TRUST IN HEALTHCARE
RWANDA AT THE FOREFRONT

THE MEDICAL FUTURIST
PREPARING FOR DIGITAL HEALTHCARE

HEALTHCARE IMPACT 2020

AN FII INSTITUTE PUBLICATION

CREATING AN EXTRA DECADE OF HEALTHY LIFE
A CORE CALL TO ACTION

HEALTH EQUITY
A MORAL IMPERATIVE

FII INSTITUTE
Future Investment Initiative Institute
Impact on Humanity

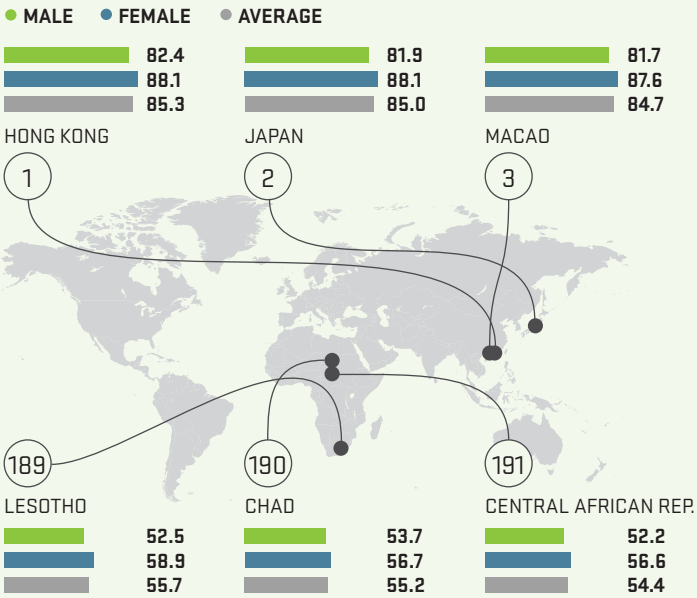
FACTS AND FIGURES

HEALTHCARE TECHNOLOGY IS THE ANSWER TO WIDESPREAD INEQUALITY

AS OF SEPTEMBER 2020

LIFE EXPECTANCY WORLDWIDE

One of the greatest expressions of global health inequity is the difference in life expectancy depending on where you are born. Here we show the top and bottom three performing countries.



DOUBLE BURDEN

When healthcare costs exceed a certain proportion of household income, it can lead to difficult choices. A comparison of countries by income grouping.

GLOBAL OBESITY FIGURES

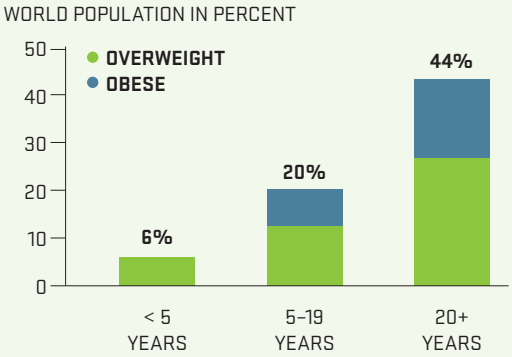
Obesity is one of the top three killers. Global rates have nearly tripled since 1975, placing it at the heart of the health agenda.

2 billion worldwide are obese or overweight: one person in four.

70 % live in low- and middle-income countries.

4 million people die annually from obesity worldwide.

7 trillion $ – the cost of obesity in next 15 years in developing countries.



Percentage of global population that is overweight or obese, by age group (2016 figures)

RESULTS OF OUR HEALTHCARE STUDY A CORE CALL TO ACTION

What is the price of an extra year of health?
An additional **5% of GDP** invested in the healthcare systems of developing countries could lead to almost a **decade of additional healthy life expectancy.**

Technology transforms existing healthcare systems.
Integrating **AI and robotics** into healthcare systems could increase the **efficiency of healthcare investment** by **up to 20%**.

A crippling disadvantage.
Developing countries' healthcare systems **lack the financial means and access to innovative technology** to reap the **significant social and economic benefits of 9 additional years of health and productivity.**

A core call to action.
We have all the **building blocks** for extending healthy lifespan, **increasing global productivity** and **improving quality of life** in developing and developed nations. What is keeping us from **creating this decade of healthy life?** Let us seek answers together for this call to action.

LEARN MORE: ABOUT THIS CORE CALL TO ACTION IN OUR GLOBAL HEALTHCARE STUDY ON PAGES 44-49

SOURCES: WORLD BANK GROUP REPORT: OBESITY, HEALTH AND ECONOMIC CONSEQUENCES ON AN IMPEDING GLOBAL CHALLENGE, 2020; WHO REPORT: PRIMARY HEALTH CARE ON THE ROAD TO UNIVERSAL HEALTH COVERAGE, 2019; LIFE EXPECTANCY BY COUNTRY IN THE WORLD, WORLDOMETER HTTPS://WWW.WORLDOMETERS.INFO/DEMOGRAPHICS/LIFE-EXPECTANCY

EDITORIAL

FII INSTITUTE Future Investment Initiative Institute | Impact on Humanity

HEALTH IS A GLOBAL GOOD DRIVING TRANSFORMATION IN HEALTHCARE

WE ARE AT A CRUCIAL MOMENT IN THE EVOLUTION OF HEALTHCARE. As the global population swells and the moral imperative of health equity becomes undeniable, the need for profound innovation in the field of healthcare delivery has become more urgent. The good news is that it is happening. The driver is UN Sustainable Development Goal 3: "To ensure healthy lives and promote well-being for all at all ages." This report explores how we are setting about achieving that goal – the challenges, the technological innovations and the lived experience of those in countries such as South Africa and Rwanda – as new technologies and systemic changes in health delivery improve people's everyday lives.

The FII Institute is contributing to the global conversation around change with a new healthcare study that we will update every year. It includes a global ranking of healthcare delivery systems based on the efficacy of their structures, processes and, most importantly, outcomes. One of the headline insights from our first analysis, published in this report, is that, regardless of a country's resources, investing in preventative health measures is considered to be far more efficient in delivering positive outcomes than relying on the traditional curative model.

The research also indicates that, by increasing expenditure on healthcare by 5 percent of GDP, developing countries could extend average healthy life expectancy by roughly nine years, and that AI and robotics have the potential to improve healthcare efficiency by up to 20 percent. You can read more about our healthcare study on pages 44–49 of this report.

Health is a fundamental human right. We at the FII Institute believe that technological advances, improved nutrition, and government policies based on the principle that prevention is better than cure can drive transformative changes in healthcare systems worldwide. We need to grasp this opportunity, because good health is the foundation for achieving our true human potential.

Richard Attias
CEO, FII Institute

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Future Investment Initiative

COVER: VIAFRAME/ GETTY IMAGES; ILLUSTRATION THIS PAGE: ANJE JAGER/SOOTHING SHADE

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HEALTH TECH REALITY CHECK

New technologies are emerging that promise to deliver great advances in healthcare. How can we speed up their implementation in real healthcare settings?

PHOTO: MLADEN ANTONOV/AFP VIA GETTY IMAGES

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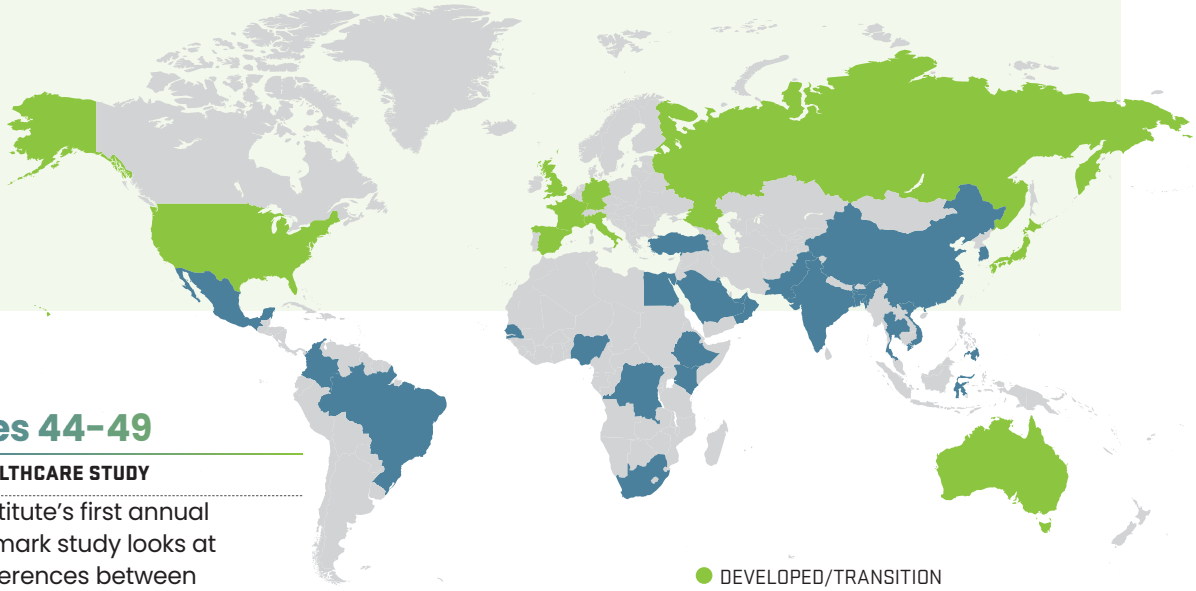

DEVELOPED/TRANSITION COUNTRIES

DEVELOPING COUNTRIES

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FII-I HEALTHCARE STUDY

The Institute's first annual benchmark study looks at the differences between health systems, identifies performance drivers and offers recommendations

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INTERVIEW AGNES BINAGWAHO

Rwanda's former health minister and Vice Chancellor of the University of Global Health Equity on creating one of the best health systems in Africa

ILLUSTRATION: ULI KNÖRZER, GETTY IMAGES

Prevention

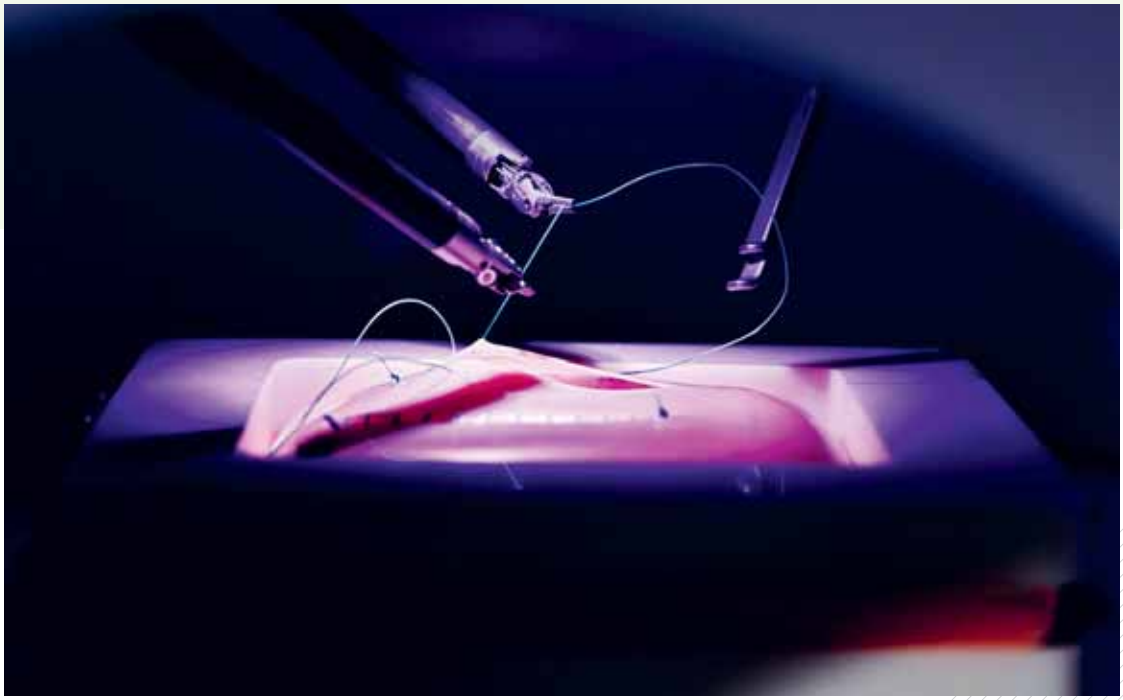
Run by the non-profit organization Smile Foundation, Smile on Wheels is a healthcare van delivering essential medicines to an elderly woman on the streets of Mumbai, as well as offering mobile screening for Covid-19.

PHOTO: ASHISH VAISHNAV/SOPA IMAGES/LIGHTROCKET VIA GETTY IMAGES

PHOTO: SPENCER LOWELL / TRUNKARCHIVE.CO

THE FUTURE OF HEALTHCARE

Innovation is a byword when it comes to future healthcare delivery, empowering us to prevent disease, treat clinical conditions with precision, empower patient participation and predict the behavioral and environmental causes of illness.



Precision

The Da Vinci XI surgical robot supports the surgeon when performing minimally invasive surgery. It enables the tiny wristed instrument to perform extremely precise movements while remaining under the control of the surgeon.

Participation

In Rwanda, people who fail to take proper measures to stop the spread of Covid-19, such as wearing face masks correctly in public places, are required to listen to public health messages in Nyamirambo stadium in Kigali.

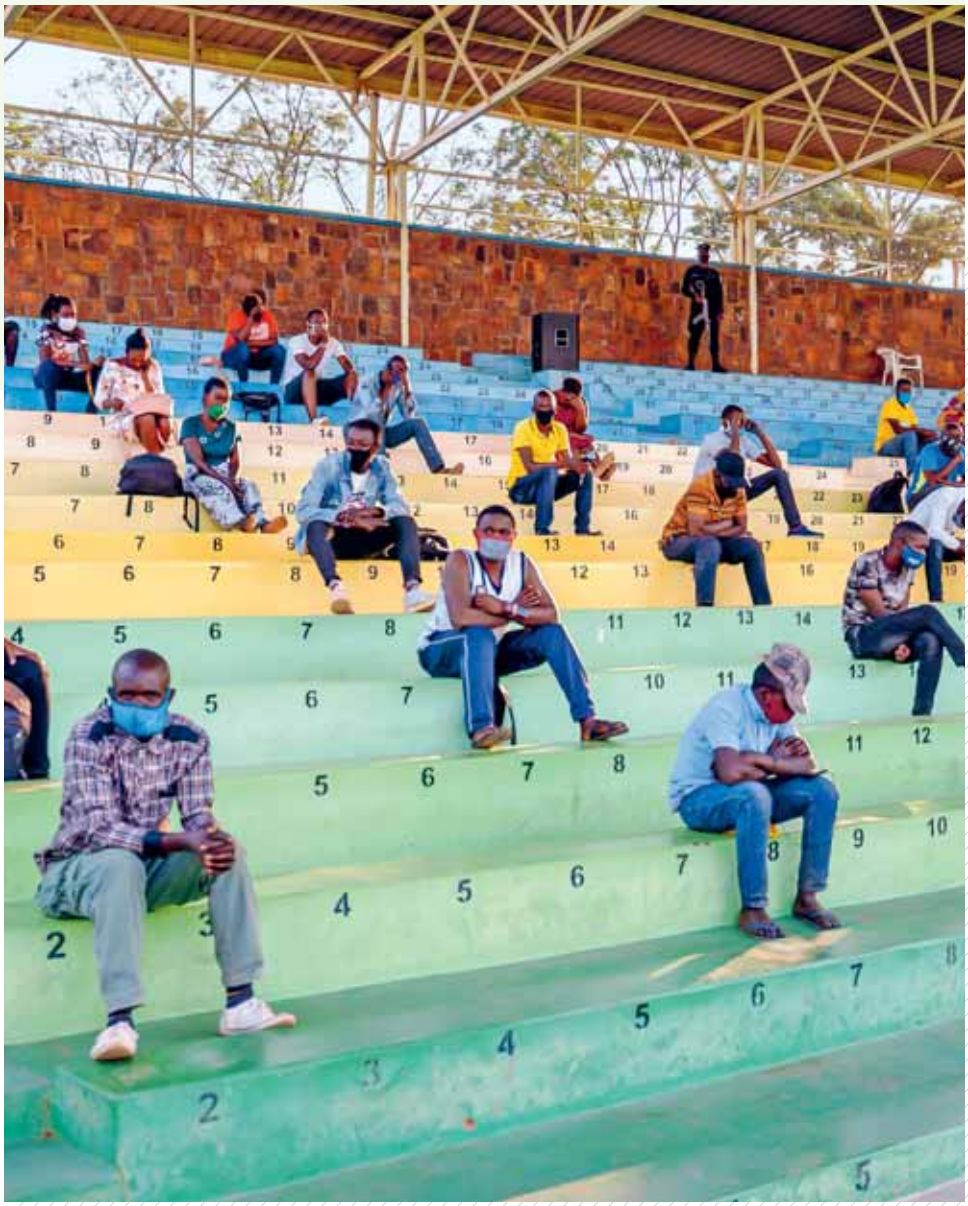


PHOTO: STR/AFP VIA GETTY IMAGES

Prediction

A genetic research scientist views DNA to confirm or rule out a suspected genetic condition or help determine a person's chance of developing or passing on a genetic disorder. More than 1,000 genetic tests are currently in use.

