CAMWHO 2020 THEME GUIDE

HEALTH & TECHNOLOGY

FOR DELEGATES AND CHAIRS

STUDENTS FOR GLOBAL HEALTH - CAMBRIDGE
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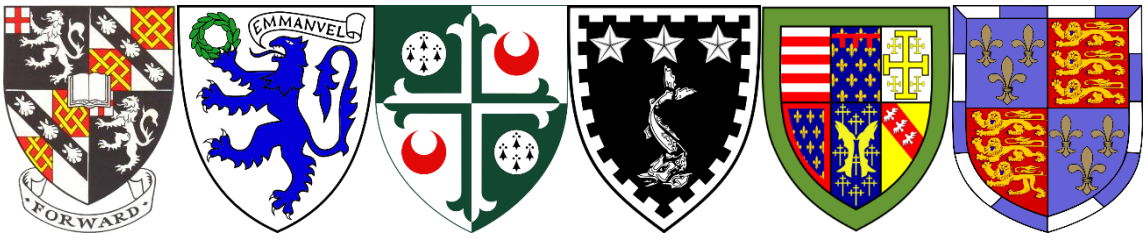

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Emmanuel Tasos, Jiaqi Li, Constance Brunet, and Kim van Daalen were actively involved in the brainstorming and conceptualisation of this theme guide.

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Jiaqi Li authored the section on Technology and Healthcare in Practice.

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With kind regards,

Emmanuel Tasos
on behalf of
CamWHO Team 2020

HEALTH AND TECHNOLOGY

Courtesy of ACTTiVAte

THEME GUIDE

Introduction

Technology is becoming increasingly important in our everyday lives, with new applications making their way into the market and changing the way we do things all the time. These changes also appear in the healthcare industry, which is benefitting from technological advances in many different ways, from the development of drugs and medicines to medical devices, and even to artificial intelligence. Research and development into new inventions and using technology in more and more aspects of healthcare provision has led to the improvement of many patients' lives worldwide; computers have become much better at analysing big data from patients and experiments, leading to a more personalised approach to medicine and a much faster process for developing and testing drugs. Similarly, medical devices and developments such as Artificial Intelligence are now expanding the boundaries of where technology can be applied in healthcare to improve patients' lives, while Electronic Health Records and other technologies where patient records can be stored, such as biobanks, make the collaboration between researchers and the access to data for public health records much easier. This has led to the development of a new industry, that of healthcare technology, which is becoming an increasingly dominant force in the worldwide market landscape and a talking point for governments and international bodies worldwide.

However, despite these positive aspects of technology in our everyday lives, there are also negative effects that have started making their way into our society. Thanks to technology, our leisure has become more dependent on social media and personal devices, which is severely damaging our physical and mental health. Meanwhile, there are now many people who have suffered from having their healthcare data sold to private companies or hacked, thus infringing on their rights to privacy and confidentiality and causing financial and personal problems. Finally, there are ethical concerns regarding the use of new technologies, which enter the market before the slow bureaucratic systems are able to regulate their use and determine appropriate boundaries to their function, while the new technologies developed can contribute to existing health inequalities, with richer countries and individuals often preferentially obtaining devices and medications at the expense of poorer countries and communities, thus further worsening inequalities on a worldwide scale.

With recent health developments brought by the COVID-19 pandemic, the role of technology in healthcare has been magnified and its importance has been highlighted more than ever before. The need to conserve resources and to reach increasingly isolated individuals and communities has led to the continued development of telemedicine and other technologies to allow remote administration of healthcare. Finally, there are concerns about the appropriate use of technology and the ethical standards to which the use of different devices and applications should be held – particularly with the advent of Electronic Health Records, contact tracing apps and personalised medicine, all of which use and store patient data for personal and public healthcare purposes, and thus may infringe on the patients' rights to privacy and confidentiality.

All of these issues are discussed in the study guide, and hopefully this document will be a useful tool for delegates to research their country/pharmaceutical company/NSA positions and come up with solutions to the problems concerning the different uses of technology in healthcare.

Subtheme 1: Drugs and Medicines - Research and Development

Drugs and medicines have been an integral part of human history, with references to medications being dated to ancient times. A widely cited example is aspirin, which has been used by ancient Egyptians and Sumerians in its more primitive form of willow bark[1] for pain relief and is still used widely today for its anti-inflammatory and anticoagulant properties. As more diseases were beginning to be understood, drug discovery became more target-specific and complex, leading to constant improvements in terms of drug efficacy and safety and increasing life expectancy and quality. The process today is ongoing, with constant research into identifying and testing new drugs, and there is still significant scope for technology to improve drug discovery and make drugs more accessible for low-income populations in developing and developed countries alike.

How does technology assist us in the development of new drugs?

The initial process of drug development would typically include discovering or making candidate drugs against a particular target, using molecular targets or cells to analyse the *in vitro* efficacy of these candidates, and then sequentially testing the candidate drug in animals and humans to analyse their *in vivo* safety, side effect profile, efficacy, and appropriate dosage. In the past, the process of developing a new drug from discovery to approval could take upwards of a decade, but the advent of new technological advances has led to the process speeding up considerably – large scale drug screens taking place through supercomputers and modelling of biochemical interactions between candidate compounds and drug targets, as well as complex data analysis, all have helped make the process of drug discovery much less time-consuming and push many drugs to the markets sooner.

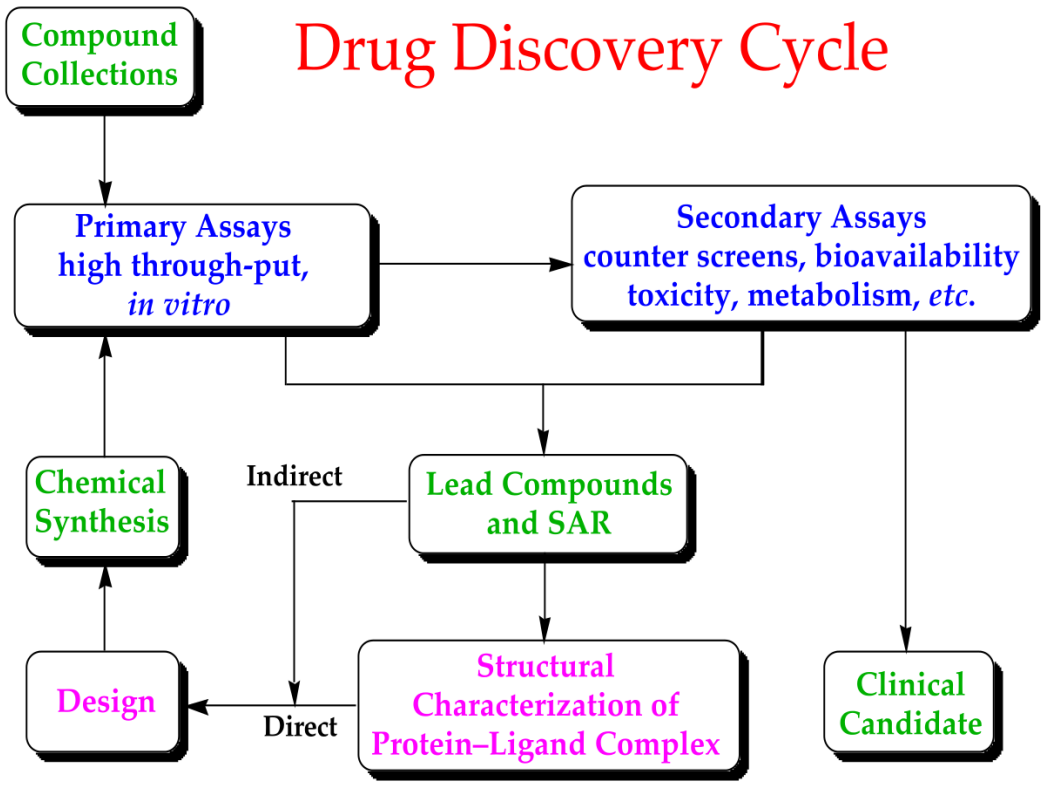

Figure 1: The process of drug discovery. Courtesy of Wikipedia

As a further development, pharmaceutical companies and researchers have increasingly turned to AI to assist them in the development of new medications. AI can help perform many computations that would take many years or be absolutely impossible without it, including:[2]

1. Identifying drug targets and validating them
2. Target-based and phenotypic drug discovery with optimisation capabilities of aspects such as absorption, distribution, metabolism and excretion of the candidate drug
3. Polypharmacology discovery (combinatorial studies of multiple different drugs/regimes for the treatment of a disease)
4. Drug repurposing programs
5. Handling biomedical, clinical, and patient data
6. Developing disease biomarkers
7. Analysing research literature, patents, and publications

For all of these purposes, pharmaceutical companies have started partnering with AI companies (some examples can be found in the article as cited above), while research institutes are also slowly shifting towards such research to optimise drug discovery and development. As a general rule, AI and large scale drug screens thanks to these technological advancements have made the process of drug production much cheaper and significantly more simple by reducing the complex steps from initial research to eventual drug development and marketing, therefore medications developed and produced for the markets thanks to modern technologies should be more accessible to lower-income populations across the globe.

