: Saleem Sayani, Aga Khan Development Network Digital Health Resource Centre

Saleem Sayani is Director of the Aga Khan Development Network Digital Health Resource Centre (AKDN dHRC), Director of the Technology Innovation Support Centre at the Aga Khan University, and serves on the faculty of the Department of Community Health Sciences at the Aga Khan University. He is also a member of WHO Roster of Experts on Digital Health. The Aga Khan development network is a global not-for-profit, which embraces a huge network across 30 countries mostly across Asia and Africa, such as Pakistan, Afghanistan, Tajikistan, Kenya, Tanzania, Uganda, also the Middle East and Syria. Saleem's role is to provide leadership in digital health in these countries. A big focus is on technology to provide access to healthcare services to those that otherwise would not have access.

Global Health Strategy Group Chair: Darlington Akogo, minoHealth AI Labs

Darlington Akogo is Founder and Director of AI at GUDRA, and its subsidiaries in healthcare, biotech and biomedical research, minoHealth AI Labs; in plant & pest disease detection and precision agriculture, karaAgro AI; in AI and data science training, Runmila AI Institute; in AI and Data Science development, Gudra AI Studio. GUDRA was set up to focus on AI and related technologies to address problems in Africa, and global challenges.

minoHealth AI labs explores AI for health, covering, for example, radiology, infectious diseases, malaria, COVID-19, access to care to people who usually do not have access. They are currently looking at automatic radiological analysis to diagnose diseases from medical images. Darlington is also very active in standards development and regulations, specially leading the AI for radiology topic group as part of the work of the ITU WHO partnership.

He is the chair of the Data WP, under the UKRI-funded Digital Diagnostics for Africa network led by Imperial College London in partnership with minoHealth AI Labs and other organisations. In addition to this work, Darlington is involved with the MIT Tech Review Global Panel and the World Economic Forum's Global Shapers. Darlington also taught as Lecturer (Adjunct Faculty) of Artificial Intelligence at Academic City College and served as the Bioinformatics (AI & Data Analytics) Resource Person at West African Centre for Cell Biology and Infectious Pathogens (WACCBIP). He has also served as a resource person to the United Nations, African Union (AU), The Organisation of African, Caribbean and Pacific States (OACPS), Economic Community of West African States (ECOWAS).

Wilfred Njagi, Villgro Africa

Wilfred Njagi is co-founder and CEO of Villgro Africa, a health care incubator started in 2015 in Nairobi, Kenya, part of the AfriLabs community, and the first health business incubator in east Africa. The location was chosen because of is nascent global health innovation ecosystem, including closeness to renowned research institutes. Over 5 years Villgro Africa has seed-funded more than one million dollars into 30 innovators, which unlocked 17 million dollars of further funding, creating over 200 jobs and benefitting millions of lives in East Africa. Villgro Africa's funding partners include Argidius Foundation, Lemelson Foundation, IDRC, USAID, Grand Challenges Canada, Saving Lives @ Birth, Villgro Innovations Foundation (India), Villgro USA & Villgro Philippines. Villgro is also active in India, the Philippines and the US. Villgro Africa recently launched a pan-Africa call for innovations around AI, "Harnessing the power of AI for Africa development" which received 200 applications from across Africa. Innovation support offered is highly individualised and contextualised and depends on the stage; ranging from product innovation, IP, innovation management, value proposition, and validation, through to market readiness, market-entry support, and regulatory issues. Recently they have worked on democratising access to diagnostics by bringing affordable point-of-care diagnostics from China, India, and the US. Handheld devices have been given to clinics on lease-loan to reduce the barrier to some of these clinics. They are also active in micro insurance products. A recent call for COVID-19 response innovations, led to them funding about 12 enterprises.