PHOTO: ANDREW BROOKES/GETTY IMAGES

AMBITIOUS TARGETS FOR GLOBAL HEALTH

ON 23 SEPTEMBER 2019 heads of state, health leaders and policymakers gathered in New York for a meeting of the United Nations General Assembly. The meeting resulted in what UN Secretary-General Antonio Guterres described as "the most comprehensive agreement ever reached on global health".

It was considered a watershed moment in achieving the key Sustainable Development Goal (SDG) of ensuring all people receive the quality health services they need by 2030. At the heart of the agreement was a pledge to implement high-impact health interventions to combat communicable and non-communicable diseases, and strengthen the health workforce, infrastructures and governance. It was also agreed that no one requiring healthcare should suffer financial hardship by paying for health out of their own pocket.

If these commitments are to be achieved by 2030 worldwide, the global community must focus on achieving them in Africa. With 16 percent of the global population, the continent accounts for 26 percent of the global disease burden yet receives less than 2 percent of total global healthcare funding. If we can make significant progress here, it will be a major step forward, which is why Africa is a focus of this section.

We will look at solutions being explored to address these new commitments set by the UN when it comes to healthcare

The United Nations has set ambitious targets to improve healthcare delivery in developing countries as part of the Sustainable Development Goals for 2030.

PHOTO: LI MUZI/XINHUA/EYEVINE/LAIF

in Africa, and in developing countries elsewhere. Achieving "high-impact health interventions" while ensuring access to affordable healthcare is going to require a new generation of digital innovations along with R&D in the field of vaccine and drug delivery. Vaccines have extraordinary knock-on effects, reducing healthcare costs, wages lost as the result of illness, and infections that impair cognitive and physical development. They also lead to lower birth rates as mothers no longer fear infant mortality. According to the International Vaccine Institute, every $1 invested in vaccine technology saves $44 to society.

One of the key findings of the FII Institute healthcare study (pages 44-49) is the need for future initiatives to be heavily focused on ill-health prevention measures. So we explore how it is possible to reach low-income communities that are reliant on a few staple crops and are most at risk of nutrition loss. The UN Food and Agriculture Organization estimates that around one-quarter of the world's population is deficient in minerals and vitamins, increasing the risk of lifelong deficits in physical and cognitive development. We look at how the new science of biofortification is helping alleviate the problem.

HEALTH IN THE BALANCE

The good news is that since 2000 life expectancy in Africa has been ↘

60%

The recent increase in skilled African healthcare workers migrating to OECD countries

SOURCE: WHO

> **"I have seen first-hand how lack of access to affordable healthcare can blight the lives of ordinary people."**

DR. NADINE HACHACH-HARAM

Founder, Proximie

increasing on average at a rate of five years per decade. With economic growth at over 5 percent between 2000 and 2010, improvements in health structures have been paying dividends. Other key metrics include the infant mortality rate, which since 1990 has more than halved, and maternal mortality, which fell by just under 1 percent a year between 1990 and 2015.

There have also been some momentous achievements. On August 25 this year, the World Health Organization (WHO) celebrated ridding the Africa region of wild polio, an event described by WHO Director-General Dr. Tedros Adhanom Ghebreyesus as "one of the greatest public health achievements of our time". Wild polio was a source of the polio virus, responsible for paralyzing more than 75,000 children a year in the mid-1990s. Its eradication is thanks to a 30-year campaign to vaccinate over 95 percent of Africa's population.

But Africa still has a long way to go to meet the UN's health-related SDGs by 2030. Covid-19 has thrown into sharp relief the strengths and weaknesses of Africa's health structures. On the plus side, African states have had extraordinary success in marshaling armies of community workers to get to hard-to-reach communities to stem the spread of the virus. "Local, well-trained community workers who have a lot of past experience in dealing with contagious diseases have been key to our strategy," says Dr. Ahmed Ogwell, Deputy Director of the Africa Centers for Disease Control. "The reason we have been so aggressive with prevention measures is that if people start requiring critical care, countries will get overwhelmed very quickly." It is at the acute end of health delivery that the African health systems are at their weakest.

LOSS OF SKILLS

According to research published in December 2019 by the UN Economic Commission for Africa, skill shortages are one of the biggest obstacles to strengthening healthcare structures. The WHO recommends a minimum of 23 skilled health workers per 10,000 population. In 11 African states that ratio is below five, while in Niger and Somalia it is less than two. The problem is more acute in rural areas where it is difficult to attract qualified workers. The report reveals that skill shortages are being compounded by a recent 60 percent increase in qualified health workers migrating to OECD countries.

PHOTO: TOMMY TRENCHARD/PANOS PICTURES/VISUM, PRIVAT

An ophthalmologist at the Nampula hospital in Mozambique examines a patient after a cataract operation. The country has just 18 ophthalmologists for a population of 23 million.

Africa's age demographic is also a challenge. With its population expected to double between 2015 and 2050, one-third will be under 14 in 30 years. While this has the potential to create a "demographic dividend", boosting economic growth and productivity, the flip side is that the 60 percent of Africa's population currently under 20 will, by 2050, be starting to age. It means health systems will need to respond to heavy demands from both ends of the age spectrum. The sort of rapid urbanization Africa is experiencing is also set to pose problems. Urban migrants switch to less healthy diets, resulting in higher rates of costly chronic disease, while also living in overcrowded conditions, often with poor infrastructures.

COST OF CARE

According to the latest figures, the current healthcare funding gap for the continent is around $66 billion per annum. This is a serious obstacle to achieving affordable universal healthcare by 2030. On average, 36 percent of healthcare spending in Africa is paid for by those who require the medical treatment, compared to 25 percent in middle-income countries. This figure rises to 70 percent in countries like Cameroon, Comoros, Equatorial Guinea and Nigeria. The rest of the funding comes from domestic governments, external assistance or prepaid private spending in the form of some kind of health insurance. The inevitable consequence is that those who need treatment the most tend to be those who can afford it least.

LEAP INTO THE LIGHT

"Leapfrogging" is a term often used when discussing healthcare delivery in the developing world. It is shorthand for leveraging digital healthcare technology to compensate for severely stretched traditional primary care structures.

The term derives from the way cell phone technology has leapfrogged the development of fixed phone line infrastructures in Africa and Asia. It is an appealing idea, a sort of silver bullet that many believe will go some way to ↘

A boy who lost his leg in a traffic accident watches as a 3D printer produces a prosthetic socket for him at CoRSU hospital in Kampala, Uganda.

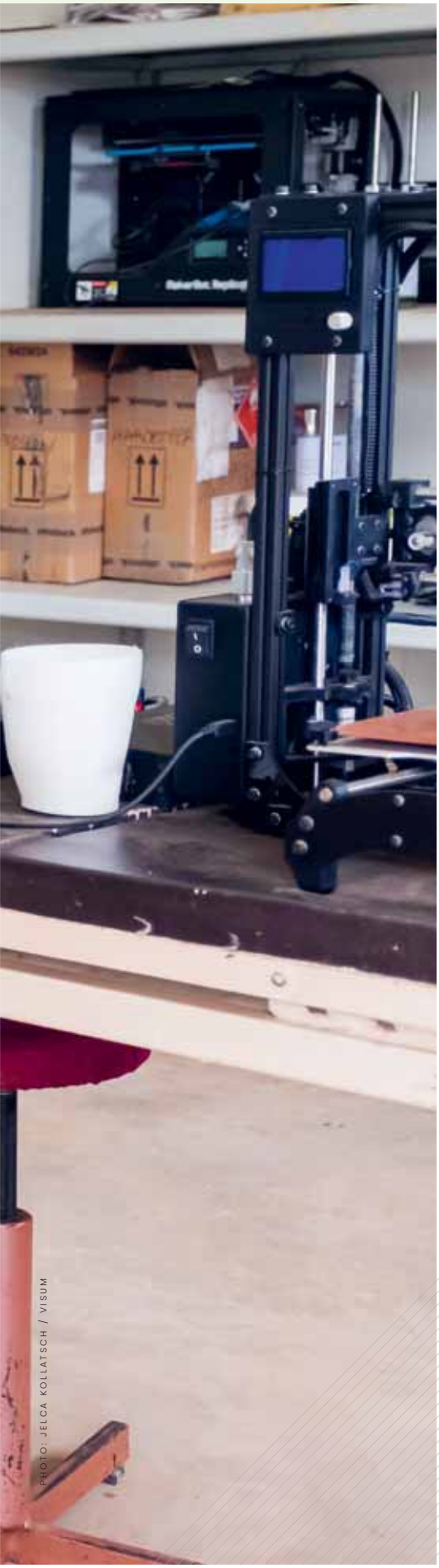


PHOTO: JELCA KOLLATSCH / VISUM

narrow the gap in global healthcare equity. The idea has attracted a huge number of tech companies to the healthcare field, many of which are having a positive impact on health delivery.

However, there are major obstacles to be overcome. Most recent World Bank figures show that in Sub-Saharan Africa about half the population lacks access to electricity. In rural communities, a solution is being found in the development of micro-grids connected to renewable energy sources. The African Development Bank is developing new finance structures to support companies providing off-grid, largely solar-powered electricity solutions rather than trying to extend existing grid networks. Ethiopia has ambitious plans using decentralized renewable energy grids in rural areas, while Kenya has embraced geothermal, wind and solar power to drive access to electricity up from 20 percent of the population in 2002 to 75 percent in 2018.

Another challenge in low-resource environments is that, when it comes to more advanced telehealth, poor connection speeds and "not spots" – areas with no cell coverage – are proving an obstacle. But there may be solutions in the pipeline here, too. In July 2020, Google and Telkom Kenya launched Project Loon: an initiative that enables high-speed Internet to be beamed from a fleet of high-altitude hot-air balloons over an 80,290 square-kilometer area of central and western Kenya, including the capital, Nairobi. The initiative is cheaper than laying cables or building cell towers and is being closely watched by other telecom providers.

SURGICAL CARE

But even with the existing patchwork of cell phone coverage, sophisticated telehealth solutions are still being developed. In 2016, plastic surgeon Dr. Nadine Hachach-Haram decided to combine her knowledge as a surgeon in the UK's National Health Service with her charity work to help address a global shortage in surgical expertise. She founded Proximie, now operating in more than 35 countries, a platform that enables an expert surgeon to virtually transport themselves into any clinical setting simply by using a phone, tablet or computer to interact and support surgical procedures. "It allows two people in remote locations to interact virtually in a way which mimics what they would experience if they were collaborating in the same room," explains Hachach-Haram. "I have seen first-hand how lack of access to affordable healthcare can blight the lives of ordinary people, technology is part of the solution."

The ability of the technology to operate at low bandwidths means it can be used in low-resource settings as well as high-end hospitals. In a recent initiative, a leading Chicago-based ear, nose and throat (ENT) specialist was able to mentor surgeons in Ethiopia, increasing the skill pool so the number of surgeons now able to carry out ENT procedures has risen from one to six.

Digital solutions are also helping with health skill shortages at other points of health delivery. In Tanzania, where there is one doctor for every 25,000 people, a Swahili-speaking free-to-download app uses AI to enable a patient to input symptoms and pre-existing medical conditions. The Swahili-speaking chatbot app questions the patient, provides a diagnosis and recommends treatment. Swahili is spoken by 100 million people in East Africa, and the hope is to increase coverage across the region.

According to Dr. Ahmed Ogwell, Deputy Director of the Africa CDC, cell phone technology has been empowering health delivery in Africa for many years. "An example is the way the African Medical Research Foundation has been using mobile technology for a long time to build the capacity of our health workers and for providing information for facility-based health workers," he explains. "It really is a standard tool that is largely being used to provide SMS messages rather than the level they are being used elsewhere with GPS positioning."

MEDICAL ADVANCES

Technological advances are not confined to the digital. Jamie Bay

At the national hospital in Cotonou, Benin, research is carried out into tuberculosis. Molecular testing is used to diagnose this highly infectious disease.

↘ Nishi is director of the Global Health Technologies Coalition (GHTC), which brings together 30 organizations working to accelerate development of drugs, vaccines and diagnostics for the developing world. "We look at where the biggest market failures happen, and that's often around TB, malaria, HIV, neglected tropical disease and of course emerging infections," explains Bay Nishi.

The GHTC acts as an advocate for public investment and policy solutions to advance global health research and development, such as improving delivery mechanisms for drug treatments in low-resource settings. "Some of our partners have worked on child-friendly formulations of tuberculosis and malaria medications," says Bay Nishi. "Realizing that TB medications historically taste horrible and getting the right dosing amounts for pediatric populations was a really big problem. Reformulating an existing drug so that we can reduce its dosing and make it something that actually tastes good is a real game-changer for kids living with TB."

GHTC and its partners are currently advocating for solutions for non-intravenous delivery of Remdesivir, an Ebola drug being used for Covid-19 treatment. "An IV drip is just not going to work in a low-resource setting," says Bay Nishi. "We need partners to think about how to have this in pill or inhalable form that is also heat stable and does not require a cold chain."

Safe delivery of vaccines and drugs has always been a challenge in developing countries. Most vaccines must be stored in temperatures between 2°C and 8°C, with too-cold storage temperatures often a bigger problem than spoilage from heat. A 2018 review by the journal *Vaccine* revealed that 37 percent of vaccines in low-income countries are exposed to temperatures below recommended ranges during storage. The advent of sensors capable of monitoring temperature as well as humidity, and storing the information in the cloud, is proving invaluable in optimizing supply chains to safeguard vaccine quality.

PREVENTION OVER CURE

Low immunity to disease as a consequence of malnutrition is also a major area of concern. A technological advance that many believe could have a dramatic impact on disease prevention is biofortification. Unheard of 20 years ago, it is the science of improving the nutritional quality of crops through conventional (non-GMO) plant breeding.

Jen Foley is a senior program manager for the HarvestPlus program, which leads a global effort to address malnutrition. "It is essentially the process of making micronutrients available to smallholder

PHOTO: YANNICK FOLY/GETTY IMAGE

Proximie enables surgeons to collaborate remotely via audio, video and augmented reality. The software works at low bandwidth and latency.

37% of vaccines are spoiled due to incorrect storage temperatures

SOURCE: VACCINE JOURNAL

farmers and vulnerable populations through the crops and foods they are already eating every day. Year after year they can grow nutritionally enriched crops, without any extra cost to themselves," explains Foley.

It is estimated that over 40 million people worldwide currently benefit from foods made from biofortified crops. In August this year, India's third-most populated state, Bihar, announced plans to significantly scale up production of zinc-biofortified wheat. Zinc deficiency can be a major cause of stunted physical development and child mortality while also making people vulnerable to diarrhea, malaria and lower respiratory infection. It is estimated that the government-led initiative will increase availability to millions more nutritionally vulnerable families in a state with the lowest per capita income in the country. Other biofortification initiatives across Africa, India, Asia and Latin America provide micronutrients such as zinc, iron or vitamin A in maize, rice, sweet potato, wheat, beans, pearl millet and cassava, among other crops.

In 2019, the UN Food and Agriculture Organization published a joint report with HarvestPlus outlining this still relatively new strategy's benefits. It concluded, "biofortification is a cost-effective, food-based, nutrition-sensitive agricultural approach for improving nutrition". The World Food Programme includes biofortified crops in its guidance on food relief procurement.

Foley claims that while it has taken 15 years for the science to establish itself, it is now at a turning-point. "There are now nearly a hundred global and regional strategies that include biofortification," she says. "We believe we have reached a significant point where we can rapidly scale up." ■

CALL TO IMPACT

1 Technologies like sensors and cloud data storage must be made available along the vaccine supply chain to ensure that more vaccines are stored in the correct conditions.

2 Innovative solutions must be found to help address the challenges of delivering healthcare in regions where mobile phone coverage is weak.

3 Policies must be developed to sustain and scale up biofortification of crops as these help prevent disease by building immune systems.

PHOTO: PROXIMIE

ACCESSIBLE HEALTHCARE ROBOT AND ATM PHARMACIES LEAD THE WAY IN SOUTH AFRICA

Right ePharmacy was established to support the health sector in South Africa with innovative pharmaceutical supply chain solutions aimed at relieving the burden on hospitals and clinics and curbing non-adherence to chronic medication. Making use of the latest technology, it eases access to medication for patients.