Due to the COVID-19 pandemic, many software companies have provided their supercomputers for the benefit of science: in March 2020, together with its Watson Health unit, IBM dedicated its supercomputer Summit to the search of potential drug targets and agents that could treat COVID-19, running simulations of multiple interactions between the virus and many different pharmaceutical compounds, thus massively reducing the amount of time it would take researchers to find suitable treatments.[3] In addition, an initiative called Folding@Home, which started in 2000 and uses the idle CPU time of personal computers to run molecular dynamics simulations of protein dynamics, has also helped in the search for treatments for conditions such as COVID-19, cancer, Alzheimer's disease, and the Ebola virus.[4] Such actions may pave the way for future developments, particularly for non-communicable diseases, and help protect against future epidemics. COVID-19 drug research has also made use of drug repurposing, with drugs developed for other diseases (including Ebola, SARS, and HIV) being tested, which could pave the way for other such experiments.

Given this transition to a virtual environment, pharmaceutical companies are at an increased risk of cybersecurity attacks. Data from pharmaceutical companies can be very valuable, especially when concerning intellectual property (IP) or commercial secrets. Mergers and acquisitions also pose a security threat, as shuffling between the companies is unavoidable and breaches might jeopardise the deal governing the merger/acquisition. Location-dependent regulations, such as the EU General Data Protection Regulation (GDPR) legislation, also must be adhered to and complicate what is legal use of data by companies and cybersecurity protocols.[5] As such, companies must be vigilant towards attacks and have flexible governance protocols to be able to respond to cyber challenges.

Patent/Exclusivity Laws and Trade Agreements

As almost all inventions, drugs are commercially protected by laws regarding patents and exclusivity. This allows a pharmaceutical company to have exclusive rights over the production, distribution, and market access for a particular drug, which helps offset the costs that go into the research, development, and production of the drug and generate profit for the company.

Two different but related concepts are employed to achieve this: patents and exclusivity. Although the two are governed by different principles and legislation, they both confer the company producing and developing a drug protection against market competition from generic drugs or other companies making the same product. The main difference between the two is that exclusivity is automatically attached to a drug upon approval and expires after a specified time frame, while patents can be attached to a drug regardless of approval status. Patents also tend to be longer than exclusivity – in the US, for instance, patents last for 20 years from when the application for a patent is filed, while the longest possible exclusivity period is 7 years (for orphan drugs).[6]

Exclusivity and patents have greatly benefitted both governments and the pharmaceutical industry, as they allow companies to invest in new medications with fewer restrictions and help promote research. On occasion, they have been used directly for that purpose, such as the prolonged exclusivity of 7 years upon approval of a new orphan drug in the US (thanks to the 1983 Orphan Drug Act). However, they also have the unintended side effect of inducing a monopoly, which can lead to problems in negotiating prices and allowing generics to enter the competition at a later stage. As such, governments often have problems with pharmaceutical companies and their practices aimed at increasing profit, such as price gouging – these can be solved with trade agreements between governments and companies, where the governments can set terms for a drug to enter the market and for checks to exist on companies (to be discussed further below).

What is the relationship between governments and pharmaceutical companies?

The relationship between governments and pharmaceutical companies has generally been complicated. As the pharmaceutical industry has monopolies on the market for most medications and the companies are the ones driving discussions around drug pricing, governments and the international community have less of a say than what would be expected in equitable drug distribution, appropriate pricing, and governmental oversight over their processes of research, testing, and drug production. As such, there have been measures in many countries to allow the government more control over the pharmaceutical industry. In Germany, for example, unilateral raises in prices are banned, while drug prices are negotiated by the body responsible for covering the healthcare expenses for German citizens, known as sickness funds.[7] Similar price control mechanisms exist in France, the UK, and Sweden.[8]

There is currently significant controversy regarding overpricing of certain essential medications, particularly in the United States. This concept, known as price gouging, has affected many medications, even essential ones. The two most controversial examples in recent history have been the toxoplasmosis drug Daraprim (pyrimethamine), whose price was raised from $13.50 to $750 per pill overnight under the then CEO of Turing Pharmaceuticals, Martin Shkreli, and has since had a

generic version approved by the FDA[9], and EpiPens, whose price has been significantly raised by Mylan Pharmaceuticals from $100 to $600 for a two-pen set and is now competing against generic alternatives that can cost as low as $10 per set[10]. Such examples are not uncommon in the pharmaceutical industry because of patents and monopolies in place, and nations have been trying to reduce the changes of such phenomena happening.

Practices such as price gouging have made pharmaceutical companies less popular with the public, as their lack of transparency and overall fixation on profit rather than the benefit of the global community have had a negative impact on the equitable supply of medications and contributed to the perpetuation of health inequalities across the globe. Therefore, it is important for any countries that haven't done so to adopt measures to regulate their internal markets and to give the local governments the ability to negotiate drug prices and regulate pharmaceutical company spending.

Incentivising the development of new treatments

The research and development of new drugs is essential to the function of a pharmaceutical company, but also the most expensive and time-consuming one by far. Drugs in development often take upwards of 10 years to reach approval and distribution to the market, and billions are often spent in drugs that end up being non-viable. As a result, pharmaceutical companies often develop drugs only for conditions prevalent in developed countries, thus actively not investing in finding treatments for conditions mostly present in developing countries or for rarer diseases across the globe. Measures have been taken to try to improve the situation, but more progress needs to happen to achieve a significant investment in the development of such treatments.

NTDs (Neglected Tropical Diseases) have been another area where the development of new treatment options has stagnated. As indicated by their name, neglected tropical diseases are infections conditions that affect impoverished communities and rarely spread to the developed world or affect tourists. Infectious diseases are only given due attention when they pose a significant threat to the developed world, such as HIV/AIDS, Ebola, and the Zika virus, which have at times spread to developed countries and caused epidemics or pandemics. As indicated with COVID-19, which is also most likely to have been a zoonosis, i.e. an infection originating from or solely transmitted by animals (such as the ones mentioned above), and the pandemic it has caused, any condition can theoretically cause devastating effects worldwide,

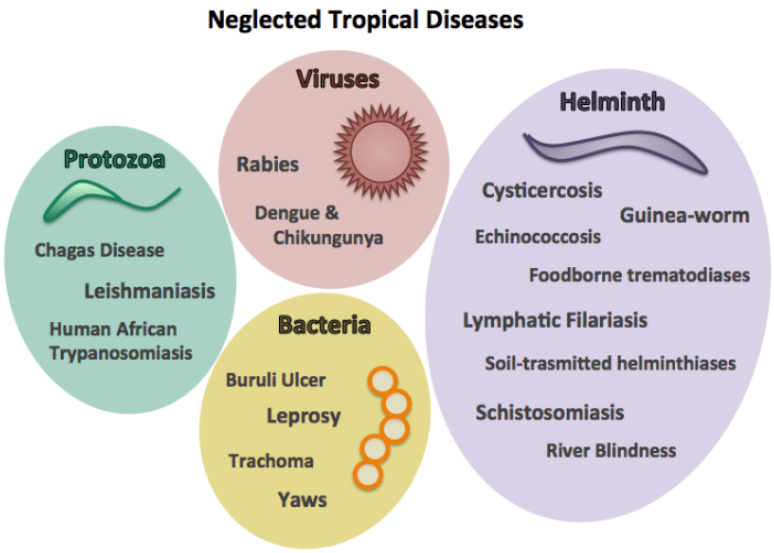

Figure 2: The list of different Neglected Tropical Diseases currently endemic in LMICs. Courtesy of Harvard University

therefore treating NTDs can improve the quality of life of many millions of people and significantly reduce the risk of a pandemic of that scale from happening from an NTD in the future.