Wilm Quentin, Department of Global Health Management at Technische Universität Berlin

Wilm Quentim is leading the focus area of global health at the Department of global health management at TU, one of the largest universities in Berlin. The department has traditionally focused on European health systems, but over the last 10 or so years Wilm has built the global health focus, with more than 30 research fellows (36 at present), with 30% currently pos-docs. The departments is one of the partners in the Berlin School of Public Health which brings all public-health-related institutes together to run masters of public health and to coordinate PhD training in the field of public health. A close link to the WHO is based on their work as part of the European observatory on health systems and policies, and they are now in the process of supporting an Africa health observatory platform on health systems and policies, working with the LSHTM and WHO Africa region, and colleagues from KEMRI and the university of Rwanda, on developing methods for systematic comparisons of health systems in the Africa region.

Naomi Muinga, The KEMRI Group

Naomi Muinga is a Research Officer with the Health Systems Unit (HSU) at KEMRI/Wellcome Trust Research Programme Nairobi, Kenya. Naomi works in areas closely related to that of the others in the KEMRI group, namely information systems and how they can be leveraged to improve care in LMICs, with a primary focus on Kenya and hospital settings where patients are admitted rather than outpatients. What are the factors, especially human factors, around the usability of technologies and how can we learn from other areas and apply the lessons to digital technologies? She spoke on behalf of five others in the first meeting of the Global Health Strategy Group. The work in KEMRI, Kenya, over 25 years in collaboration with researchers from Oxford and from other locations, is the inspiration for their engagement in digital health and AI. They seek to use AI to improve quality of care and coverage, but it must be guided by human-centered design, that always puts users at the heart of whatever is being designed, and draws off great health system knowledge and networks to make sure that the tools developed work and continue to work long after the researchers have left. As well as technology skills, their team has strengths at analysing the ethical and social dimensions in their local context with intent to apply the lessons to other settings. They have particular strengths in partnership and capacity strengthening with other universities. They look forward to learning and seeing where they can apply these strengths.

Timothy Tutti, The KEMRI Group

Timothy Tutti is a Post-Doctoral Research Associate interested in developing digital tools for use in routine hospital settings, all with a focus on improving quality of care. His research aims to understand the learning experiences of clinicians with no or limited emergency care training opportunities and using the LIFE platform (www.oxlifeproject.org) to focus on how, by leverageing adaptive feedback mechanisms, it can be designed to deliver context-relevant "intelligent" training to health-workers in low-resource settings.

Prior to starting the DPhil, he was a research officer at KEMRI-Wellcome Trust Research programme, working on the intersection of health systems strengthening and governance (specifically looking at quality of paediatric care), health informatics, and contemporary debates on health capacity strengthening vis-à-vis social epidemiology. He has been recognised for his work in the field of health informatics and social epidemiology with awards and grants from the Wellcome Trust and UNESCO's Institute of Lifelong Learning.

His aim is to create a common data platform and a learning health system, integrating digital interventions, and using dashboards and smartphones and apps to support quality improvement programs at the hospital level. Timothy is also interested in developing a prognostic risk model for hospital settings in low resource settings, with the goal that whatever they learn can be applied to similar settings, as well as exploring other digital tools for hospital discharging and neonatal monitoring. Their work has mostly focused on pediatric and newborn care, but also other areas of clinical care.

Jacob Mcknight, University of Oxford

Jacob McKnight is a post-doctoral researcher at the University of Oxford with an interest in health systems and reform. After working for Medecins Sans Frontieres, he completed a PhD at Oxford's Said Business School focused on hospital management in Ethiopia. He used organisational and marketing theory to provide new perspectives on public health problems.

Jacob leads the ethnographic element of the Health Services that Deliver for Newborns (HSD-N) study. He also co-leads an ESRC-funded project that seeks to understand Infection Prevention and Control practices in Kenya and the response to the threat of Anti-Microbial Resistance (AMR). Jacob is also the Principle Investigator on a Gates-funded project that is seeking to build an app that helps Kenyans locate better, cheaper lab services.

Jacob has an interest in digital market places in healthcare and how to make information available and at what prices and times and quality, to improve access to, and quality of, health services such as laboratories and pharmacies. Part of his work is attempting to build a simple digital market place for laboratories in Nairobi such that lessons learned can be extended to other settings.

Chris Paton University of Oxford

Chris Paton is the Head of the Global Health Informatics Group at the University of Oxford and his research explores improving healthcare using new digital health technologies.