1 Cutting waiting times

A busy Monday in Alexandra Township in Johannesburg, South Africa. Patients collect their chronic medication at the dispensary's Pharmacy Dispensing Unit (PDU) or ATM pharmacy, as it is popularly known. Quick service – less than three minutes – has become the new normal. The Alexandra flagship site serves an average of 200 patients every day.

2 Learning from banking

"Patients can see for themselves through the window how the technology behind the ATM works. It helps create awareness and get buy-in from the public. It's as easy as going to the bank," says Hendriksz.

> **"We've shown that with automation in pharmacies and public health, you can do up to 65 percent more prescriptions with the same amount of staff and the same space."**

FANIE HENDRIKSZ

Managing Director, Right ePharmacy

3 The convenience of a card

Stable chronic patients with conditions such as asthma, high blood pressure, HIV/AIDS and diabetes are issued with a card and pin. Two days before their due date, they receive a reminder SMS to go to the ATM. There is a "Call pharmacist" button on the machine if they have any questions. It links them immediately to a pharmacist via video call.

PHOTOS: GULSHAN KHAN, PRIVATE

4 Stocking up

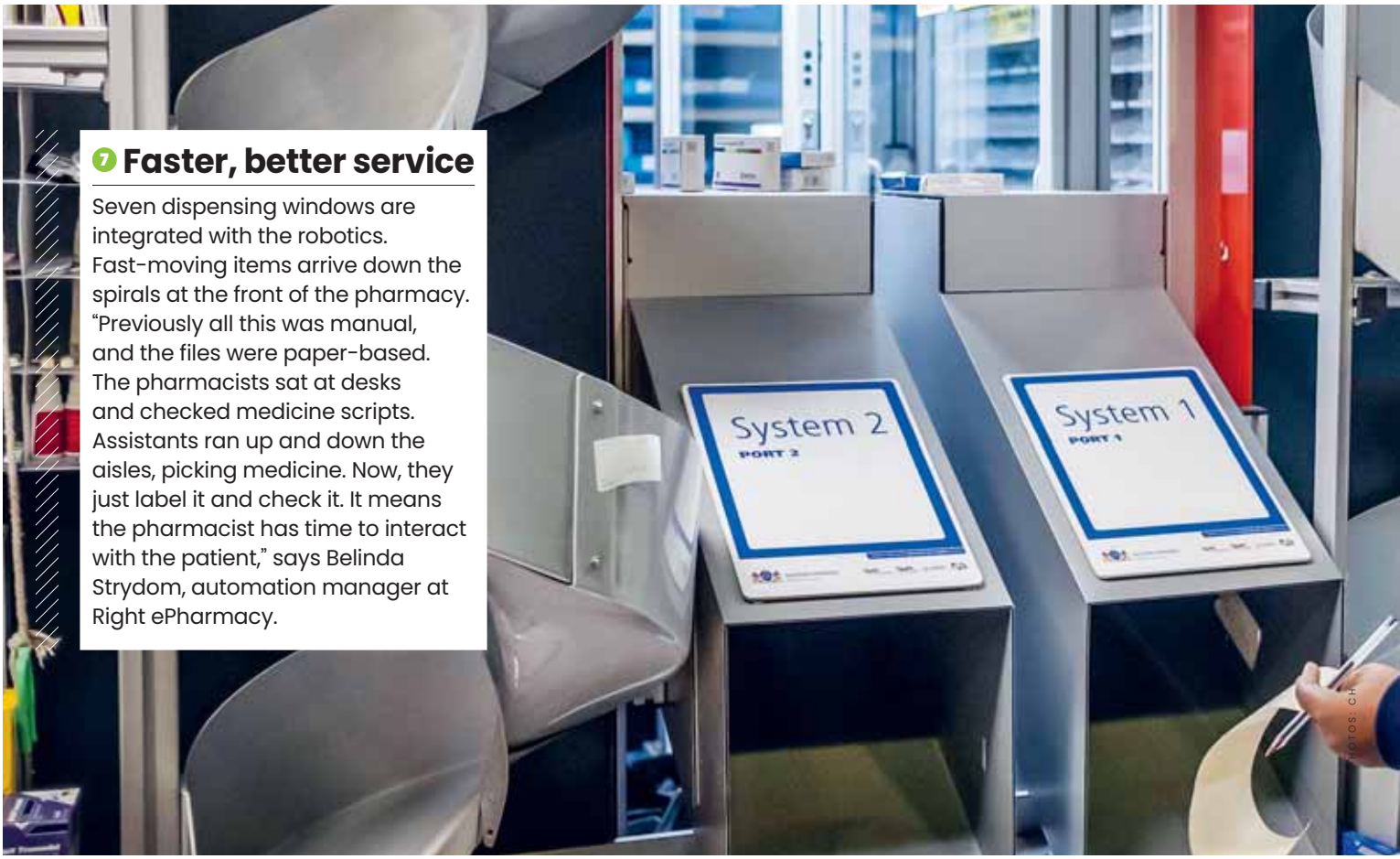
A pharmacist scans the barcode on the medication and loads it into a Speedbox behind the ATM. Lights alert the pharmacist to the boxes that need to be prioritized for restocking. Each slot is programmed for specific items to reduce mistakes.

5 Remote control

When a patient at the ATM selects their medication, it is moved from the slot down a chute and labeled. The centralized system means stock can easily be controlled across all sites.

7 Faster, better service

Seven dispensing windows are integrated with the robotics. Fast-moving items arrive down the spirals at the front of the pharmacy. "Previously all this was manual, and the files were paper-based. The pharmacists sat at desks and checked medicine scripts. Assistants ran up and down the aisles, picking medicine. Now, they just label it and check it. It means the pharmacist has time to interact with the patient," says Belinda Strydom, automation manager at Right ePharmacy.



6 Optimal organization

A short drive away from Alexandra is the Steve Biko Academic Hospital in Pretoria. The pharmacy has five Speedboxes and an in-pharmacy robot. The machine loads medicines on the shelves, scans the barcode and locates each package to optimize space. Pharmacists and machines work side by side to serve patients quickly.

PHOTOS: GULSHAN KHAN, PRIVAT

8 The night shift

At 4 pm the pharmacists pack up and leave. Silence reigns in the hospital that has been buzzing since the early hours. The pharmacy waiting room is bare, with little evidence of the many people who gathered there. Inside the pharmacy, the robots begin their work ensuring that medicine is packed again in time for the morning shift.

BUILDING ON TRUST

In 1994 Rwanda suffered one of the worst genocides in recent history. Today it has one of the best health systems in Africa. Former Rwandan health minister Agnes Binagwaho explains how this was achieved.

PROFESSOR AGNES BINAGWAHO

Vice Chancellor, University of Global Health Equity

Impact: You returned to Rwanda from France after the genocide in 1994. What have you witnessed in terms of change since then?

Agnes Binagwaho: The biggest change is around the rebuilding of the social fabric. We had one million dead. Neighbors killed neighbors with machetes. There were also heroic people who saved others, but when I came back in 1994 the distrust was so high you could not leave your drink for fear it would be poisoned. So it was critical to rebuild trust and create a strong avenue for peace and reconciliation with a recognition of the victims. The message was that people are not in essence bad; they turned bad through bad leadership.

How has the healthcare system evolved since 1994?

→ When you are sick and vulnerable, you will not seek healthcare from people you do not trust. By building trust, we have achieved the best rate of child vaccination on Earth. To vaccinate your child is an act of trust by the parent because that infant is not sick and yet you are going to make it cry and give it a fever when you give it an injection. The parents have to believe the vaccination will help that baby. In 2018, the Welcome Trust surveyed people from 104 countries on trust in their national healthcare systems. Rwanda came out top. Rwanda is a poor country and yet we have better survival rates than countries with three times our GDP. This is not by chance. This is because we have managed to create the demand for healthcare, and that demand is based on trust.

How have you embedded the principle of trust in your local healthcare systems?

→ I think you should look at it the other way around. We gave people the right to control their destiny and then they created the trust. One of the first policies I passed when I was health minister was to make it a legal obligation to make communities participate in healthcare. At a community level, people are requested by law to elect health workers they trust. After that, it is up to the ministry to train them. Four health workers are elected for each village. They are responsible for women's

> **"By building trust, we have achieved the best rate of child vaccination on Earth."**

ILLUSTRATION: ULI KNÖRZER

PROFESSOR AGNES BINAGWAHO

MD, M(PED), PHD

is a Rwandan pediatrician who returned to Rwanda from France in 1994, settling permanently in 1996. She has served as **Executive Secretary of the National Aids Control Commission, Permanent Secretary of Health** and as Minister of Health. Today she is Vice Chancellor and co-founder of the Rwanda-based University of Global Health Equity, focused on changing healthcare delivery globally. She was named one of the 100 most influential African women for 2020.

and infant health, common diseases, child development and malnutrition. Community members select people to be members of the board of their health center to make sure that they are happy with the care received. This basic participation process is key to Rwanda's health policies.

How has Rwanda dealt with mental health issues following 1994?

→ Let's start with the trauma of the people who survived. They received no specialist health attention as there was no mental health policy before 1994. We had one mental health hospital with 100 beds and one psychiatrist. So, we decided to rely on the community to alleviate the pain and we changed attitudes when it came to the expression of trauma. We said, "Don't try to hide this or pretend it does not exist." It was about the whole community coming together. Then, two years ago we discovered there was trans-generational trauma. Children were turning to risky behavior like drug usage because of the actions of their veteran parents. We reacted in the same way, asking people to talk about it openly and not deny it. We launched programs to teach clinical psychologists to detect trans-generational trauma. We are also working through schools to catch children who have problems. We needed to find a homegrown solution to our national trauma, which makes every Rwandan an actor in the solution.

Africa suffers from a shortage of health skills. How is Rwanda addressing this problem with regard to mental health?

→ After 2000 we started to train psychiatric nurses, placing them in every hospital and then in every health center. We trained community health workers to recognize dangerous signs and to understand who needs to be transferred to someone more qualified. There are doctors in each hospital with mental health training who know when to transfer a patient to a psychiatrist or back down to the health center. We have also just created a rapid screening tool to detect children at risk ↘

of depression. We are creating an architecture based on the country's ability. We are not undermining specialist skills, we are just demystifying them by task sharing. Rwanda has also created a program called Human Resources for Health in partnership with 23 American higher education institutions to create residencies and start specializations to train Rwandan faculties to train psychiatrists.

There is talk of Africa having the opportunity to leapfrog or bypass traditional healthcare solutions with new technology. To what extent is that happening in Rwanda?

If we see an opportunity to leapfrog, we go for it. We have done it with HIV treatment and our vaccination program. Let's take Covid-19. If health workers take temperatures while treating patients, they risk infection. So, we are using robots to take temperatures. We found a company that produces them, we tested them and now we use them to decrease the risk to health workers. The other area is in the organization of the health sector. We are very proud of our health information system. For example, if a community worker gives a treatment for malaria, the data is updated on a server using their phone, the information is collected at district level and the health minister can see each month how many treatments there have been. Drones are another example. We use them to send life-saving drugs or equipment to cut a four-hour road trip down to 25 minutes.

The WHO fears that Covid-19 is impacting immunization programs. How is Rwanda dealing with this risk?

In other countries, people don't want to go to hospital for fear of catching Covid-19. In Rwanda, if you suspect someone has Covid-19 you call a number and an ambulance takes them to a special center. To make sure we protect the health system, you are not allowed to go to hospital with Covid-19. You don't have to leave your district to get a vaccination because every district has many health centers. We have also been able to maintain our supply of vaccines throughout the outbreak. By comparing vaccine numbers with the number of children born, we believe we have been able to deal with the problem.

> **"If we see an opportunity to leapfrog, we go for it. We have done it with HIV treatment and our vaccination program."**

Key information about pregnant women is held in the RapidSMS database, enabling healthworkers to coordinate care with hospitals.

PHOTO: STEPHANIE AGLIETTI/GETTY IMAGES

> "Rwanda is a poor country and yet we have better survival rates than countries with three times our GDP. This is not by chance."

Non communicable diseases are on the rise in Africa. What are you doing in terms of public health measures to prevent disease?

→ We have been very attentive to this issue after seeing how China went from problems with malnutrition to problems with obesity. We have done a number of studies and we have unexpected levels of obesity. It is not high, but it is unexpected. Exercise has been made a state issue. Before Covid-19, every Friday all public institutions closed for people to do exercise. Every month in Kigali there is a car-free day where everybody is encouraged to walk in the city. You see ministers, you see your neighbors, you meet the president walking. It's fun and you do a lot of exercise. This has now spread to districts. Every week people have to exercise, football matches are arranged between parliament and the ministries. Our message is to exercise to avoid non-communicable diseases. More than a message: we walk the talk.

One of the Sustainable Development Goals is about affordability for all. How are you achieving this in Rwanda?

→ The country cannot provide free healthcare and the people cannot afford to pay. The only thing to do is to adapt health insurance to our culture. We also have an efficient system with the highest level of affiliation. There is health insurance for the military and police, we have insurance for civil servants, we have private insurance and we have community health insurance, which is mandatory and costs $5 per person per year. The poorest 25 percent of the population pay nothing – the government pays their premium. At the point of care, you only have to pay 10 percent of the cost, because we don't want the population to believe that care has no cost. We now have an aging population, so we have to find a way to add a little more to deal with chronic diseases – we are having to adapt as we go.

Where do you hope to see Rwanda in terms of healthcare in 20 years?

→ We have a long way to go to get where we want to be. We are missing advanced care like cardiac surgery. You save people from TB and HIV and then they die of a heart attack. I want to continue to develop access to more sophisticated care. I want to continue to make care accessible, to grow communities and make every person contribute to this development. I want healthcare even more embedded in the community. This is why we created the University of Global Health Equity, to advocate for community-centered development with health at its center, providing for each and every person, especially the vulnerable. ■

CALL TO IMPACT

1. Governments must build trust in healthcare systems by enabling communities to participate in healthcare delivery.
2. A focus must be placed on preventing non-communicable diseases – for example, by introducing more opportunity for exercise.
3. Every opportunity should be taken to bypass traditional healthcare solutions with new technologies.

THE CORRECT PRESCRIPTION FOR HEALTHCARE SYSTEMS UNDER STRAIN

FOR THE DEVELOPED WORLD, Covid-19 was the starkest possible reminder that it was far from immune to communicable disease outbreaks. But despite the pandemic's devastating impact, the major long-term health challenge remains the ever-growing burden of non-communicable diseases (NCDs) – and a healthcare system ill-equipped to cope with them.

People are living longer, which is good news. However, they are living longer often with multiple chronic conditions. Meanwhile, sedentary lifestyles, obesity, poor diet and alcohol and tobacco use are leading to increasing rates of "lifestyle-related" diseases such as heart disease, hypertension, cancers and type 2 diabetes.

According to the World Health Organization (WHO), obesity is now at epidemic proportions, with around 2.8 million people a year dying as a result of being overweight or obese. And this is no longer a problem confined to the developed world. As the economies of developing countries continue to grow, so does the demand for Western-style food products. World Bank figures reveal that obesity-related diseases are now among the top three killers in most countries and NCDs in general are responsible for almost 70 percent of global deaths.

The tragedy is that many of these deaths are preventable. This realization is prompting a reexamination of some of the fundamental notions behind healthcare. Most healthcare systems were designed to intervene primarily at the stage where the patient notices symptoms and to offer "one size fits all" solutions. In terms of infectious diseases, as the findings of the FII-I's first healthcare study revealed (see pages 44–49), the most effective measure countries can take is to focus investment on prevention of pandemics. Likewise, in the case of NCDs, shifting from caring and curing to prevention and predictive healthcare can improve outcomes and reduce overall costs.

SHIFT IN APPROACH

The biggest cause of morbidity in developed countries is NCDs. Yet NCDs are increasingly preventable. According to a study by Ramon Martinez et al. (*The Lancet*, 2020), between 1990 and 2017 the number of avertable NCD deaths increased globally by almost 50 percent, from just over 23 million to more than 34 million. However, many healthcare systems are based on a model of reacting to problems rather than prevention. But with the rising burden of NCDs, this approach is proving inadequate. Healthcare systems in developed countries are struggling to deal with ever-growing need and substantial costs. According to WHO, by 2017 health spending in high-income countries had reached almost $3,000 per capita, ↘

In Mexico, 75% of adults are overweight or obese. Police officers in Mexico City join an exercise program to lose weight.

RODRIGO ARANGUA/GETTY IMAGES

A healthier diet could prevent between 20 and 24 percent of deaths a year.

SOURCE: EAT-LANCET COMMISSION

↘ standing at just under 8 percent of GDP. There is little room for it to go higher.