An important concern cited by pharmaceutical companies is that the development of medications for neglected tropical diseases in LEDCs and for rare diseases is extremely unprofitable, with the process requiring extensive financing with very little positive results and with a very small market for investment returns to hope for. However, although the financial factor should be accounted for, there is also the need to balance profits with benefitting the society as a whole.

To improve the situation, a "Push" and "Pull" model can be implemented. "Push" strategies aim to cut the current costs of research, through measures such as tax breaks for pharmaceutical companies that are involved in R&D and national investments into research for new drugs for neglected tropical diseases, as well as creating binding treaties with companies and creating an open source model for drug development. Open source models have been successfully implemented with the Human Genome Project[11] and many other examples of collaboration between companies, individuals, and research institutions, driving forward the development of many medications. On the other hand, "Pull" strategies aim to improve the market competitiveness of such medications, with rewards and prizes for companies, priority review vouchers that allow drugs to be fast-tracked for approval, and market exclusivity for "orphan" drugs.[12]

One of the main breakthroughs in promoting drug development for rare diseases was the Orphan Drug Act of 1983 in the United States, which covers all drugs for diseases affecting under 200,000 people in the US. Under the Act, exclusivity for the manufacturer can be conferred for 7 years for an orphan drug and a 50% tax break for the company while a drug for an NTD is being developed, while the Act has also helped provide many grants for academic-based researchers or companies.[13] The Act has been successful in incentivising the development of drugs for rare conditions and NTDs, though there has been controversy about pharmaceutical companies using it to get financial benefits while marketing orphan drugs off-label (for more common conditions for which they were not initially licensed). An example is modafinil, a stimulant initially licensed for narcolepsy that turned out to be very profitable after being sold to the rest of the population as a stimulant.

Intelligence sharing and collaboration

Due to the intense competition between companies in the pharmaceutical industry, cooperation between companies is often problematic. Sharing data from clinical trials or other scientific discoveries and tests would invariably lead to sharing commercial secrets, therefore collaboration and information sharing would invariably hurt the companies themselves. Thus, most companies employ some degree of protection of their data and projects through Non-Disclosure Agreements or similar methods, which prevent the release of any information to competitors or the general public. This has led to significant problems in the past, as companies have often chosen to not disclose necessary information to researchers and governments to maintain their market share, leading to scandals when medicines were found to have massive side effects. Recent examples of this include Vioxx, a COX-2 inhibitor drug by Merck which was pulled from the market after increasing the risk of cardiovascular events in many of its users and was directly linked to cases of fatal heart attacks[14], and a number of drugs by GlaxoSmithKline (including Avandia, Paxil, and Wellbutrin) for which safety

data was not reported or they were misbranded by the company.[15] Pharmaceutical companies have also been found guilty of marketing drugs for off-label uses (i.e. conditions for which the drug has not been licensed by the official authorities), which can lead to significant side effects.
Thanks to AI and the development of blockchain, pharmaceutical companies can now selectively share information about their clinical trials without revealing their commercial secrets to competitors, which has made the process of evaluating the safety and efficacy profiles of different drugs much easier and furthered the development of new medications based on trial information.[16] This step will hopefully improve the situation and lead to pharmaceutical companies collaborating with each other more often and with greater transparency, as it will also allow regulators to receive data from pharmaceutical companies with much less trouble.

COVID-19 has led to unprecedented intelligence sharing between pharmaceutical companies, due to the need to produce vaccines and curative medications quickly to stop the pandemic from spreading further. When the outbreak was first noted, Chinese scientists shared the genome sequence of the virus in early January, allowing many countries and private research centres to come up with potential vaccines for the disease. Pharmaceutical companies are also collaborating to create viable treatments and vaccines – for instance, the Solidarity Trial, led by the WHO, has gathered $108 million and has 45 countries participating in various stages of development and testing of candidate drugs against COVID-19.[17] Without this information sharing, studying the virus and trying to identify potential vaccines and treatment options would have taken significantly longer, thus having devastating financial effects and placing further stress on health systems across the globe. These technological advances have also been instrumental in bringing public institutions to the fold, as research institutes and universities now collaborate with the industry more freely and readily by sharing data and working together on drug discovery and development research.

Transparency, diversity and inclusivity in clinical trials

Clinical trials are the gold standard method used by pharmaceutical companies and regulatory bodies to bring new drugs to the market. Through rigorous testing in animal models and humans, trials provide invaluable information for both the efficacy and safety profile of new potential drugs, which can be of tremendous help to people for many diseases. However, the process is remarkably expensive and time-consuming, as it can take over 10 years for a successful compound to enter the market after first being discovered or produced, while only a small number of tested compounds are tested on many different types of people to evaluate their efficacy across a spectrum of patients.

Due to financial disparities in different countries, many populations are inadequately represented in trials. This does not only concern diversity in representation; the physiological differences between people of different races, ethnicities, ages and gender can affect the efficacy and clearance of medications. In the US, fewer than 5% of the patients in 24 out of 31 cancer drug trials were African-American, even though they make up 13% of the population, while the elderly and people with pre-existing health conditions are routinely excluded, even though their study can yield information about potential side effects and a pharmacokinetic and efficacy profile on someone with health conditions. For women in particular, the endocrine changes during pregnancy, puberty, and menopause significantly change their physiological responses to different medications and increase their risk of depression, and yet they are rarely included in trials for antidepressants.[18] Importantly,

low-income individuals find it difficult to participate in trials if they experience logistical difficulties (i.e. cannot take time off work, lack the means of transport etc.)

In many countries, such as the US, there is legislation aimed at improving the inclusion of women and minorities in clinical trials, while the FDA has created an action plan to support industry efforts at making trials more diverse.[19] Pharmaceutical companies often perform multi-centre studies across different continents, which helps recruit a more diverse cohort for drug trials. As outlined on the 2012 FDA Safety and Innovation Act, companies must report how diverse the participants are and to what extent that affects the drug efficacy and safety profile, while the Centre for Drug Evaluation and Research has established Drug Trials Snapshots, which provide information regarding the demographics of the participants in all trials currently taking place. More solutions to improve participation and coverage of trials include telemedicine initiatives, which can assist in getting low-income individuals to participate, as well as financial incentives and schedule flexibility. Similar initiatives exist in Europe and other countries and can serve as a model for low-income countries.

How can we improve global access and ensure equitable distribution of medicines?

Due to the nature of drug marketing and development, companies focus mostly on developing drugs for developed markets, ignoring markets in lower-income countries, as they are less likely to be able to afford the same medications. This is despite the fact that NCDs are becoming much more prevalent in the developing world, with projections for Africa indicating a 27% increase in NCD prevalence over the next 10 years[20]. This leads to significant imbalance in access, with areas of the world completely shut out from the global drug markets. To improve this, the main step is the development and marketing of generic drugs, which provide competition to patented drugs. Generic drugs can significantly drive down prices of medications and make them more accessible to low-income countries and markets, though there need to be regulations to ensure they are rigorously tested and as effective and safe as patented drugs.[21] Another proposition has been to use revenues from extended patent terms for different medications to fund drug donations to LMICs[22], while differential or tiered pricing, where LMICs have drugs sold to them at lower prices than countries with higher income and development indices[23] can improve access to essential medications.