He is the Principal Investigator for LIFE, a smartphone-based simulation training platform that uses a virtual hospital environment to simulate medical emergencies to train healthcare workers. Launched in April 2019, LIFE has now been downloaded by thousands of healthcare workers in Africa, and Chris is now leading a clinical trial of the platform in Kenya funded by GCRF. He collaborates on several large-scale international projects including NEST360, a £50 million initiative that aims to deliver new technologies and training to improve neonatal care in Africa, and a new Wellcome Trust Innovation Flagship in Vietnam that will develop and implement a range of new AI-based monitoring devices in intensive care units (ICUs) in South-East Asia.

Chris has served as a digital health consultant for the New Zealand Government and the Pathways for Prosperity Commission. He co-founded and chaired the International Medical Informatics Association (IMIA) social media working group and is currently co-chair of the IMIA open-source working group. He is Associate Editor of "Digital Health Journal" (Sage Publishing) and "BMC: Medical Informatics and Decision Making". He is a peer reviewer on digital health topics for scientific journals including Nature, PLOS One, JAMIA, JMIR, ANZJPH and serves as an expert grant reviewer for the UK's Medical Research Council, and the Research Council of Norway.

Roland Eils, Digital Health Center at the Charité Berlin

Roland Eils is the Founding Director and Chair of the Digital Health Center at the Charité in Berlin, which is Europe's largest university medical centre, and has a strong focus on implementation of AI concepts in clinical care.

The centre has five branches of activity with Roland heading the AI in Life Sciences group. The group in computational medicine is headed by Claudia Langenberg. Another group, headed by Irina Lehmann, is very strong in molecular epidemiology, and focuses on child health and respiratory diseases. The group in medical omics is headed by Soeren Lukassen. A group bridging the fields of imageing and genomics is headed by Christian Conrad.

The strength of the digital health centre comes from bringing together many forms of data, such as molecular data, electronic health records, and population cohort data. Typically, they start with fundamental questions arising from molecular biology that are backed up by multi-omics data. They then study mechanistic effects at a population scale or at a clinical cohort scale, taking advantage of German health records across different disease areas. They also exploit data from smart wearables and/or patient-reported outcome data. They have had a particular focus on child health for many years. In future they will be interested in rare and understudied diseases.

The Digital Health Centre is strongly imbedded in international activities, including building capacity for cancer genomics, and international networks studying disease at the single cell level. The Digital Health Center has been very active in combating the pandemic from the start by using tools of computational and single cell genomics, for example studying key factors at the cellular level allowing virus entry in the respiratory systems of patients and exacerbating COVID-19 disease. Some of this has helped to identify "drugable" targets for preventing severe COVID-19. They are interested in reaching out to clinical study centres abroad, and hope to be able to identify common ground with others in the Global Health Strategy Groups being convened by Oxford in Berlin for further discussion and future collaboration.

Louise Thwaites, The Oxford University Clinical Research Unit (OUCRU) Vietnam Group

Louise Thwaites is an associate professor, clinical researcher and member of the Emerging Infections group at OUCRU. OUCRU Vietnam has been based in Ho Chi Minh City since 1991, and is part of the Nuffield department of Global Health and Tropical Medicine in Oxford. Its remit is to carry out globally-relevant and impactful research into infectious disease.

Louise's background is in critical care, and she works on a relatively new Wellcome funded initiative—part of a flagship for innovation for impact, based at OUCRU in Ho Chi Minh City and partner hospitals for tropical diseases—with international partners to bring digital health technologies to solve local problems. In several areas, her group is working with Oxford's biomedical department and David Clifton to look at the role of wearable devices and machine learning in vital-sign monitoring for critically ill patients.

Her group is also working with Imperial College London on developing new devices particularly around syndromic monitoring in dengue, and with Kings College London on imageing based on the acquisition and interpretation of ultrasound and MRI imageing. They are working with the University of Melbourne on rehabilitation equipment and with partners in Zurich on new devices for bio-impediment and syndromic monitoring in the area of dengue.