Public health experts have long argued for a fundamental shift. "Western health systems have been focused on dealing with the consequences of poor diets and inactivity, rather than spending more of their efforts dealing with prevention," says Walter Willett, Professor of Epidemiology and Nutrition at Harvard's T.H. Chan School of Public Health. "There are a few places that are moving toward a different model, but the kind of system we have is really irrational. And the training of doctors still includes almost nothing on nutrition."

UNEQUAL BURDEN

While more people are responding to healthy eating messages, it still tends to be those with higher levels of education, just as the people buying healthier products tend to be in higher income brackets. Poor diets, along with issues such as inadequate housing and higher rates of smoking, mean there are significant gaps in life expectancy between rich and poor even within the same countries. In England, for example, the life expectancy gap between the least and most deprived areas is almost ten years for men and eight for women.

In addition, there is the vicious circle created by NCDs and poverty. Studies show that low income increases exposure to risk factors that cause NCDs, such as unhealthy diets and insufficient physical activity, while NCDs in turn contribute to poverty by reducing household income and increasing healthcare costs.

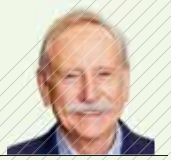
As long as the cheapest foods are among the unhealthiest – like starch and sugar – the difficulty will be in getting more people to change their behavior. "That is a huge challenge. The food industry makes massive profits by selling starch and sugar in thousands of different ways," says Willett. "They spend billions a year on marketing just in the US. That creates a huge challenge for helping people eat a healthy diet."

But if the industry can put huge resources into making products like red meat and dairy products affordable,

The microgreens market is growing rapidly. Research is being carried out into their use as functional foods in diet-based disease prevention.

PHOTO: OLLIE MILLINGTON/GETTY IMAGES, PRIVAT

> **"Western health systems have been focused on dealing with the consequences of poor diets and inactivity."**



WALTER WILLET

Professor of Epidemiology and Nutrition,
T.H. Chan School of Public Health, Harvard

then a rebalancing of the system could easily make things like fruits, vegetables and whole grains cheaper instead. Consumer habits do change, as the fall in consumption of red meat in countries such as the US shows, with two-thirds of American consumers saying they are now eating less of at least one kind of meat.

"It's a delicate balance," says Willett. "We have evidence that we can make big changes. Some of it is due to education and awareness, some of it is due to pricing, but to have the most effective change it's going to be some combination of those."

Younger generations may well be easier to win over, with vegan and "flexitarian" diets becoming more popular amid growing levels of concern about animal welfare and the environmental impact of the food industry. The Meatless Monday movement, for example, now has initiatives in more than 40 countries, and sections of the food industry see huge opportunities in healthy eating. "Some of the fastest growth in the food retail and restaurant industry in recent years has been in the healthier sector," says Willett. According to the US Food Industry Association, sales of plant-based meat alternatives increased by over 19 percent in 2018 and accounted for $878 million in sales.

Changing habits could bring immense benefits, as was shown in the landmark 2019 EAT-Lancet Commission report, of which Willett was a lead author. "We used three different approaches to calculate how much premature mortality we might prevent if everybody shifted to a healthier diet, and we all came up with a similar figure – about 11 million deaths a year. That's around 20 to 24 percent of the total number of deaths. If you added in more physical activity, that would have a further reduction. So there's a huge potential impact."

THE POWER OF DATA

One country always close to the top of the league table for life expectancy is Japan, and one of the key reasons is thought to be diet. The Japanese government, like many others, issues healthy ↘

eating guidelines that recommend daily servings of foods such as grains, vegetables and fruit, alongside other nutritional guidance. But there are other reasons, too, why life expectancy in Japan is among the highest in the world.

As can be expected for a country famous for its technological advances, Japan is also utilizing technology to meet its healthcare challenges, for example by investing in robots to provide nursing assistance and in wearable robotic technology to help elderly patients remain independent and stay in their own homes. Many people also expect virtual reality (VR) to become an integral part of the healthcare landscape, from education and training to rehabilitation and mental health services.

Tomohiro Kuroda is a professor in the faculty of medical informatics at Kyoto University Hospital. "There is a lot of potential in these technologies. During the Covid-19 pandemic, students could not come to the university medical school so we introduced VR instead of anatomy training," he says. "It can't replace everything, of course, but I think it will be a very powerful tool. You can use it to evaluate the skill of a surgeon before they embark on real clinical practice, for example. Another successful application is for the families of dementia patients. It can help families to understand what people are experiencing."

Doubling what OECD countries invest in their information systems would deliver a threefold return, according to OECD research.

SOURCE: OECD

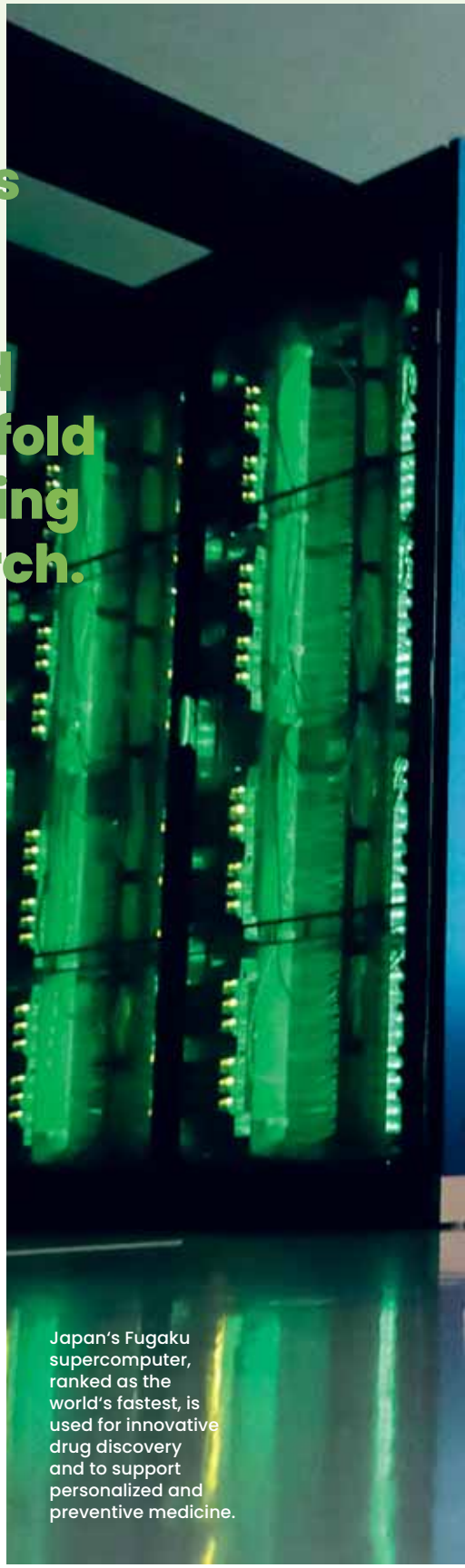
MASS DATA – INDIVIDUAL CARE

One of the most promising areas in healthcare is the use of big data to monitor the effectiveness of public health initiatives, improve understanding of the links between behavior and health outcomes, or even compare DNA data and anonymized health records to study the links between gene variants and disease.

Japan is one of the countries that is realigning its health system around the use of big data to help create more personalized care and move away from a "one size fits all" approach. The country recently passed legislation to allow the anonymizing of personal health data for public use – data is collected, anonymized and made available to organizations including in the private sector, where it is used to inform the development of new treatments and drugs.

"The body that collects the information collates it so you have a connected history of the person, and then anonymizes it for when it is provided to private sector companies, local governments or university research centers," says Kuroda. The information comes not just from medical bodies, but any organizations with health-related data. It is mainly sent from hospitals, but local governments also hold data, for example from health checkups.

Countries such as Finland and Estonia have led the way in using anonymized health data, with the latter establishing a voluntary "gene bank" now covering 5 percent of the population. But such initiatives are not free of controversy. "The Japanese government started collecting insurance claim data from about ten years ago, but at the beginning access was restricted," says Kuroda's colleague, Assistant Professor Genta



Japan's Fugaku supercomputer, ranked as the world's fastest, is used for innovative drug discovery and to support personalized and preventive medicine.

PHOTO: STR/JIJI PRESS/GETTY IMAGES

Japan is home to the world's oldest population, with 80,450 centenarians – a rise of 9,176 since 2019.

SOURCE: JAPANESE MINISTRY OF HEALTH AND WELFARE

An attendee at Ceatec Japan 2019 wears 3D glasses to try out the new Orbeye surgical microscope system.

Kato. "However, gradually they have changed their minds to accept private sector researchers." The legislation is subject to revision every three years. Acceptance of the policy is high among Japanese citizens as they can see the potential benefits. "Most of those coming into hospital want their data to be used for medical advancement," says Kuroda. "Importantly, people also have the right to opt out, but in our experience less than 1 percent want to. This says quite a lot."

What is crucial, however, is that the data is consistent, well-organized, detailed and universal, so it can be pooled with other datasets to offer far greater insights than those available from a single study. "This is what makes it precious," says Kato. "Other countries that want to use healthcare data to improve their healthcare need to make sure they gather it systematically and from universal coverage – then later generations can enjoy the fruits."

CHANGE OF DIRECTION

Many sectors have been transformed through new technologies, but the healthcare sector has generally, for a number of reasons, been relatively slow. "We are late in implementing some technologies because there are all sorts of regulatory barriers and issues around approval and reimbursement," says Claude Clément, President of BioAlps, an organization that works to support and represent the growing cluster of life sciences companies and institutions in western Switzerland. "Also, people in the field of health are intrinsically conservative, especially doctors – the mindset of the health industry is not naturally adapted to the changing world."

Clément believes, however, that there is enormous potential. A good example is the field of neuroscience. "We are really at the very beginning of trying to understand the brain and how it works," he says. With aging populations, Alzheimer's, Parkinson's and epilepsy are more prevalent than they were 50 years ago, yet while billions have been invested in seeking new drugs to tackle these diseases, little has come of it. "We need to go another way," says Clément. "While in the past we mainly relied on pharma, increasingly we are looking to med tech for solutions. That means looking at electricity, light, ultrasound."

As well as benefiting patients, this shift could also help to ease the burden of healthcare costs. "The cost of developing drugs is enormous, sometimes well over $1 billion. In some special cases, like rare diseases, the price charged can reach $1 million a year for treating a single patient. Should we develop such a drug, or should we focus on how to treat other unmet medical needs that have a big impact on society? These are fundamental questions," says Clément. "We need to find better healthcare solutions at a lower cost. We need to redirect our efforts

PHOTO: TOMOHIRO OHSUMI/GETTY IMAGES

Digital therapies support neurorehabilitation for stroke or Parkinson's patients. Mindmaze, a Swiss company, enables patients to practice movements with their healthy side, while giving the brain the illusion that the paralyzed side is moving.

toward affordable healthcare that is available more widely."

MAKING TECHNOLOGY MAKE A DIFFERENCE

Developments in smart health or digital health have wider implications. "Up to now we have always tried to keep health data private, between your doctor and you. Now we are trying to gather data to find trends and treatments using AI and big data. It is a collective approach, instead of the private approach we have had in the past," says Clément. "But the results will be more treatments that are better tailored to individual needs. In the future, new data technologies will lead us to pursue personalized medicine, but this will only be possible if we have first collected a mass of information. Diseases propagate everywhere in the world. Covid-19 is a good example. There are no continental or national borders. So, we need to think in a different way."

CALL TO IMPACT

1 Food companies should put more effort into encouraging consumers to eat fruit, vegetables and whole grains, for example by making these more affordable.

2 Governments must find ways to alleviate privacy concerns around the collection of mass data as this will enable the development of more personalized treatments.

3 New technologies should be used to develop affordable healthcare that is widely available, not to develop solutions that are only accessible to those who can afford them.

Some progress is being made in this direction with global initiatives working to remove the obstacles to data sharing across borders. Among them are the International Rare Diseases Research Collaboration, the Global Alliance for Genomics and Health, and Neurodata Without Borders. Research into the brain is one area where global collaboration on sharing data and infrastructure has great potential.

For Clément, this new approach could bring huge benefits not just to patients in developed countries but around the world. "The approach we have today is very selfish. You treat yourself, your own disease, by going to your personal doctor. Individual treatment like this is reserved for rich countries. But disease does not only affect the wealthy," he says. "We should focus on what the population needs. If our technological dreams are not in line with this, we should not develop them." ■

PHOTO: MINDMAZE

NEW TECHNOLOGIES in healthcare augment body functions, sense and track vital signs, support complex surgical interventions, and inform and educate patients. They promise to empower patients and healthcare workers alike, improving and prolonging life for millions and alleviating the economic and organizational burdens on creaking healthcare systems. The medtech industry is going from strength to strength, but many technological, regulatory and commercial challenges still need to be resolved to pave the way to a healthier future.

1. CARE WHEREVER

The remote delivery of health-related services has proven its relevance during the Covid-19 pandemic. From the provision of medical information and patient education to the complex remote rehabilitation of stroke patients through gamification, telehealth answers new and growing consumer demands and expectations in the healthcare sector.

While it reduces the need for in-person consultation, information and treatment can be distributed conveniently and efficiently to a broader patient base.

The growing industry still needs to answer questions regarding reimbursement, patient privacy, legal issues and digital equality.

2. LITTLE HELPERS

The health wearables market is booming. Innovative hearing aids use AI, track brain and body activity, and even analyze social interactivity – essential for mental health and overall wellbeing. They are also now nearly invisible, improving patient experience.

Acceptance is important and aesthetics play a decisive role in the success of wearables. Patients do not want to be reminded that they are ill.

The industry still needs to tackle data security issues and technical challenges such as battery life, miniaturization and radio and antennae integration in typically small, light and ergonomically sound devices.

3. THE ROBOT WILL SEE YOU

Robots have helped medical teams for decades. Today robots routinely assist in a variety of surgical interventions, including urological and heart operations. The industry is growing and allows for ever greater precision and efficiency.

Although technology is making great strides and an increasing number of patients are prepared to let robots carry out operations on them, many are still hesitant about trusting their lives to an automated machine.

As robots in healthcare become more widespread, trust will grow. But it must not be forgotten that machines can make mistakes so human supervision will still be required.

TECHNOLOGIES TRANSFORMING HEALTHCARE

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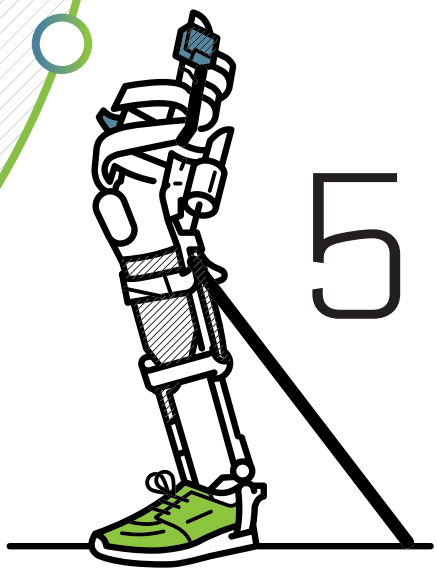

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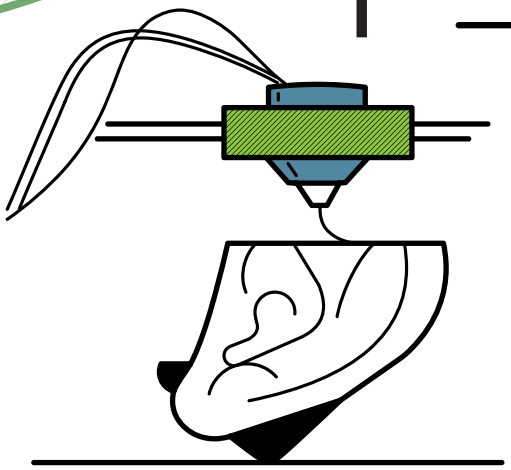

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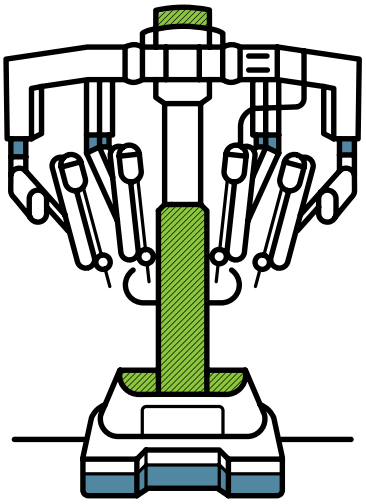


4. PRINT ON DEMAND

3D-printing technology has the potential to help overcome a global shortage of donor organs. Scientists recently presented the first 3D-printed heart. In the future we may be able to print a complete spare-part warehouse of organs and provide them in large quantities on an economically viable basis.