Collaborative efforts, such as Product Development Partnerships, where stakeholders (both public, such as research institutes and governments, and private companies) come together to create new drugs and enable their local production and distribution to developing countries, allow knowledge and technology transfer in both directions and foster innovation in drug development and marketing, allowing these technological advancements to also drive further innovation in lower-income settings through local research and drug development. Intellectual property, technology, and know-how (IPTK) banks could also help in navigating drug registration with national regulatory authorities, while there have been considerations to reduce intellectual property hurdles for innovation and to use different IP strategies depending on the setting and disease to be tackled.[24]

A further step towards improving access to medicines worldwide is the WHO Model List of Essential Medicines, which outlines all the medications a health system should be able to provide to its citizens to fulfil their most important health needs. This list can work as a framework for countries to have to plan their healthcare programs, as they are an important resource to indicate what demands

might be likely. As mentioned above, laws such as the Orphan Drug Act and tax breaks or other assistance to pharmaceutical companies to provide medications for rarer diseases can help with providing treatments for NTDs, which predominantly affect lower-income settings.

In addition to the above measures, there are also initiatives such as Gavi, the Vaccine Alliance, which have been working to achieve equitable distribution of vaccines worldwide – for instance, Gavi has raised $567 million to ensure COVID-19 vaccine distribution in low-income countries.[25] Such initiatives are essential to the pursuit of fairer and more equitable access to essential medications, and similar alliances and plans exist for other medications. Moreover, the international community should draft legislation and create protocols for the equitable distribution of medications, as achieving this equality is integral to the prevention of new epidemics and can help improve quality of life in low-income populations. Future developments over the next month regarding candidate COVID-19 vaccines and legislation signed for their distribution could set important precedents for drug distribution and marketing worldwide for generations to come.

Subtheme 2: Medical Devices

Medical devices can be termed as all devices developed for healthcare purposes and aiming to improve diagnosis, treatment and management of different health conditions, thus improving patients' quality of life. These can be very simple, such as tongue depressors, which are wooden sticks used to examine the back of the throat, or very complicated, including robotic surgery machinery able to perform many different operations with extremely high precision. The advent of devices and technological advances in the field of healthcare has completely changed how we think about medicine, by enabling vast improvements in the management of acute and chronic conditions and leading to many lives being saved or improved. However, new devices must adhere to strict criteria of safety and efficacy, similar to other medical interventions, while their development at the moment is not as sustainable, accessible or environmentally friendly as it could be, thus unnecessarily burdening the resources of different healthcare systems and the planet as a whole.

This increasing dependence on medical devices needs to be assessed carefully to ensure that access to them is as equitable as possible, with special care to be shown to the improvement of access to devices in LMICs, where even simple interventions will lead to monumental changes in clinical practice. Furthermore, given the continuous and rapid evolution of technology, new advances should be evaluated, and plans should be put in place for its efficient evaluation and integration into clinical practice, while healthcare systems should aim to use medical devices in ways that will make their healthcare provision more sustainable and environmentally friendly.

What regulations are in place for medical devices and robotic surgery?

In the past few decades, technological advancement has seen the introduction and vast application of robotics in healthcare, with experts predicting a double-digit growth rate per annum in medical robotic device market potential in the next 5 years. A transparent regulatory environment is key for the development of a robotics and autonomous systems market, where products and services can be incubated and deployed[26]. Although there is concern that premature and obstructive legislation might slow scientific advancement, burden competitiveness or cause economic inefficiencies, without a secure legal environment, technological innovation may equally be hindered.

International standards systems

The medical devices that are produced for intended global distribution should follow international standards. These are set by international standardisation organisations such as the International Electrotechnical Commission (IEC) which covers electrical and electronic engineering; the International Telecommunication Union (ITU) which covers telecommunications; and the International Organization for Standardization (ISO) which covers the remainder.[27]

The Global Harmonization Task Force on Medical Devices (GHTF) is a voluntary group that was formed from the founding countries of medical device regulatory framework. They work internationally to strengthen this regulatory regime by circulating guidance documents that discuss the safety and effective performance of medical devices. Harmonization encourages the convergence of regulatory procedures to achieve effective yet safe medical device production,

facilitate medical trade and guide innovation. The foundational work of the GHTF is subject to review and improvement by the International Medical Device Regulators Forum, which has representatives from regulatory authorities from Australia, Brazil, Canada, China, European Union, Japan, United States, and the World Health Organization (WHO), as well as from various other stakeholder groups (e.g. industry, academia, healthcare professionals, consumer and patient groups).[28]

National standard systems

Within a country, one official national organisation coordinates the standards development bodies. This organisation would be responsible for endorsing national standards according to official criteria and representing the country in organisations of international standard. Referencing a standards system assists with the administration of medical devices in developing countries where the implementation of a full regulatory programme can be monetary and resource demanding. This is facilitated by referencing international standards and the work of the GHFT.

Defining when robots can be labelled as medical devices

To set adequate regulations for robotics in the clinical setting, it has been necessary to sufficiently define medical devices. International regulatory boards have similar defining characteristics, with the EU defining medical devices (under the Medical Device Regulation (EU 2017/745)) as:
"means any instrument, apparatus, appliance, software, implant, reagent, material or other article intended by the manufacturer to be used, along or in combination for human beings for one or more of the following specific medical purposes:

- *Diagnosis, prevention, monitoring, prediction, prognosis, treatment or alleviation of a disease,*
- *Diagnosis, monitoring, treatment, alleviation of, or compensation for, an injury or disability,*
- *Investigation, replacement or modification of the anatomy or of a physiological or pathological process or state,*
- *Providing information by means of in vitro examination of specimens derived from the human body, including organ, blood and tissue donations,*

and which does not achieve its principle intended action by pharmacological, immunological or metabolic means, in or on the human body, but may be assisted in its function by such means."[29]

While there has been much progress made in harmonizing the definition of medical devices, the criteria of various national regulatory boards still vary. As a result, regulators are able to exercise a significant amount of discretion in assessing whether a given system or device meets those criteria. Such variations make it difficult to state with certainty whether a specific robotic device used in a medical application will be classified as a medical device, and therefore subject to regulatory oversight, review or clearance.

FDA laws for autonomous surgical robots

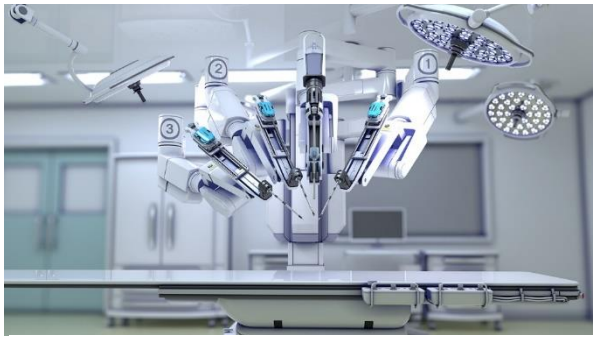

Figure 3: Courtesy of orthofeed.com

The FDA announced on February 28th 2019[30] that device manufacturers looking to market surgical tools for use in the prevention or treatment of cancer may now be required to study long-term oncologic endpoints in surgical trials. This is hoped to be achieved through "equivalence" trials designed to establish noninferiority of robotic procedures. In order to demonstrate long-term safety and effectiveness, endpoints specifically addressing cancer-related outcomes are to be used. As of yet, the FDA has still not granted marketing authorization for robotically assisted surgical devices, due to the lack of establishment of survival benefits for some of these procedures.

What are the current developments in the field and how could they be used to improve healthcare in low income settings?

Current developments in the field

The global need for access to effective, innovative, and affordable medical devices is a critical component of the United Nations Sustainable Development Goals, to ensure healthy lives and promote well-being for all at all ages. Medical devices, assistive technologies, and eHealth are essential tools for the attainment of the WHO goal of 3 billion lives saved as stated in the 13th General Programme of Work. Lack of access to quality, affordable medical devices is most apparent in low – and middle – income countries and contributes to global health inequalities.[31]

Medical device availability in low income settings

In developing countries, most research has focused on development and access to pharmaceuticals and vaccines even though medical devices are a key component of health care technologies. Medical devices are critical for diagnosis, patient care in operating theatres, at the bedside, and even before a patient is admitted into hospital, or after being discharged. Yet, in the case of emerging and developing countries, the development of appropriate medical devices affordable to local populations and inequality of access to essential devices remains largely under-researched.[32]

Almost 80% of medical devices in LICs are acquired by donation. In addition to donations, medical devices are also acquired through technology transfer: local production of devices that resemble technology designed for use in high-income countries (HICs) or the low-cost sale of older models of devices originally designed for use in HICs. However, use of medical devices in LICs that were originally designed for use in HIC are not entirely successful; one study noted that 40% of medical devices were dysfunctional in LICs versus less than 1% in HICs. In LICs, constraints including unreliable energy supply and water, limited distribution and infrastructure, inadequate or untrained workforces, lack of spare parts, required consumables, and high costs affect the availability and acceptability of many devices.[33]

Appropriate healthcare technology for developing countries

Medical devices have a limited, yet important role in the effective delivery of health care. The role of medical devices and health technology in the fight against NCDs was emphasized in the Global Action Plan for the Prevention and Control of NCDs proposed by the WHO and endorsed by the World Health Assembly in 2013. However, the mismatch between the number of commercialized medical devices, which are specifically designed for and accessible in LICs, and the projected burden of diseases due to NCDs in LICs is of concern.