They are very focused on critical care and diseases that are problematic in Vietnam such as tetanus, dengue, TB, and TB meningitis. They are part of a large critical-care Asia network which is also funded by Wellcome and part of its innovations for impact initiative. Their eventual plan is to roll-out some of these innovations across their networks. The program is supported by economic analysis and implementation and health systems research components (also involving Jacob McKnight and Chris Paton and many others).

Thomas Wiegand, Technical University of Berlin, (ITU/WHO)

Thomas Wiegand is a professor at the Technical University Berlin, Chair of the International Telecommunications Unit (ITU) Focus Group on AI for Health (FG-AI4H) and Executive Director of the Fraunhofer Heinrich Hertz Institute.

The AI-for-health work of the ITU/WHO FG-AI4H has a mandate to work on standards around AI and to also offer best-practice examples. The group was established in 2018 as a collaboration between ITU and the WHO, and brings together the multiple fields of machine learning, AI, medicine, public health, government, regulations, statistics, ethics, etc. The outputs of the group are guideline documents for AI for Health and online open source tools.[9] Its members are experts from around the globe. Vice chairs come from India, The Lancet, the WHO, China and Canada; and they are supported by Fondation Botnar.

David Clifton, University of Oxford

David Clifton is professor of clinical machine learning at the Institute of Biomedical Engineering at Oxford, and covers AI (non-imageing) for health care. He also has a lab in Oxford physical sciences division, and in Suzhou, China tackling similar healthcare problems. Loiuse Thwaites introduced the activity now funded by Wellcome, which is a tremendous opportunity to work in LMIC settings over a long-time scale, something otherwise very hard to fund. Their group is interested in physiological data, blood tests, genetic data, diagnosis and wearable data. They work in hospitals with rich data sets such as the NHS and others, and in primary care. One big advantage in the UK is that surveillance data sets cover some 55% of the population. A current project, for example, is to predict blood clots from COVID-19 vaccines.

[9] Whitepaper for the ITU/WHO Focus Group on Artificial Intelligence for Health
https://www.itu.int/en/ITU-T/focusgroups/ai4h/Documents/FG-AI4H_Whitepaper.pdf

Their work in hospitals comprises probably about 80-90% based in OECD countries, and 10%-20% based in LMICs. Because they are about "putting stuff into the hands of clinicians", they create a lot of companies, including selling to companies (such as recently to Rolls Royce). Their patient monitoring activity has led to a university spin-out, Sensyne Health. They are working on cameras monitoring body size and, recently, wearables for estimating wellbeing and stress. Two months before the previous Berlin meeting David attended they floated a company on the London stock exchange which now has 150 employees translating some of the early-stage work. They have a big team of AI people learning to speak medicine, epidemiology, cardiology, etc. and are looking to find common interests.

Andrew Jack, Financial Times

Andrew is the Global Education Editor at the Financial Times.

Even though the Financial Times is not doing digital and AI research per se, they are really keen to raise the profile of interesting research insights and trends given their readership (which includes decision makers such as funders, health systems regulators and others), and to discuss both the potential of digital/AI innovation and the challenges that need to be addressed.

One of Andrew Jack's particular interests is thinking about not just the potential but also the risks of expansions of technologies like digital health and AI, and what the implications are for equity, and how such technologies might also be creating an ever-greater divide in terms of health outcomes for those in LMICs and marginalised groups around the world.

Appendix 2: Members and Observers of the Group

Members and observers of the Global Health Strategy Group for Digital Health and AI for Health and their host organisations arranged in alphabetical order:

Members

1.	Anant Jani	University of Oxford
2.	Andrew Bastawrous	London School of Hygiene and Tropical Medicine
3.	Andrew Jack	UK Financial Times
4.	Andrew Farlow	University of Oxford
5.	Aris Papageorghiou	University of Oxford
6.	Benedikt Kessler	University of Oxford
7.	Benjamin O'Brien	Deutsches Herzzentrum, Berlin, and Charité
8.	Claudia Langenberg	Charité-Universitätsmedizin Berlin, Berlin Institute of Health
9.	Cecilia Lindgren	University of Oxford
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