A widespread roll-out of the technology would save millions of peoples' lives. 3D-printed tissue also plays an important role in pharmaceutical research. Even functional cancer cells can be printed for the development of new cancer treatments.

The sector is making huge strides, but the technological hurdles in developing complex organs are still significant.

5. LIFTING THE BURDEN

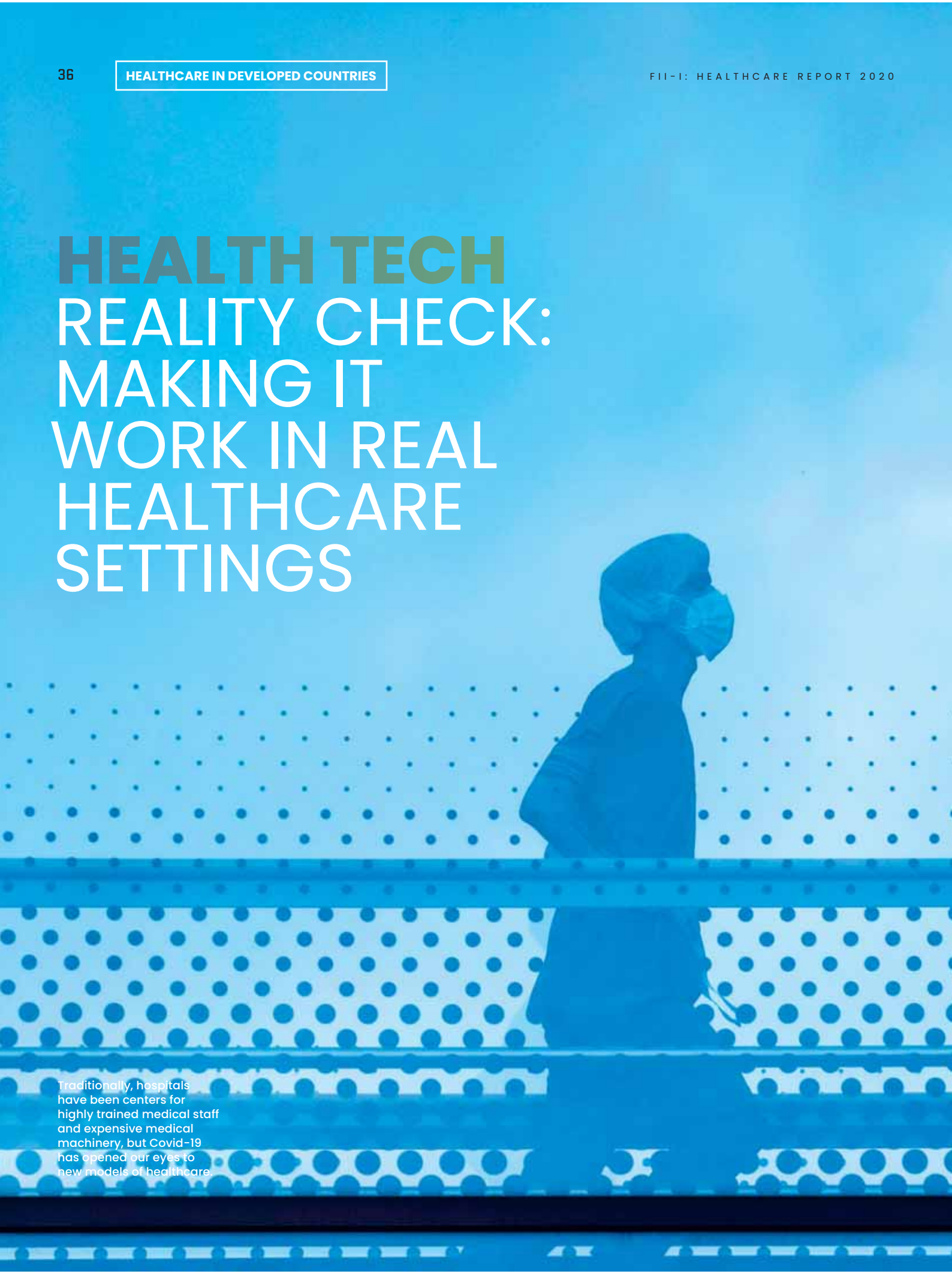
Exoskeletons primarily substitute or augment lost or impaired limb motion in patients. They play an increasingly important role in rehabilitating patients who have lost their mobility due to injury, and get them back on their feet quicker. They can also lighten the burden for people suffering from neurophysical conditions such as cerebral palsy.

In the future, exoskeletons may help nurses lift patients, support surgeons during exhausting operations, and keep people safer and healthier at work for longer. The human, societal and economic impact in an aging world would be significant.

But first, exoskeletons will have to become softer, smaller, more discreet and more personalized. And prices per unit need to drop.

ILLUSTRATION: EVA REVOLVER

HEALTH TECH REALITY CHECK: MAKING IT WORK IN REAL HEALTHCARE SETTINGS



Traditionally, hospitals have been centers for highly trained medical staff and expensive medical machinery, but Covid-19 has opened our eyes to new models of healthcare.

PHOTO: ODD ANDERSEN/GETTY IMAGES

WHAT IS IT that we like about hospitals? We have been putting sick people together in one building since the days of ancient Greece. And hospitals were the testing grounds for 20th-century medical advances, such as X-rays, insulin and antibiotics. But let's consider some of the compelling arguments against them.

Hospitals can be hard to get to, especially for those most disadvantaged. And they kill people. Burnout, which has been found in a survey to affect up to half of all doctors in Germany, Spain, Portugal, the UK and US, is a major cause of medical errors. Wards and operating theaters are also breeding grounds for deadly "superbugs".

Once a hospital has been built, it must be filled with patients to be economically viable, even in publicly funded healthcare systems. So hospitals provide an incentive for unnecessary treatment and a disincentive for upstream preventive healthcare. Despite these facts, hospitals remain the bedrock of the world's healthcare systems.

Traditional hospitals were centers for expensive machines and hard-to-acquire medical specialisms, but the logic of today's fast evolving, data-enabled technologies means that medicine will increasingly move away from dedicated buildings and towards patients.

HOSPITAL AT HOME

Niels van Namen, global healthcare leader of Swiss-based CEVA Logistics, points out that a tsunami of medical innovation has hit the developed world in the last two decades. Cell and gene therapies support targeted, precision medicine; drugs are becoming smarter. Meanwhile, AI has accelerated diagnosis, and technologies such as drones, virtual reality, robotics and 3D printing are increasingly being used for medical applications.

To these factors should be added the communication revolution of both smartphones and wearable sensors and medication systems, connected by ↘

the "internet of healthy things". For many people, van Namen argues, digital connectivity could remove the need for human contact in healthcare. And yet, in the "advanced" medical systems of most OECD countries, we still travel miles to a hospital for a routine test. It makes no sense.

There would still be hospitals, in van Namen's ideal world, but they would be used only for pediatrics, intensive care, surgery and imaging. They would be complemented by agile, mobile health centers, which would also deliver some acute care. For the majority of people, including some with acute conditions, there would be no need to go to the hospital anymore – they would receive most of their care in their own homes.

SLOW PACE OF CHANGE

Driven by hospital-based investment, the cost of healthcare is rising. On average, since 2013, annual per capita health spending across the OECD has grown by 2.4 percent. In the US it has increased sixfold over the last four decades, from $1,832 per capita in 1970 to $11,172 in 2018.

Van Namen argues that a home-based healthcare system could be up to ten times cheaper than one delivered from traditional hospitals with their high fixed costs. The short-term cycles of political decision-making are the factor that leads, paradoxically, to inflexible, long-term investment in hospitals.

Admittedly, some progress has been made. Germany has recently passed the world's first legislation allowing doctors to prescribe health apps. We have pills containing microchips and smart watches that can monitor heart rate to a diagnostic standard using highly accurate electrocardiogram (ECG) trackers. But we have a long way to go. The US Food and Drug Administration has only recently approved wearable medical devices.

Dr. Greg Parston is a visiting professor at the Institute of Global Health Innovation, based at Imperial College, London. He notes that, before Covid-19, the average implementation period between an innovation's arrival and its application in medical settings was commonly cited as 17 years. One problem, he says, is the time required by clinical trials: "It can be argued that they take far too long – we already have the next innovation before we've completed the last trial."

ADOPTING INNOVATION FASTER

A study by Parston for the World Innovation Summit for Health looked at factors which slow down the adoption of medical innovation. Its international case studies included programs to promote road safety, vitamin use and vaccination

> **"In the future we'll be ready to deliver more flexible care."**

RACHEL DUNSCOMBE

CEO, NHS Digital Academy, UK

qXR is a chest X-ray screening tool developed by Mumbai start-up Qure.ai. It uses deep learning to automate and speed up the process.

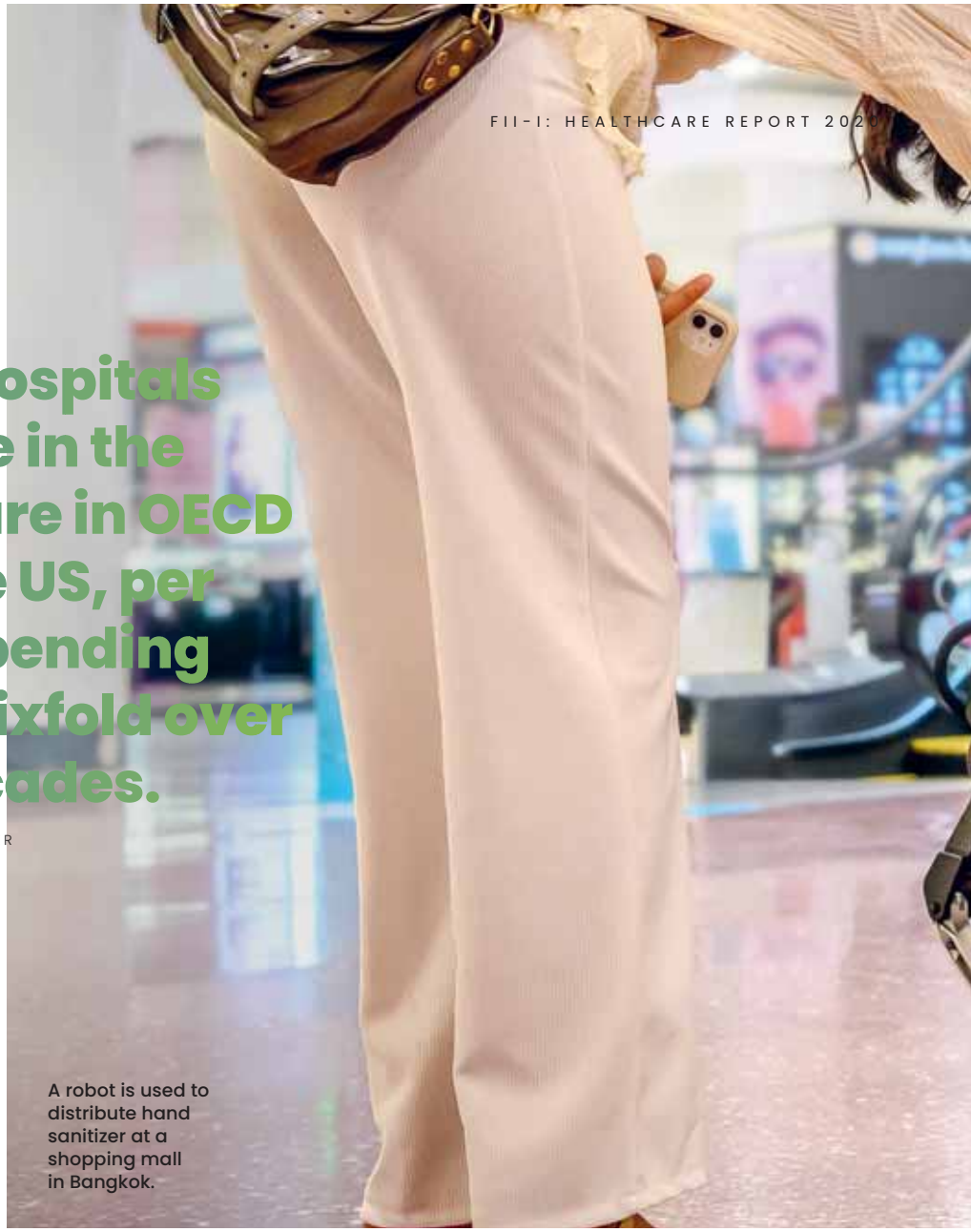
PHOTO: QURE.AI, PRIVAT

and to diagnose infant HIV; a health insurance system; and the adoption of digital imaging for X-rays. The main factors slowing innovation, it found, were clinical bias, delays in the publication of research findings, and resistance to change.

"One issue is that the clinical leadership in most institutions is old men. If you begin focusing on younger clinicians, I think you'll find a quicker pace of change," says Parston. "Also, doctors are taught to doubt. That is an important part of diagnosis. And doubt plays a big role in their suspicion of new ways of working."

Rachel Dunscombe is CEO of the National Health Service's (NHS) Digital Academy in the UK and a member of a small group of professionals advising the UK government on digital technology. As Arch Collaborative lead for research company KLAS on refining electronic health records, she is in a good position to assess what has slowed down the digital healthcare revolution. "It's not skills. The digital professionals in healthcare are in many cases where they need to be," she says. "In the UK, procurement has been a drag factor, but we are starting to improve that with new dynamic frameworks." It is also not the tech industry's lack of willingness. The main problem, says Dunscombe, is the legacy IT systems that lock in data and cannot talk to each other. "The average organization has something like 700 different systems," she says.

Parston identified four key factors needed to speed up change: vision and strategy, a specific agency to promote diffusion, dedicated funding, and ↘



A robot is used to distribute hand sanitizer at a shopping mall in Bangkok.

Investment in hospitals has driven a rise in the cost of healthcare in OECD countries. In the US, per capita health spending has increased sixfold over the last four decades.

SOURCE: PETERSON KFF HEALTH SYSTEM TRACKER

effective communication. When all are in place, the results can be impressive.

MORE SMART ROUTING, LESS FACE-TO-FACE

The NHS has invested in technology through its high-tech offshoot, NHSx, its Digital Academy and the NHS Innovation Accelerator. The government has devoted almost $6.5 billion to its digitization strategy in the last five years. The NHS data-sharing platform, The Spine, is used daily by half a million healthcare professionals, supporting up to 47 million transactions. But this investment is dwarfed in the US where, last year alone, private investors poured more than $8 billion dollars into digital healthcare start-ups.

The hospitals of the future, predicts Dunscombe, will be supplemented by high-tech clinical back offices that will receive and aggregate data from multiple sources, enable personalized medicine, and deploy human resources as required – whether a nurse, a social worker or health coach. It has been called an Opodo model of healthcare.

Central to this vision of integrated care are "smart routing tools" and "clinical field force management". Healthcare is ultimately about logistics – getting the right service to the person at the right time, enabled by the right data. The growing number of digitally enabled patients will rarely require face-to-face contact. Those who do need it will get it. How long before this vision arrives? Thirty years to fully realize, Dunscombe anticipates.

What about data confidentiality? Concern about it has been a major drag on health-tech adoption. The need, says Dunscombe, is for secure, audited, encrypted data that can only be used for the purpose of direct care, unless other use is consented. The answer? Distributed ledger systems, like blockchain. In Estonia, 1.3 million citizens have the holy grail of a "single unified identifier" and a distributed record. They can all access their medical records online. They also use the system for voting and shopping.

PANDEMIC'S POSITIVE IMPACT

The Covid-19 pandemic will have a lasting legacy for healthcare. In the US, for example, healthcare providers rapidly scaled telehealth offerings, seeing 50 to 175 times the number of patients compared to pre-Covid. Dunscombe estimates that it has accelerated technical evolution in some parts of the UK healthcare system by up to a decade.

In some cases, technologies previously regarded as improbable ideas have moved straight to implementation. During the lockdown, for example, it is estimated that up to 93 percent of GP consultations were carried out virtually. The NHS in Bolton worked at great speed with Mumbai-based medical tech company Qure.ai to implement an AI-based system to scan X-rays for Covid-19 symptoms.

PHOTO: MLADEN ANTONOV/AFP VIA GETTY IMAGES

It functions thousands of times more quickly than human eyes.

Other examples include 3D printing used to mass produce screens for personal protective equipment (PPE), head-mounted cameras allowing senior surgeons to supervise operations, and US military robots, used at three NHS sites, to minimize physical contact with highly infectious patients.