Successful design for LICs depends on understanding the broader issues associated with implementation in the early stages of the development process rather than after the validation and production stages. For example, considerations regarding medical device commercialization and adoption are likely to be different in LICs. Therefore, novel medical device design frameworks that consider downstream variables (e.g., manufacturing plans, regulatory pathways, etc.), as well as the broader context during the front-end phases of design (e.g., development of product requirements and technical specifications), are needed. Design approaches that consider local and regional constraints, cultural contexts, and stakeholder needs, and enhance the capacity of the local health care workforce are particularly effective.

The limited availability of highly trained health providers presents an extraordinary challenge in providing universal quality care. This has dramatically increased the need for automation in the healthcare industry medical devices are designed to provide, as being able to delegate certain tasks to easy-to-use devices will save countless hours of work for healthcare professionals and allow more efficient and sustainable allocation of time to different tasks, thus improving the quality of healthcare provided to patients. The use of such easy devices would also be essential for reducing the cost of healthcare to taxpayers, as funds would be freed up by having tasks automated or done much more easily thanks to medical devices.

To date, limited medical devices have been designed specifically for task-shifting applications; such devices can play a critical role in improving access to universal care and tackling the threat of NCDs, particularly in rural LICs. Devices that are easy to use, have limited components, no need for spare parts, minimal to no maintenance or need for calibration, and use reliable and readily available energy sources may increase their suitability for community health workers performing task-shifting duties. Relevant information can be found on the WHO Compendium of Innovative Health Technologies for Low-Resource Settings[34], which contains details on many devices that can improve the standard of healthcare provided in LMICs.

How can we improve worldwide access to medical devices, technology, and complex surgery?

The medical device industry plays an important role in the health outcomes of global populations with a projected sales revenue of over five-hundred billion dollars in 2020, dominated mainly by United States companies despite the increasing spread of consumers.[35] With seven of the ten major medical device companies housed in the United States, supply chain dictates the access rural populations have to devices with 72% of companies reported infrastructure as a major impactor on timely access.[36] Rural infrastructure development—one of the United Nation's Millennium

Development Goals—is the one of the main obstacles for increasing access to medical devices across the globe.[37] This is just one factor that contributes to the higher mortality rate from the five leading causes of disease within rural populations in the United States.[38]

Medical devices that operate through universal devices may be suitable for increasing global access to medicine until rural infrastructure can be developed. Such technologies as telemedicine, which refers to caring for patients remotely with devices including mobile applications, provide a means to medical information or consultation without the requisite of moving people or devices across rural areas. Telemedicine constituted nearly 25% of the health IT market in 2014.[39] According to research, there was no significant reduction in health outcomes with telemedicine, and patient readmission rates decreased due to this technology.[40] However, progress is hampered in telemedicine by access to mobile technologies and wired or wireless connections, language barriers, lack of standards and regulation, and the ongoing costs of telemedicine that are higher in rural areas.[41]

The current COVID-19 pandemic has prompted many healthcare systems to adopt telemedicine systems to reduce transmission of the virus. An example of this is in Massachusetts, where telehealth services are expanding since the pandemic started and many health centres are increasingly utilising these services for communication with patients[42] – the Boston Dynamics' Spot robot, for example, which is in operation at the Brigham and Women's Hospital belonging to Harvard University, has been able to reduce the need for physical presence of some healthcare physicians thanks to its use of a two-way radio and iPad to enable remote communication with patients, thereby reducing infection risk for healthcare workers and conserving the limited and vital Personal Protective Equipment currently in the hospital.[43]

In cases beyond consultation with doctors or ongoing care, recent advances in remote surgery provide opportunities to increase the access to medicine into rural and remote populations. Remote surgery is essentially telecommuting of surgeons, in which these individuals can perform surgeries from elsewhere using robots connecting the two locations. This industry is expected to grow at a rate of 15% per year up until 2022 with current revenues approaching three billion US dollars.[44] While the value—or the ratio of quality to cost—of this technology is considered lower than typical surgery, remote surgery is a suitable technology for use in rural populations who do not have constant access to surgeons.[45] However, the upfront and ongoing costs of these devices, numbering well above one million dollars, reduce the feasibility of their use in impoverished, rural communities, especially those without proper healthcare facilities. Until these factors are addressed, remote surgery will only be feasible for countries with wealthy populations.

Ultimately, greater research and development should be devoted to producing medical devices that are transportable, long-lasting, and reusable. In 2015, with 28% of medical device companies having experienced a recall due to shipping, there is clear evidence of a need for these technologies.[46] Recent advances towards this goal include the World Health Organization's promotion of rapid diagnostic tests (RDTs) which are used to diagnose infectious diseases in low-income settings. These tests are optimal for diagnosing disease in rural communities given their low cost, ease of transport and storage, quick results, and reduced level of training required to operate them.[47] Significant improvement in patient outcomes have been linked to RDTs, illustrating the feasibility of cheap technologies in the global medical device sector.[48] On a broader scale, medical device companies

and international coalitions like the World Health Organization need to promote the development of technologies that are not only economical but usable in rural populations across the globe.

Can medical devices help the healthcare industry become more sustainable?

With the increasing popularity of sustainability as a policy, every sector is taking a more holistic view of their activities, including the healthcare industry. Although there is a widely held perception of the health and social care system as ever-present and theoretically sustainable, because it does not create the expenditures of other sectors, there are still many challenges to be resolved to ensure that the provision of healthcare is done in a truly sustainable manner; this is necessary due to cost limitations, the increasing demands on the healthcare system due to an aging population, and damage to the environment necessitating a more environmentally friendly approach.

Figure 4: The three axes of sustainable healthcare - economic, social, and environmental. Courtesy of the NHS

A sustainable healthcare system can be achieved by delivering high quality care and improving public health, without exhausting natural resources or causing severe environmental damage.

The relationship between sustainability and health can be imagined along three different axes – environmental, social, and economic. According to the Sustainable Development Unit of the UK National Health System, the following are potential steps towards the development of a more sustainable healthcare system (in terms of the healthcare system and our way of life in general):[49]

1 - Sustainable Health and Care Sector

This involves 'greening' the sector with particular attention to energy, travel, waste, procurement, water, infrastructure adaptation and buildings. This ensures resources (physical, financial and human) used in the sector are:

- Used efficiently (e.g. buildings and homes are well insulated and use less fuel to heat)
- Used responsibly (e.g. clinical waste is disposed of safely to protect local people)

2 - Sustainable Health Care

This is slightly broader (but more health care specific) and involves working across the health system and partners to provide health care that delivers on simultaneous financial, environmental, and social return on investment. It includes adapting how we deliver services, health promotion, more prevention, corporate social responsibility and developing more sustainable models of care.

3 - Sustainable Health & Well-being

This is the broadest level and involves considering the sustainability of everything that impacts on health and well-being (e.g. education, farming, banking etc.).

Based on the above principles, there is definitely significant scope for making the healthcare services more efficient and less wasteful. Medical devices can help in this, as they allow more efficient provision of particular healthcare services and resource allocation – such an example is their ability to reduce hospital stay requirements, improve timely access to treatment, and overall provide patients with a better quality of life overall.[50] Production is also becoming more sustainable, with medical device packaging becoming less complex and more friendly to the environment, 3D printing being increasingly used (as shown by its use in creating ventilators for ICUs in the COVID-19 pandemic), greener materials becoming more popular, and new techniques such as multiplexing being used for production.[51] Aspects of regular hospital function, such as meal choice for patients and education in terms of recycling policies, are becoming increasingly popular, thereby contributing to making the system more sustainable. However, there is still a long way to go, with the use of technology being a significant talking point and progress needing to be made in terms of passing policies to ensure Member States are committed to such policies in the future.

VR as a potential tool in healthcare

Among its many uses, virtual reality can also be very beneficial for the healthcare industry and for educational purposes. The use of many different aspects of VR, including auditory and video feedback, as well as haptic technology offering sensory and force feedback, is especially useful for the provision of effective and repeatable training at very low costs, as it allows trainees to correct errors as these appear. This makes it a very good tool for teaching robotic surgery and other medical procedures, as it provides an immersive experience unmatched by other methods of teaching,[52] while its repeatability can help drive down the cost of medical training.

VR has also been used in physical therapy since the 2000s, thus providing a promising alternative to the existing pain relief medication market worldwide, which costs individuals $17.8 billion in the US annually.[53] Some uses in physical therapy include myoelectric and motion tracking control for treatment-resistant phantom limb pain[54] and restoring balance and walking function in children with cerebral palsy, where it has been proven to have superior results to other forms of treatment.[55] However, research on its effectiveness in treating different conditions has so far been inconclusive for conditions such as Parkinson's disease.[56] Other uses can also be explored, such as increasing disease awareness by allowing an immersive experience into the reality of someone with a chronic condition, or mental health and psychological therapy, through the same principle of immersion.

Although there is some degree of ambivalence, these results show there is a clear possibility for VR technology to be a useful tool for educational purposes and for various medical uses, both in already tested domains such as rehabilitation and in new ways where it hasn't been applied yet. Given its potential, delegates should consider promoting the use of virtual reality for healthcare purposes and adopting policies to secure funding and resources for its further development.

Subtheme 3: Technology and Healthcare in Practice

Ethical and Legal Considerations

With the rapid rise of the use of technology in various healthcare settings, there is a changing dynamic and role of the patient. Primarily, there is increasingly a greater role and individual responsibility conferred to the individual. This is can be attributed to the ability of new technologies to promote more active participation by users – one can imagine the diabetic now being able to monitor his blood sugar levels from his smartphone. While this can lead to more informed, more empowered patients that take a greater responsibility for their own health, there is a new complex set of ethical considerations: voluntary participation may become obligatory, and citizen participation in health research may begin to resemble instrumentalisation, even exploitation.[57]

Furthermore, in addressing the General Assembly on 24 September 2019, the Prime Minister of the United Kingdom raised concerns of dangers of the technological age. This includes

(a) Risk of round-the-clock surveillance and implications on privacy and autonomy
(b) Dangers of algorithmic decision-making
(c) The difficulty in appealing against computer-generated determinations
(d) The inability to plead extenuating circumstances when the decision maker is an algorithm[2]

The fact that many algorithms still remain a 'black box' to most renders algorithm-based decision making a difficult topic, and how can one argue 'against' such computer-generated decisions?

The role of governmental regulation?

Furthermore, technological advancements have exploded rapidly in the past few years – the rapidity that which we have acquired new technologies is unprecedented, and unfortunately ethical regulations have lagged behind. The reality is that Governments have not regulated the technology industry taking into consideration issues of human rights' the technology sector essentially remains a 'rights-free' zone. The big technology companies ('big tech' – Google, Apple, Facebook, Amazon and Microsoft) have worked hard to keep it that way. In many ways, their arguments greatly parallels those used previously in the arguments against governmental regulation in scientific research. Some principle concerns raised include:

a) The ability to innovate requires freedom, especially from regulation.
b) There are no universal values: quoting Brad Smith, President of Microsoft in his recent book *Tools and Weapons: the Promise and the Peril of the Digital Age*, ""How can the world converge on a singular approach to ethics for computers when it cannot agree on philosophical issues for people?"
c) Governments are inherently slow and clumsy, and relying on governmental regulation only leads to bureaucracy and slowing of progress. *Of note, regulation in the digital sector is largely self-regulatory*
d) Finally, many believe that the free market is the best regulator. With citizen vigilance, great scandals are perhaps more easily surfaced, and the resulting backlash against big tech ('techlash') argues that the public plays an indispensable role in regulation.[58]

The dangers of algorithm-based decision making

Artificial intelligence (AI) is rapidly moving to change the healthcare system. With the development of powerful machine learning techniques, including deep learning and convoluted networks, together with big data, this has led to the development of new technological tools. Such tools can be used to improve the process of clinical care, to advance medical research, and to improve efficiency. These tools rely on algorithms, programs created from health-care data that can make predictions or recommendations. However, the algorithms themselves are often too complex for their reasoning to be understood or even stated explicitly. Such algorithms may be best described as "black-box."[59]

The most fundamental question is of course: how do we ensure that these black-box algorithms are high-quality? These algorithms must be both efficacious and most importantly, safe. Furthermore, two tools generally help to ensure safety and efficacy of new medical technology: scientific understanding and clinical trials. Unfortunately, these two tools do not work well in the context of black-box medicine. Clearly, we do not understand how a black-box algorithm makes decisions. The question then is, given these constraints, clearly such algorithms have a very different nature compared to 'conventional' medical technologies, necessitating *new* legal and ethical regulatory strategies to be developed.

Summary

To conclude, there are a multitude of ethical and legal issues surfaced when considering the rapid incorporation of technology (including technological devices, algorithmic decision-making tools, etc) in healthcare. Some main problems we have described include

1) The changing role of the individual – citizens taking a greater responsibility of their own health, increasing citizen participation
2) Potential exploitation of individuals' data
3) 'Big Tech' companies arguing against governmental regulation
4) The many unknowns when dealing with algorithm-based, "black-box" decision making

Subtheme 4: Electronic Health Records

What are Electronic Health Records and how are they currently implemented worldwide?

Besides improving standards of care, patient data can predict epidemics, inform policy and improve the function of health services (uses can be seen on the picture). This has led to Electronic Health Records (EHRs), an electronic version of paper-based stores of patient data. These can only be accessed by authorised personnel in settings such as hospitals, pharmacies, emergency services, as well as school and workplace-based health services. EHRs fall into the topic of eHealth, which the WHO defines as 'the use of information and communication technologies (ICT) for health'[60], and includes mHealth, which is the use of mobile phones to deliver eHealth strategies.

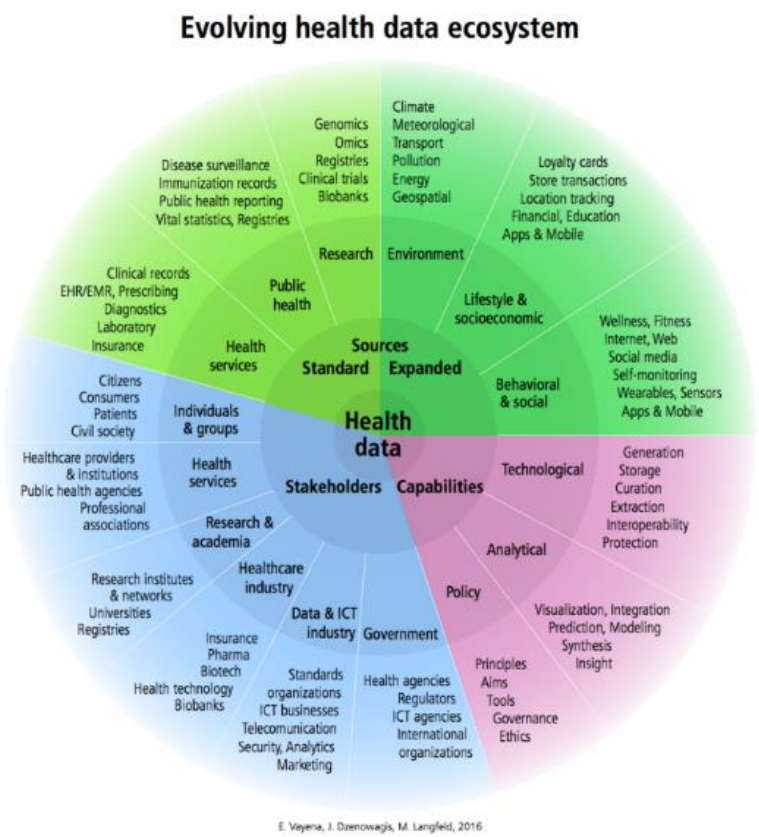

Figure 5: The evolving data ecosystem linking health-related big data. Courtesy of Vayena et al (2018), published in the Bulletin of the World Health Organisation.