There are an estimated 2 million new medical studies a year and medical knowledge doubles every two months. Ideas and innovations proliferate more quickly than any human could possibly keep up with. But, although human and technical factors may be holding us back, the pandemic has significantly accelerated both technology and its adoption. The New York-based Macy Foundation is set to bring together academics and clinicians to learn lessons for medical training, as it did after World War Two. And the US Defense Advanced Research Projects Agency (DARPA), begun in the Cold War to accelerate US space and defense technology and with a $3.4 billion annual budget, is researching technical and clinical solutions.

"Look at the speed with which we built the Nightingale Hospital in London for Covid-19 patients. It was set up in nine days. The pairing of military-style governance and decision-making with the best of the NHS and technology was incredible," says Dunscombe. "Add to that the ability to communicate digitally with every citizen, and in the future we'll be ready to deliver more flexible care when the next crisis hits." ■

CALL TO IMPACT

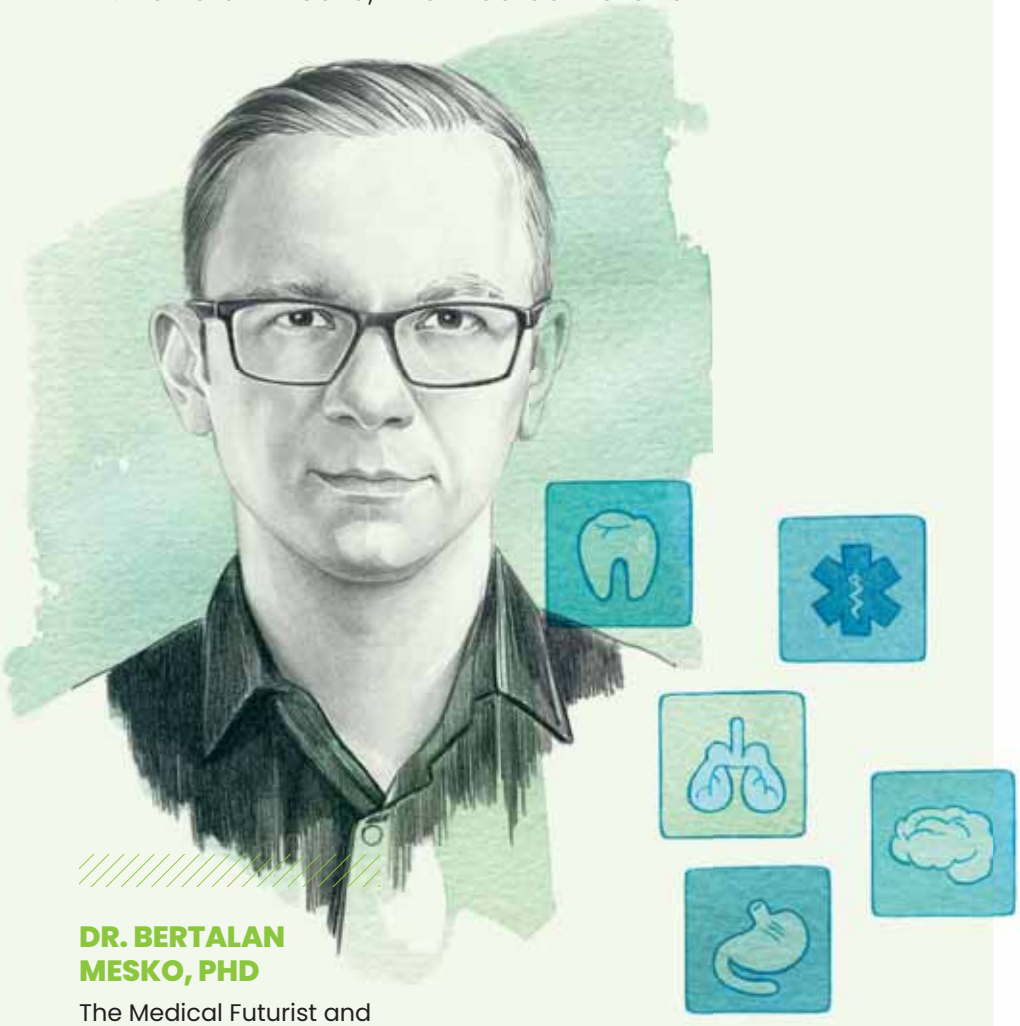
1 To speed up the adoption of innovations, healthcare systems must have a vision and strategy, an agency to promote diffusion, dedicated funding and effective communication.

2 Legacy IT systems that lock in data and cannot talk to each other are one of the biggest obstacles that must be overcome.

3 Covid-19 has shown that technologies that previously had the status of improbable ideas can be moved straight to implementation if the will is there.

PREPARING FOR THE FUTURE OF HEALTHCARE

Dr. Bertalan Meskó, The Medical Futurist



DR. BERTALAN MESKO, PHD

The Medical Futurist and **Director of The Medical Futurist Institute** analyzes how science fiction technologies can become reality in medicine and healthcare. A physician with a **PhD in genomics**, he has given courses at **Harvard, Stanford and Yale universities**, as well as at the Singularity University. He is one of the top voices globally on healthcare technology.

Find out more: www.medicalfuturist.com

John wakes up in his apartment in 2031 and grabs his tiny, artificial intelligence-based chatbot device. He takes it everywhere with him all day long as it has access to all his data, habits and digital channels. It wakes John up from light sleep in the morning with a smart alarm that ensures he feels energized for the day. His breakfast is chosen from a database that matches his microbiome and genome sequencing results with the best kind of food to keep him healthy. It notifies him when any of his major health parameters or vital signs change and compares the results to millions of medical studies and the expertise of medical professionals available in the cloud. If there is anything John has to do, he receives clear instructions, with gamification to help him stick to the solution. He is being taken care of while not even noticing it.

HEALTHCARE IS FACING unprecedented challenges: a growing number of patients with chronic conditions; a global shortage of healthcare workers – 5 million and rising; physician burnout; and the financial discrepancies of care. The revolution in technologies, access to them, and information and the general concept of the Internet, have deepened these challenges in the 21st century.

The major consequence of these is the ivory tower of medicine breaking down. Information, knowledge, studies and technologies had only been accessible within the ivory tower, only medical professionals were granted access. With the expansion of the Internet, patients have started to get access too. Open access studies, technologies available from a distance without a middleman, knowledge shared on curated social networks – all have led to patient empowerment.

Empowered or e-patients are stepping up, sharing their insights and looking for those of fellow patients, measuring data, keeping track of their condition and becoming engaged in their care. Working with them requires a different skillset,

experience with working with advanced technologies and judgment about how to implement technologies into everyday care.

The role of every stakeholder in healthcare is shifting too. Medical professionals are not keyholders to the ivory tower but guides for patients through the jungle of health and digital information. Policymakers have to act faster when regulating new technologies. Providers need to analyze huge datasets to constantly improve the efficacy, safety and cost-efficiency of care. Researchers are turning towards data measured by and obtained from the sensors and smartphone apps patients use.

Digital health technologies that change the doctor-patient relationship and the basics of healthcare facilitate these transitions. Healthcare in the 21st century is open to data and information generated by patients. It is global thanks to access to technologies and remote care provided by companies in other countries and systems, and is centered around the patient and their medical team.

The point-of-care is shifting from facilities to wherever the patient is. If patients are the point-of-care, diagnostics and treatments can be offered from a distance; patients can be involved in their care, releasing the burden on medical professionals; waiting times and costs can be reduced while improving patient satisfaction and the main features of good quality care: personalized, accessible, affordable, preventive and humanistic.

For a seamless transition that benefits patients, it is important to prepare the healthcare workforce, patients and policymakers. The most essential concept here is "patient design", which means empowered patients are invited to the top decision-making level of organizations and involved in designing processes, products and technologies for them from the first step.

A reshaped medical curriculum is needed to prepare medical professionals for the use of advanced technologies and working with empowered patients. Studies have highlighted the problem of physician burnout worldwide. Unmanageable technological challenges are among the major causes. The future generation of physicians must be trained differently. Guidelines such as the Digital Health Playbook released by the American Medical Association provide key steps, best practices and resources to accelerate the adoption and scale of digital health solutions.

Patients will become active in managing their condition, rather than passive recipients of care. Data from health sensors, wearables and health apps will help to analyze and predict trends in the health of individuals and populations. But only if physicians act as guiding partners.

Patient engagement and chronic disease management are connected in three ways: preventing and detecting the condition; managing the condition with the provider; and self-management. To empower patients to take care of their illnesses themselves, providers need to employ digital health in both the technological and cultural sense. Medical school curricula should emphasize this besides health and prevention, rather than only diseases and pathology, and medical students must prepare for predictive and proactive working environments.

Finally, policy makers need help in creating better regulations for these advanced technologies by involving the communities that create them. A good example is the #wearenotwaiting Twitter movement for patients suffering from diabetes. The initiator of the community, Dana Lewis, and her husband built a so-called artificial pancreas at home and spread the blueprints and knowhow on Twitter to other diabetes patients. She had been using the device for almost two years by the time the US Food and Drug Administration finally approved it.

We must ensure that the expansion of digital health is not the cause of more social health inequalities. Investigating the social implications and consequences of digitalization is ever more important. Higher age and lower income, lower education, living alone, and living in rural areas have been associated with lower digital health use. Suggested solutions include personalized social support, use of different types of Internet services to deliver digital health technologies, and the involvement of patients in the development of digital health interventions.

Only with this preparation will it be possible to protect the privacy of patients in technology-filled healthcare and avoid ethical issues that would hinder the adoption of digital health.

There are many challenges, but when I look at the global movement of empowered patients, the enthusiasm of some medical professionals and the policies implemented by governments such as those of Denmark or New Zealand, I have no doubt that digital health can finally bring healthcare into the 21st century. ■

> "I have no doubt that digital health can finally bring healthcare into the 21st century."

CALL TO IMPACT

1. Patients must be given a key role in designing healthcare processes, products and technologies.
2. Physicians must be trained to work predictively and proactively, focusing on health and prevention as well as diseases and pathology.
3. Policies must be developed to ensure the benefits of digital healthcare are accessed by individuals across society.

ILLUSTRATION: ULI KNÖRZER

CONTENTS OF THIS STUDY

44-45 **Country ranking** 46-47 **Performance** 48-49 **Optimization**

HEALTHCARE INVESTMENT PAYS OFF A BENCHMARK STUDY OF HEALTHCARE SYSTEMS

IN 2020, healthcare systems around the world have been subject not only to new pressures but also to intense scrutiny, revealing gaps and deficiencies everywhere. At the same time, communities have drawn on deep reserves of resilience and ingenuity to address the challenges. Once the Covid-19 pandemic is behind us, how will healthcare systems have been transformed? To track these developments, the FII-I is launching an annual benchmark study.

Now is the time to invest in healthcare. Do it right, and we will not only be better prepared for another pandemic, but will also build more robust systems that deliver better outcomes for everyone.

AIMS OF THE STUDY

The study covers 35 countries, representing every region of the world and a broad spread in terms of population size and media coverage of their handling of the Covid-19 pandemic. Based on an expert survey and publicly available data, its aim is fourfold:

- **UNDERSTAND** the differences among diverse healthcare systems
- **RANK** countries based on their healthcare system quality
- **IDENTIFY** performance drivers and risk factors
- **DERIVE** tailored optimization levers

KEY FINDINGS

1 An additional 5 percent of GDP invested in healthcare could potentially increase average healthy life expectancy in developing countries by roughly 9 years.

2 The use of AI and robotics in healthcare has the potential to increase investment efficiency by up to 20 percent.

3 Signs of wealth and a successful healthcare system in "normal times" appear to be a risk factor during pandemics.

4 Regardless of their healthcare system setup, countries worldwide should focus their future initiatives heavily on preventive measures.

THE RANKING

THIS FIRST STUDY compares healthcare systems in 35 countries. More countries will be added in future issues. While the ranking supports the common opinion that developed and transition countries have a higher healthcare system quality than developing countries, it also delivers some surprises. For example, given recent media coverage of the Covid-19 pandemic, one might not expect Spain, the UK and Italy to achieve leading ranking positions. Another surprise is that some countries reveal a variance in their performance with regard to structure, process and outcome. Clearly, other factors outside the healthcare system, such as lifestyle, also play a role in the overall outcome.

METHODOLOGY

Overall ranking is based on a weighted average of individual indicators. A wide range of indicators was taken into consideration, grouped into three clusters: structure, process and outcome.

This approach is based on Avedis Donabedian's framework for evaluating the quality of health services.

INDICATOR WEIGHTING

STRUCTURE: 8 INDICATORS – E.G. HEALTH EXPENDITURE — 25%

PROCESS: 5 INDICATORS – E.G. IMMUNIZATION COVERAGE — 25%

OUTCOME: 10 INDICATORS – E.G. HEALTHY LIFE EXPECTANCY — 50%

You can find more details on the methodology here: **impact.fii-institute.org/methodology/**

RANKING HEALTHCARE SYSTEMS IN 35 COUNTRIES

AVERAGE RANK FOR DEVELOPED/ TRANSITION COUNTRIES

AVERAGE RANK FOR DEVELOPING COUNTRIES

1 AUSTRALIA	19 COLOMBIA
2 SPAIN	20 THAILAND
3 JAPAN	21 BRAZIL
4 UNITED KINGDOM	22 VIETNAM
5 ITALY	23 RUSSIA
6 KOREA, SOUTH	24 BANGLADESH
7 NEW ZEALAND	25 EGYPT
8 FRANCE	26 INDONESIA
9 GERMANY	27 PHILIPPINES
10 BAHRAIN	28 KENYA
11 UNITED ARAB EMIRATES	29 INDIA
12 UNITED STATES	30 SENEGAL
13 OMAN	31 PAKISTAN
14 SAUDI ARABIA	32 SOUTH AFRICA
15 KUWAIT	33 ETHOPIA
16 TURKEY	34 CONGO, DEM. REP.
17 CHINA	35 NIGERIA
18 MEXICO	

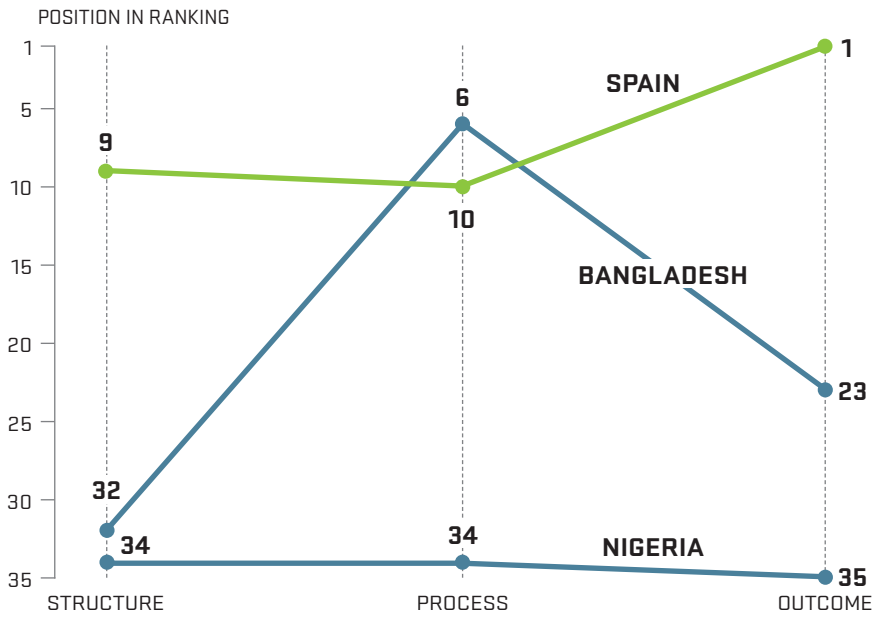
DEVELOPED/ TRANSITION COUNTRIES

DEVELOPING COUNTRIES

THE RELATIONSHIP BETWEEN STRUCTURE, PROCESS AND OUTCOME IN HEALTHCARE

The ranking per indicator cluster shows that structure, process and outcome are interdependent. Countries with a high ranking for one generally have a high ranking for the other two. However, for some countries the rankings vary significantly. For example, Bangladesh's high ranking for process contrasts strongly with its rankings for structure and outcome. This is driven mainly by its high immunization coverage.

In many cases, the ranking shows that other factors, such as lifestyle, also drive healthcare outcomes.



PERFORMANCE
IDENTIFYING SIGNIFICANT DRIVERS

CORRELATION BETWEEN INPUTS AND OUTPUT

In the next step, key drivers of healthcare system quality are identified using statistical correlation between inputs and output (healthy life expectancy).

A coefficient of **0** in this context implies no correlation in the direction the two variables move; a coefficient of **1** means perfect correlation.

In terms of inputs, of all the structure and process indicators analyzed, capacity and financial investment inputs are the most significant drivers of healthy life expectancy, with correlation coefficients greater than 0.7.

This result is reflected in the ranking. Most countries that invest relatively heavily in their healthcare systems achieve a relatively high ranking.

DRIVER 1: CAPACITY INVESTMENT

MEDICAL DOCTORS
PER 10,000 POPULATION

NURSING AND MIDWIFERY PERSONNEL
PER 10,000 POPULATION

DRIVER 2: FINANCIAL INVESTMENT

DOMESTIC GENERAL GOVERNMENT HEALTH EXPENDITURE
AS PERCENTAGE OF TOTAL CURRENT HEALTH EXPENDITURE

CURRENT HEALTH EXPENDITURE
AS PERCENTAGE OF GDP

0 NO CORRELATION **1** PERFECT POSITIVE CORRELATION

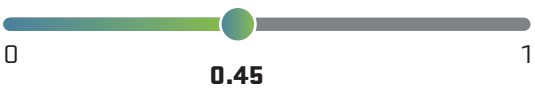
OVERALL PERFORMANCE VS. PANDEMIC PERFORMANCE

High-quality healthcare systems have not fared as well as expected in the pandemic. The statistical correlation analysis reveals why.

Signs of wealth and prosperity, such as international connectedness and a generally well-functioning healthcare system with high healthy life expectancy, seem to correlate at least to some extent with Covid-19 death figures. Factors that are normally desirable are a risk in pandemics – an older population is more vulnerable to disease, and international connectedness eases the spread.

SLIGHTLY POSITIVE CORRELATION
IN GENERAL, THE OLDER THE POPULATION, THE HIGHER THE COVID-19 DEATH RATE.

HEALTHY LIFE EXPECTANCY
AND NORMALIZED DEATH RATE



STRONG POSITIVE CORRELATION
INTERNATIONAL CONNECTEDNESS IS A KEY DRIVER OF COVID-19 DEATH RATES.

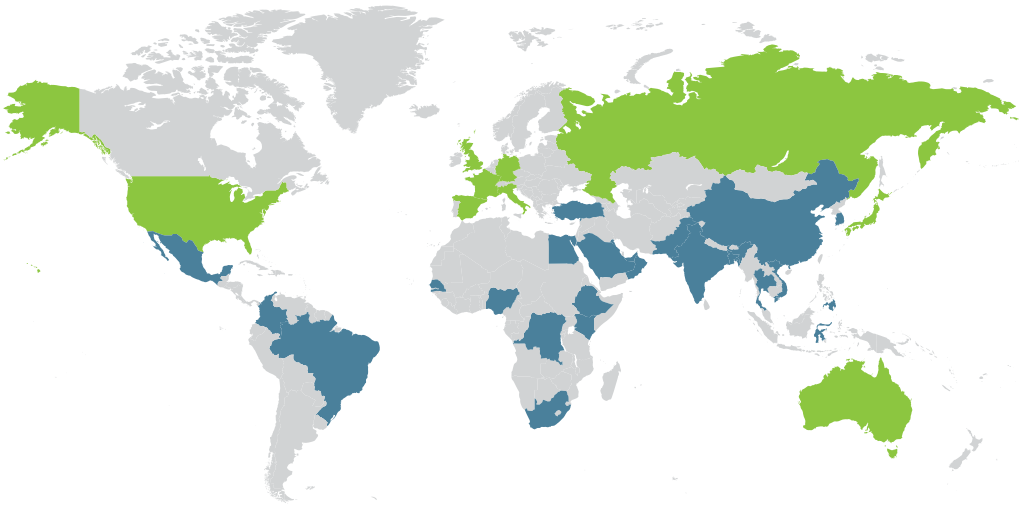
INTERNATIONAL CONNECTEDNESS
AND NORMALIZED DEATH RATE

0 NO CORRELATION **1** PERFECT POSITIVE CORRELATION

PERFORMANCE DIFFERENCES IN COUNTRY CLUSTERS

IN ORDER TO make tailored recommendations for improvements, the findings were aggregated on a country-cluster level, based on the respective state of economic development. The groupings are in line with those defined by the UN, which differentiates between developed and transition countries and developing countries. A benchmarking of the two country clusters shows strong differences between them with regard to input into healthcare systems and average life expectancy.

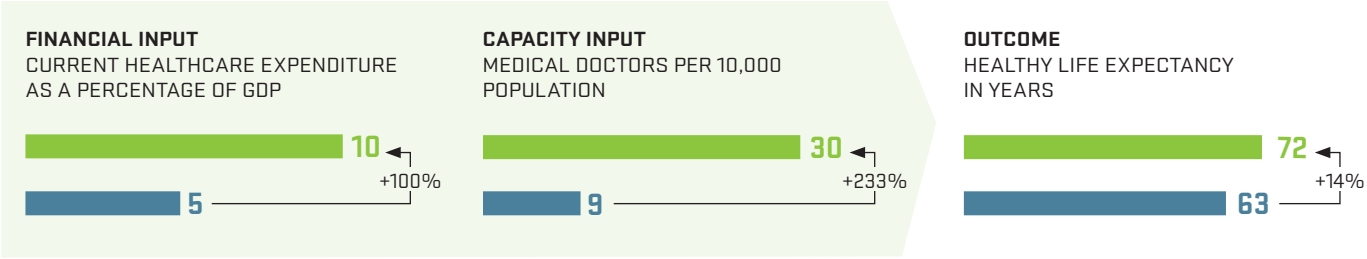
GLOBAL COUNTRY CLUSTERS BASED ON STATE OF ECONOMIC DEVELOPMENT



- DEVELOPED/TRANSITION COUNTRIES
- DEVELOPING COUNTRIES

HEALTHCARE SYSTEMS INPUTS AND OUTPUT BY COUNTRY CLUSTER

Developed and transition countries achieved comparably high average healthy life expectancy scores, supporting the impression from the correlation analysis that financial and capacity input are significant drivers. However, it becomes evident that additional input does not lead to a proportionally strong increase in output.



- DEVELOPED/TRANSITION COUNTRIES
- DEVELOPING COUNTRIES

ILLUSTRATION: GETTY IMAGES

OPTIMIZATION MARGINAL VALUE OF ADDITIONAL INVESTMENTS

DATA ANALYSIS shows that the marginal value of additional investment is negligible for developed and transition countries, whereas for developing countries there is still upward potential.

Developed and transition countries are already at the upper end of the scale in terms of both inputs and outcomes, so increasing capacity or financial input would not significantly improve healthy life expectancy.

However, for developing countries, increasing capacity and financial investment promises a significant increase in healthy life expectancy. Taking into account the positive correlation between health expenditure and healthy life expectancy, based on the analyzed data points, increasing the level of health expenditure as a percentage of GDP by around 5 percent for developing countries could potentially result in an extension of healthy life of approximately 9 years.

AI INCREASES EFFICIENCY OF HEALTHCARE INVESTMENT BY UP TO 20 PERCENT

Additional health expenditure as a percentage of GDP is strongly correlated with the number of medical doctors per 10,000 population, as financial input is, to a significant extent, allocated to medical personnel.

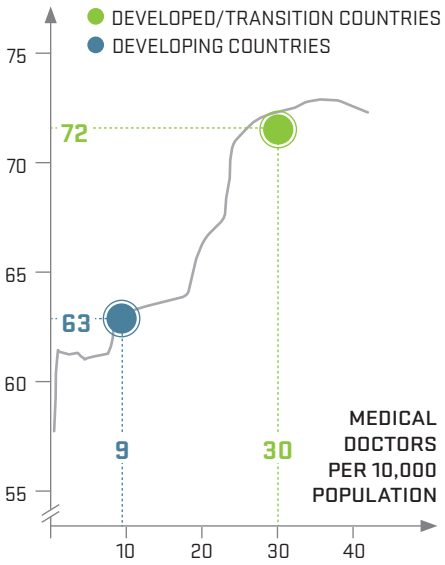
However, according to a survey of experts, up to 20 percent of the work of doctors could be substituted by AI and/or robotics by 2025. As a consequence, AI has the potential to significantly increase the efficiency of financial investment in healthcare.

VALUE OF ADDITIONAL INPUT INTO HEALTHCARE SYSTEMS – POSITIVE EFFECT WITH DECREASING MARGINAL BENEFIT

Data analysis suggests that increasing the number of medical doctors and the amount of health expenditure has a positive effect on healthy life expectancy. However, the marginal value of additional input decreases beyond approximately 25 doctors per 10,000 population or health expenditure of 10 percent of GDP. Below that level – where most developing countries lie – additional input creates significant marginal value.

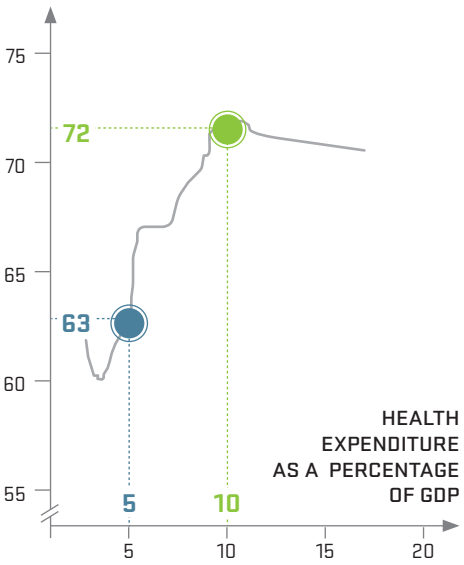
DRIVER 1

HEALTHY LIFE EXPECTANCY IN YEARS



DRIVER 2

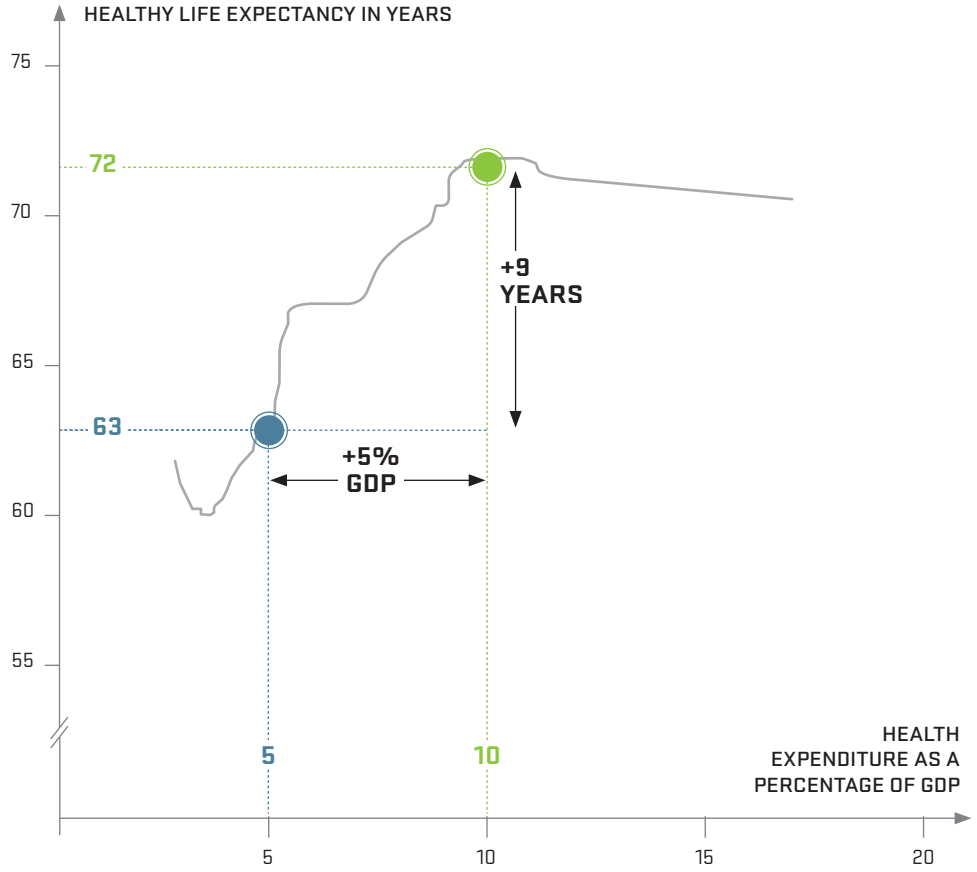
HEALTHY LIFE EXPECTANCY IN YEARS



VALUE OF ADDITIONAL FINANCIAL INVESTMENT IN DEVELOPING COUNTRIES

+5% GDP invested in healthcare

+9 years healthy life expectancy



- DEVELOPED/TRANSITION COUNTRIES
- DEVELOPING COUNTRIES

REGARDLESS OF THE CLUSTER THEY FALL IN, COUNTRIES WORLDWIDE SHOULD FOCUS THEIR FUTURE INITIATIVES HEAVILY ON PREVENTIVE MEASURES

DRIVERS OF HEALTH

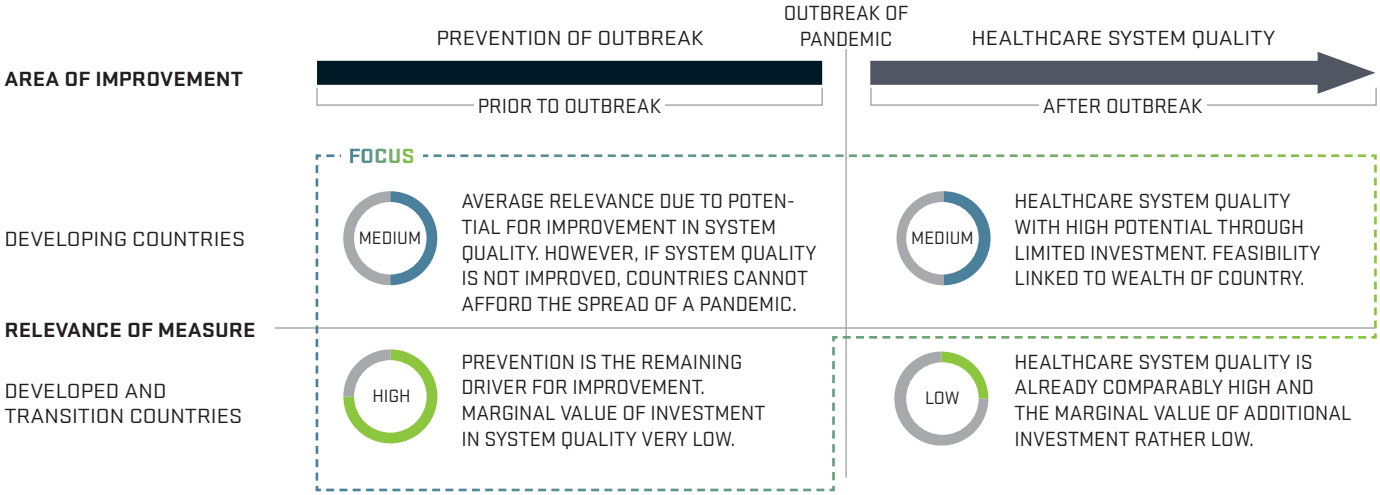


PHOTO: GILLES SABRIE

AS COVID-19 CONTINUES ...

to take its toll on our heath and economies, and a question mark still hangs over the efficacy of a potential vaccine, it has become clear to the world **that there is no quick fix** to the spread of infectious diseases and that their impact should not be underestimated.

We all of us now know that an essential tool in combatting pandemics is preparedness – something the experts had been advising for years. The message has finally hit home. This means we need to start now to anticipate future threats beyond Covid-19, and to take advantage of what have we learned in 2020 about how best to protect ourselves.

The next public health threat could be a new pathogen, a mutation of an existing one or one that has acquired resistance to treatment due to antibiotic overuse. **We have to be prepared for many different scenarios.**

Our salvation is technology. Whether we use it to accelerate vaccine development or take advantage of machine learning to better predict potential health threats, it gives us the opportunity to build resilience. Being better prepared means being smarter about the way we leverage the information technology provides. Debates around test and trace apps have taught us that we need to build confidence around big data so that citizens trust governments with their personal information. **We live in a data age. It is time to create a data governance framework to make sure it is always managed in an ethical manner.**

Covid-19 has taught us a lot, we need to ensure that the lessons learned are put to good use. ■

PREVENTION TRUMPS CURE

NEW TECHNOLOGIES AND LESSONS LEARNED COULD HELP US CONTAIN THE SPREAD OF INFECTIOUS DISEASE MORE EFFECTIVELY. BUT WHAT IF WE COULD PREVENT OUTBREAKS? ALTOGETHER?

Rapid urbanization, overcrowding and climate change are drivers of disease that must be addressed to prevent future outbreaks.