An Electronic Health Record includes the patient's medical history, immunisation records, prescriptions, diagnoses, allergies, and lab and other test results.[61] This means that all clinicians involved in a patient's care can access the same information. In practice, the lack of interoperability, the ability of computer systems or software to exchange and use information, makes this process much less simple. Within healthcare systems, even at the national level, interoperability or lack thereof is often a barrier to increased efficiency of eHealth data sharing.

In 2005, the 58th World Health Assembly adopted a resolution establishing the WHO's eHealth Strategy. Through the WHO Global Observatory for eHealth, which was established in the same year, and regional WHO Offices, the WHO has been helping monitor the progress worldwide, focusing on individual countries, especially those in the low- and middle-income categories.[62] A 2018 resolution calling on Member States "to develop, as appropriate, legislation and/or data protection policies around issues such as data access, sharing, consent, security, privacy, interoperability and inclusivity consistent with international human rights obligations and to communicate these on a voluntary basis to the WHO"[63] highlights the main challenges that eHealth systems face around the world.

On the country level, there has been significant progress in the adoption of EHRs for health data storing. This effort has largely been conducted in areas with well-funded health systems, with

regions such as the EU world leaders in this domain. In the EU in particular, the protection of personal information offered by the General Data Protection Regulation (GDPR) framework and fine of €4.34 billion against Google for illegal practices relating to its search engine dominance[64] indicate their dedication to the protection of users' data and willingness to fight against "big data" companies to protect those interests. Since 2017, the European Union has a European Reference Network of over 300 hospitals across 26 EU member states[65], as well as a framework and rules for cross-border patient information sharing[66], both aiming to securely provide patient information access to European healthcare systems, to reduce frequency of medical errors and to provide life-saving information in emergency situations.[67] Besides the EU-wide plan, most EU members also have well-defined national eHealth frameworks. The UK operates with a more decentralised system and the most recent focus has been on Summary Care Records, which exist for 96% of the population. Alignment for the UK can be sought with the EU and other like-minded partners, including Australia, New Zealand, Canada, and the US, though the variation in healthcare systems across these countries in funding, ownership and operation largely affects their ability to partner with each other.[68]

Systems can also be created in response to unprecedented health challenges – in China and Singapore, for instance, development of EHRs started with the 2003 SARS outbreak, which required a large-scale effort from public health systems to be curbed.[69] Singapore in particular has a very well-developed and efficient EHR system due to its small size and high-income levels and thanks to efficient governance[70], thus acting as a model for the health systems in similarly small-sized or highly urbanised countries. On the other hand, the system in China and other countries, such as the US, is not coordinated as efficiently, due to the presence of many different providers and systems.

Global integration of eHealth systems is covered less comprehensively. In 2012, the WHO published a practical toolkit for Member States, which is available in all UN official languages and aims to help them develop or set up national eHealth systems.[71] Although a helpful and comprehensive resource, the report emphasises that Member States can use it as little or as much as they want in line with their individual healthcare challenges, so even though there are substantial resources to help countries work towards more efficient eHealth systems, there are still no widespread commitments from Member States to organise their eHealth systems based on any particular model.

How can we transition from paper to electronic health records worldwide?

According to WHO data, only 58% of Member States currently have an eHealth strategy, and only 55% of Member States have legislation offering any sort of protection for patient data.[72] To enable interconnectivity between systems, member States will have to take steps to properly protect the health data of their own citizens, and develop eHealth strategies to help facilitate this transition. Importantly, Member States might not be incentivised to work with other Member States with a different level of legal protection to healthcare data of their own citizens and might instead wish to collaborate with countries with similar healthcare challenges and records.

African countries, for example, have highly variable policies and degrees of electronic health record implementation. Although national eHealth strategies exist in many countries, these are often lacking in basic legal and operational functions. For instance, while in Kenya and South Africa, two countries with well-outlined strategies for developing an appropriate eHealth framework,[73]

personally identifiable data are legally protected, the eHealth strategy of Malawi offers no such provisions. In contrast to the above, there are also countries such as Morocco, Lesotho, and South Sudan, which have no eHealth strategy at all, while national and international data sharing is not formally overviewed by national governments.[74] As such, the development of a continent-wide interconnected system for electronic health records is likely to be an impossible task without the further development of national eHealth strategies.

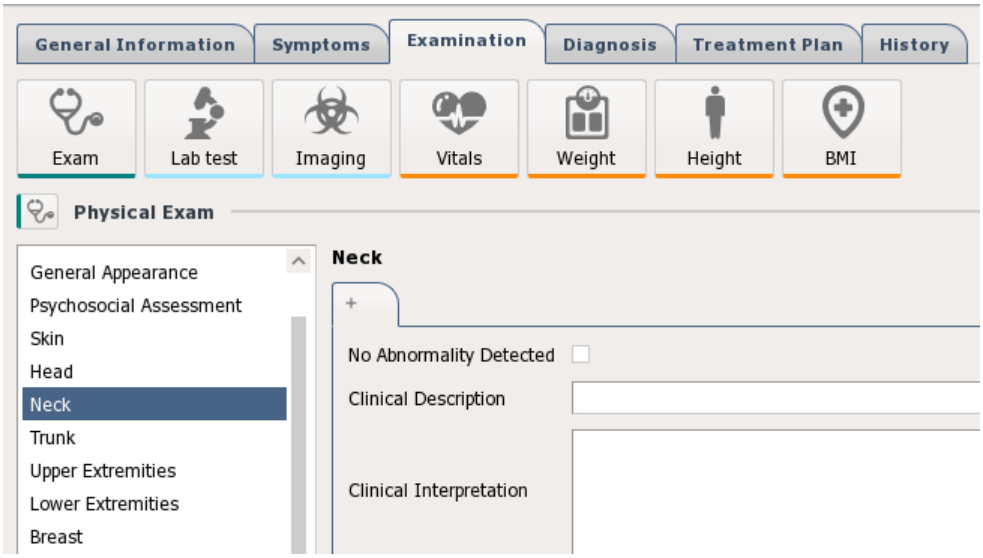

Figure 6: A sample of an Electronic Health Record. Courtesy of Galinos

However, extreme situations or financial and institutional constraints can often lead to alternative solutions. A need-based system called OpenMRS-Ebola, which was developed in Sierra Leone during the Ebola outbreak from 2014 to 2016[75], was set up within 2.5 months and proved successful in helping the recovery process from the epidemic in the country. This type of initiative can be viable in sparsely populated areas where telecommunications are limited, thus offering an alternative to centralised electronic health records. Such a model could be useful for delegates to examine, in particular increasing continent-wide coordination and information sharing via the African Union and utilising the high mobile ownership and use of mobile payments to benefit the healthcare domain.

In 2016, the WHO recommended the incorporation of mobile technologies (mHealth) into eHealth strategies, citing high use among citizens of low- and middle-income countries where such initiatives could offer high impact solutions.[76] A more elaborate version of the 2016 WHO report was published in 2018, elaborating on the applications of mHealth and indicating the potential value of advanced computer sciences such as artificial intelligence.[77]

Delegates should examine how the WHO can cooperate with nations to strengthen eHealth systems, support innovation, and make eHealth data sharing more secure. Countries might wish to look into how they can help organisations such as DeepMind Health to improve their healthcare provision.[78] AI has revolutionised almost every aspect of modern life and healthcare is no exception; for example, thanks to DeepMind and AI technologies, UK hospitals were able to use software to diagnose eye disorders (such as screening for diabetic retinopathy) with similar accuracy as top human experts. Looking out for and supporting such technological breakthroughs, whilst ensuring

third parties comply with government privacy and security regulations, is essential to the healthy progression and prosperity of eHealth solutions.

Although it may be assumed that eHealth strategies will be of limited value in LEDCs due to internet and technology access issues, the WHO has noted that digital technology and internet access is becoming cheaper and more widespread in these areas. However, eHealth strategy implementation is still limited.[79] It will be important to consider how the WHO can further the interests of these States in improving their healthcare systems and patient outcomes and adopting eHealth strategies.