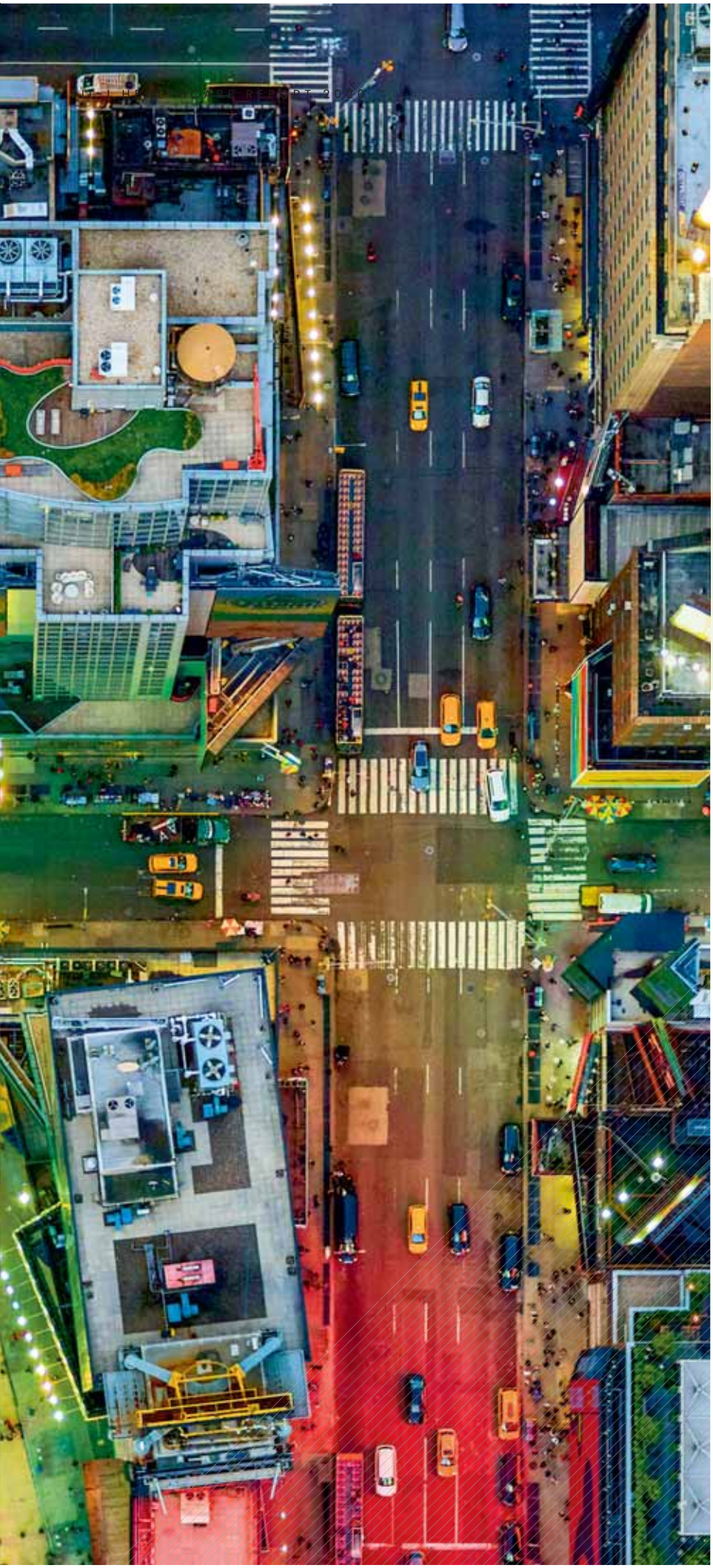


PHOTO: JEFFREY MILSTEIN

PUBLIC HEALTH EXPERTS had been warning for years that a new pandemic was long overdue, but when Covid-19 finally arrived it still found most governments unprepared. This global outbreak, if nothing else, will have focused minds on how best to prevent the next one.

One of the basic elements is deciding which diseases to focus on. The World Health Organization (WHO) maintains a list of priority diseases for research and development. There is a vast number of potential pathogens but only limited resources, so the list includes only those thought to pose the greatest potential public health threat, whether through their epidemic potential or the fact that there are still few countermeasures in place. Beside Covid-19, it currently includes SARS, MERS, Ebola, Lassa fever and Rift Valley fever.

With this list as its base, the WHO's R&D Blueprint is a global strategy and preparedness plan that provides a research roadmap and target product profiles for each disease. "The roadmaps identify key interventions, as well as important R&D gaps," says WHO spokesperson Christian Lindmeier. WHO regularly brings together experts ↘

↘ from a wide range of disciplines to revise which diseases need investment and more R&D. The experts include microbiologists, clinical experts, epidemiologists, public health policy experts, veterinarians, anthropologists, bioethicists, and biological weapons experts, among others.

THE UNKNOWN THREAT

At the end of WHO's priority disease list sits Disease X. This represents the knowledge that a serious international epidemic could result from a pathogen currently unknown to cause human disease. It could be a new pathogen such as the coronavirus that causes Covid-19, a known pathogen that does not usually cause human disease epidemics, or one that is suddenly subject to a change in epidemiology or pathogenicity, like Zika.

"Although we have experienced a series of these threats, we cannot predict when or how Disease X will strike," says Lindmeier. "We need to be ready with basic capabilities for multidisciplinary research and product deployment in the affected countries so that they reach the populations who need them. Access considerations must always be at the heart of all R&D efforts."

Among the most effective tools to prevent an epidemic are vaccines. They bolster the body's immune system and help it fight disease. The problem is that each vaccine only works against a specific pathogen, and development takes years. This means that in the case of a previously unknown or a rapidly mutating virus like Disease X, producing a vaccine ahead of an outbreak or in its early stages has, up to now, been impossible.

Platform technologies could be the solution and are being deployed in the search for a vaccine for Covid-19. The Coalition for Epidemic Preparedness Innovation (CEPI) is leading these efforts. It was founded in 2017 to advance vaccines against both known threats and previously unknown pathogens. A platform technology uses the same basic components as a backbone and can be adapted for use against different pathogens. The new pathogen's

We must reassess our relationship with the animal world if we are to reduce the risk of exposure to new pathogens.

PHOTO: QILAI SHEN/PANOS PICTURES, PRIVAT

> **“Access considerations must always be at the heart of all R&D efforts.”**

CHRISTIAN LINDMEIER

WHO spokesperson

genetic or protein sequence is simply “slotted in” like a video game cartridge to produce the vaccine.

AI AGAINST RESISTANCE

Disease X also refers to pathogens that acquire resistance to treatment. Overuse of antibiotics and intensive farming methods have contributed to the growth in resistance, and it is now a significant global threat. A growing number of infections, from TB to pneumonia, are becoming harder to treat. Given the pace at which microbes are able to evolve, the number of infections resistant to almost any available antibiotic is going to grow. The UN’s Interagency Coordination Group on Antimicrobial Resistance has warned that the number of annual deaths as a result of drug-resistant infections could reach 10 million by 2050.

One tool that shows considerable promise for preventing drug-resistant outbreaks is AI. Databases containing the genomes from different strains of pathogen are growing, along with information about whether they were susceptible to antibiotics. Using this data, AI can allow scientists to identify the DNA sequences that indicate resistance. This can speed up treatment of diseases like TB. Normally it takes a series of time-consuming tests to determine whether a patient has multidrug-resistant TB, but if the genetic code of the bacterium is known, the patient could be prescribed the right drugs more quickly.

Machine learning can also speed up the discovery of new antibiotic compounds. Using a machine learning algorithm, researchers at the Massachusetts Institute of Technology have identified a new antibiotic compound that kills disease-causing bacteria that are resistant to known antibiotics. The computer model screens more than 100 million chemical compounds in days, and selects potential antibiotics that can kill bacteria using mechanisms different to those of existing drugs.

PREDICTIVE POWER

AI can also help alert the world to the threat of a disease outbreak. We ↘

were first made aware of Covid-19 in December 2019 by BlueDot, a company in Toronto. It used an algorithm to trawl notifications, disease networks, global news stories and even airline ticketing information to accurately predict how the outbreak would spread.

BlueDot founder and CEO, Kamran Khan, is an infectious disease and public health physician. His career as a doctor began during the SARS epidemic of 2003, during which he saw colleagues become infected and die. "What we experienced in Toronto was a microcosm of what we're now witnessing around the world," he says. "That virus crippled our city; this virus has crippled the planet."

BlueDot's team of data engineers, physicians and health experts has built algorithms that can read text in 65 languages, 24 hours a day, looking for more than 150 diseases and syndromes, and organize and structure this vast amount of text data. "It is about having a machine play to its strengths, and humans play to theirs," says Khan. "AI relies on large amounts of historical data to train a machine to understand patterns. But with many of the things we're dealing with there are no historical patterns. We do not have 10,000 of these outbreaks that we can train a machine on – we have a handful." This means we still rely on human knowledge of history and context. "Human intelligence is augmented by artificial intelligence. The two are complementary; one does not replace the other."

THE HUMAN-ANIMAL INTERFACE

Like other experts, Kahn believes that to get ahead of the game we have to look more carefully at what triggers this type of outbreak. "Some of the biggest drivers are the mass consumption of wildlife, industrialization of agriculture and the disruption of wildlife ecosystems," he says. "While the life and health of every person is more connected than ever to those of everyone else, it is also more connected to the health of every living system on the planet."

Covid-19 has inevitably put the focus on zoonoses – diseases that originate in animal populations. These account for some 70 percent of all new emerging diseases. One idea is to track pathogens that have the potential to leap over into humans. The Global Virome Project was founded to do just that. It aims to identify the estimated 500,000 as yet undiscovered animal viruses capable of transmission to people, and build a global atlas of zoonotic viruses.

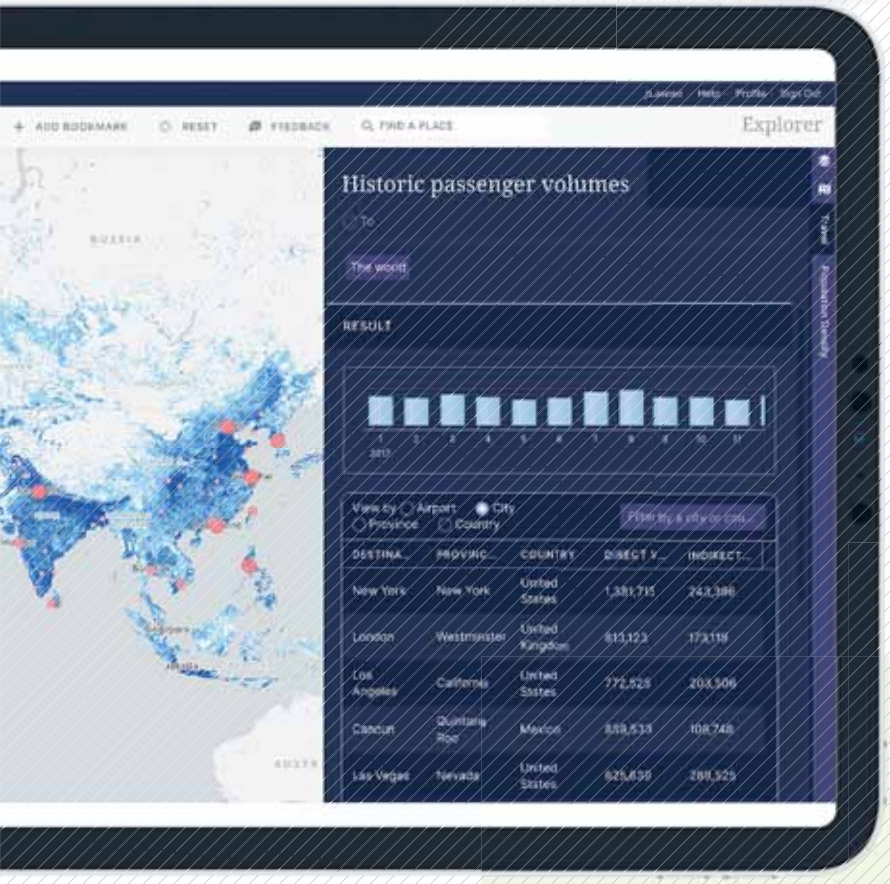
These diseases are opportunistic, thriving where there is change to the environment, to animal or human hosts, or in the pathogen itself. "The mechanisms are complex and vary among diseases," says Doreen Robinson, Chief of Wildlife at the UN Environment Programme. "This means we need to

> **"Human intelligence is augmented by artificial intelligence. The two are complementary; one does not replace the other."**

KAMRAN KHAN
CEO, BlueDot

PHOTOS: GETTY IMAGES, PR (2), PRIVAT

Infectious diseases can spread fast in a globalized world. BlueDot's risk software uses flight and mobile phone data to predict their dispersion and impact.



> "When we protect our planetary health, we are protecting ourselves."

DOREEN ROBINSON

Chief of Wildlife
UN Environment Programme

understand the ecological dimensions much better."

ONE HEALTH

As humans encroach on forests and other natural habitats, they increase their risk of exposure to potential pathogens. Understanding the relationship between environmental degradation and the spread of disease is likely to be key to preventing future outbreaks. It will mean taking action on hugely challenging areas like animal welfare, intensive farming, rapid urbanization, overcrowding, sanitation and climate change.

Robinson argues that now is the time to improve our monitoring and risk assessment for zoonotic diseases, while also improving sanitary measures for wild and domestic animals consumed as food. As our economies return and lock-downs ease, she sees an opportunity to launch a robust and accountable post-2020 global biodiversity framework to be adopted by all countries, with enough resources to take the necessary action.

But that remains only part of the picture. "Equally, we cannot lose momentum on setting new targets to reduce greenhouse gas emissions. We need to work more closely across human, animal and environmental health to find systemic, holistic solutions and mitigate future risks," says Robinson. "When we protect our planetary health, we are protecting ourselves." ■

CALL TO IMPACT

1 We must invest in AI and machine learning to further accelerate the development of vaccines and speed up the discovery of new antibiotic compounds.

2 In our interconnected world, it is vital that we leverage the power of big data to better predict where infectious diseases could emerge so that we can take swift action to prevent them spreading.

3 New pathogens are emerging, known viruses are mutating. The next outbreak could be far deadlier than Covid-19. We need to prepare today!

STRENGTH IN UNITY

WHEN THE BEST MINDS COME TOGETHER, WE CAN CREATE A SMARTER, FAIRER AND MORE PROSPEROUS WORLD

AS THE WORLD RESPONDS to the challenges of a second Covid-19 wave, the Future Investment Initiative (FII) Institute continues to empower the brightest minds to help shape the future of global business and investment. Through an interactive program of events featuring conversations and roundtables with world leaders, experts, policymakers and CEOs, the FII Institute has created a platform from which to build a better future, focusing on four impact areas: healthcare, sustainability, artificial intelligence and robotics.

A series of virtual events has been supporting this work. In April, the FII Institute brought together more than 2,000 participants from 94 countries representing 72 key industries to discuss the need for global cooperation in the wake of Covid-19. In June, a second virtual event, Don't Forget Our Planet, focused on creating a green recovery, protecting the planet's biodiversity and building its resilience to climate change.

The FII Institute has also launched *Impact*, a series of reports exploring these themes in greater depth. This current report on the future of healthcare follows *Impact* reports on the battle against disease and on achieving a sustainable future.

THE FII INSTITUTE IS GUIDED IN ALL IT DOES BY A STRONG PURPOSE, VISION AND MISSION.

PURPOSE
Enabling a brighter future for humanity

VISION
Empowering the world's brightest minds to shape a brighter future for ALL, and with ALL

MISSION
Curating and enabling ideas to impact humanity sustainably

PHOTOS: ADOBESTOCK, PRIVAT (8)

FII-I has three pillars to deliver its mission: THINK, XCHANGE and ACT

1 FII-I THINK
Identify societal challenges and current inhibitors
Curate the brightest ideas to address societal issues

3 FII-I XCHANGE
Create platforms for live discussions on the future of humanity
Share knowledge, stories and publications with different stakeholders

2 FII-I ACT
Catalyze innovation and initiatives by mobilizing partners and resources

These themes will be developed at the next FII event, to be held in Riyadh on January 27–28, 2021. The theme, "Neo-Renaissance", draws parallels between the current global situation and the historical period of cultural, political and economic "rebirth". It will provide a forum in which to envisage bold ways to rebuild the global economy through transformational investment. Taking place shortly after the Kingdom of Saudi Arabia hosts the G20 presidency, the event offers an unprecedented opportunity to drive an ambitious agenda to create a smarter, fairer, and more prosperous world.

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BlueDot
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“ BY BUILDING TRUST, WE HAVE ACHIEVED THE BEST RATE OF CHILD VACCINATION ON EARTH.”

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FORMER RWANDAN HEALTH MINISTER
AND VICE CHANCELLOR OF THE UNIVERSITY
OF GLOBAL HEALTH EQUITY