Interconnectivity between systems

As EHR systems are still in their relative infancy on a worldwide level, there would be significant difficulties in trying to adopt interconnected systems. Tracking patients throughout health record systems is difficult, and often heavily relies on information supplied by the patient themselves or contacting different health providers, even in countries where EHRs have been adopted. This can prevent them from fulfilling their intended purpose, as a failure to share the records between different providers means EHRs are not more useful than conventional paper-based patient records.

This can be observed in the US healthcare system. According to the Organization for Economic Co-Operation and Development, in 2017 the US had the highest healthcare spending per capita.[80] USA's developed economy and large amount of investments, as well as its range of healthcare providers, have led to many eHealth systems and software providers. This, in turn, has led to interoperability issues, as highlighted in a report by the American Society of Clinical Oncology (ASCO).[81] According to healthcare providers surveyed in 2015, only 19% had access to EHR systems that allowed patient data to be transmitted to third parties, which makes it difficult for EHRs to benefit public health reporting and healthcare analytics. Many EHR system providers have implemented barriers to information sharing, which has significantly affected the interoperability of the eHealth system. These include per-transaction fees within contracts for information transfer to a different platform, lack of interest in engaging with competing system providers to enable data sharing, and contractual requirements that give an EHR company exclusive license to use a healthcare provider's data.

In a poll of cancer patient advocates, ASCO also reported that 80% of participants stated that it's 'difficult' or 'very difficult to share healthcare information between providers. These barriers present challenges for patients within national healthcare systems but also demonstrate that implementing widespread data sharing on an international level is no easy feat, considering the difficulties that already exist on a national level. The same issues are seen internationally, with only 7 percent of doctors feeling like their eHealth system had meaningful connectivity with other providers.[82]

Creating interconnected electronic health records would require significant infrastructure and funds to be provided to LEDCs in particular, as they would need the greatest amount of assistance. This could be a breeding ground for interconnectivity and EHR implementation based on the alignment of nations with matching healthcare strategies, such as those with highly privatized or nationalized services.[83] As of 2016, 121 countries had adopted an eHealth national strategy, thus providing an array of approaches to compare, with some notable ones described below. Reference can be made to WHO's Atlas of eHealth country profiles, which includes existing national legal frameworks.[84]

Consent and confidentiality

Patient consent is critical in data protection and sharing. If patient consent is not addressed properly, it could undermine the public's trust to the healthcare system. To maintain this trust, patients should be in control of how their data is used, both nationally and internationally. As a rule of thumb, patient data should only be used to provide patient care.[85] However, patient data can still be used for other means, as long as explicit information and the ability to opt in and out of the various data usage options exist. As shown in the Cambridge Analytica scandal,[86] people care about how their data is used and misused, and although companies protect themselves with terms and conditions, a concise and informative interface and a clear explanation of data usage policies is much better in ensuring trust in the service compared to T&C documents that scarcely anyone reads in full.

When patients consent for their data to be used in those capacities, they must be confident their information is held securely within the healthcare service provider's servers. However, this can also increase the risk of security breaches. According to the CynergisTek Redspin 2016 report, hacking attacks on healthcare services increased by 320% in 2016 and 81% of all record breaches in 2016 were due to hacking attacks.[87] According to the same report, malware and ransomware programs that hold data hostage until certain conditions are met are particularly threatening to hospitals. Governments should consider how they can assist healthcare providers in ensuring the safety and security of their patient data and whether experts in cyber security from different civil service sections can help enhance people's trusts in EHRs, potentially by giving more people working in healthcare training on data protection and privacy issues and solutions[88], which some countries, such as the UK, are already utilising in their healthcare trusts.

If Member States are to implement large-scale cross-border health data sharing, consent for this type of data sharing should be included in patient consent forms and governments should make sure that public and private healthcare providers stick to these guidelines. It is also worth thinking about how governments can introduce national standards for EHR systems, especially for consent, confidentiality and data protection, and work with the private and public sectors to make sure that their guidelines are actually implemented into practice. This might be a harder task for countries with existing systems, such as the US. Countries that are just starting out with the implementation of robust eHealth strategies, on the other hand, can learn from other Member States' experiences and introduce government-approved standards for EHRs from the inception of their eHealth strategies.

Health data protection, security concerns, and hacking

With certain types of electronic information, especially financial information, multiple mechanisms and sophisticated algorithms can prevent data breaches and theft. In a financial service security breach, the data owner is notified immediately by their bank or building society and can fix the situation or prevent harm by cancelling their cards and reversing fraudulent purchases. However, with medical data, the affected individuals are not routinely informed by the organisation storing their data and may only find out about breaches many months or years later, when they suffer those consequences. In fact, in many regions, patients cannot access their own medical records, unless they go through a formal process to obtain approval by the healthcare record provider, which removes agency from them in terms of how their data is handled and how securely it is being held.

The Western World has had many health data hacking incidents, where the medical data of individuals were stolen for purposes of identity theft to obtain medical devices, medicine, or medical services, or to file fraudulent insurance claims as the person whose identity was stolen.[89] The US has fallen victim to many cyber-attacks; in 2015, the data breach of EHRs of the US health giant Anthem Blue Cross led to the theft of personally identifiable information such as names, home addresses and Social Security Numbers from 79 million people.[90] These were then offered back to the insurance companies or hospitals they were stolen from in exchange for hundreds of thousands of dollars. If these sums are not paid, the health records and passwords are then auctioned on the dark net at similar prices. In the UK, the NHS has also had multiple incidents of data breaches and theft, among which the WannaCry cyberattack in May 2018 that cost the NHS over £92 million, as 19,000 appointments were cancelled as a result.[91] Singapore has also had a hack of its government health database, with the records of over 1.5 million citizens being stolen.[92]

Figure 7: Courtesy of SciTechDaily

Aside from these large and widely publicised incidents, many more instances of medical identity theft often go unnoticed. An Accenture survey of US users showed that roughly a quarter of those surveyed have suffered healthcare data breaches. Of those affected, 50% have subsequently been affected by medical identity theft. On average, this has led to personal costs of about $2500 for the victims. Shockingly, half of those surveyed discovered they were victims by themselves and did not receive any alerts from their healthcare providers or law enforcement agencies.[93] This makes it a necessity to create new guidelines for informing the users about medical identity theft and safeguards for medical data similar to the ones used for financial data.

Besides financial losses, having medical details stolen can be a great source of distress for victims. Healthcare services should be prepared to address these concerns and work on increasing the capacity for early detection of data breaches.

How will the COVID-19 pandemic change electronic health record sharing and privacy laws?

Since the start of the COVID-19 pandemic, many countries, such as South Korea, have been using surveillance technology, including CCTV and infrared cameras for fever detection, to perform extensive contact tracing and help detect the exact location of new coronavirus cases. Furthermore, a mandatory government app is used to track new individuals coming into the country and to ensure quarantine is enforced by individuals who are subjected to it.[94] This strategy has been instrumental to South Korea's success in dealing with the epidemic, despite concerns that such technologies violate fundamental human rights. For delegates, this begs the question of whether sacrificing some personal freedoms is necessary to benefit the population as a whole.

Another concern comes from apps by companies such as Google and Apple to help users track whether they have come in contact with individuals positive for COVID-19 or have had a high possibility of exposure to the virus, as well as similar apps developed by governments to keep track of COVID-19 infections. The project is supposed to operate as an automated contact tracing system operating at a very large scale, with users with a confirmed diagnosis from a legitimate healthcare provider being able to flag themselves for other users and the whole communication taking place via Bluetooth.[95] Two models of apps have arisen: a centralised app, where phones can provide both their own anonymised ID and proximity and location data, and a decentralised app, where phones provide only their own anonymised ID.[96] Both models have been used in different countries, though there have been different sets of problems – in Singapore, for example, the TraceTogether app was only picked up by 20% of the population and did not prevent a new wave of the epidemic. Moreover, Apple has had to restore normal Bluetooth function on its devices, which is normally limited by privacy measures from the Apple operating system. Other challenges still need to be resolved, including whether the apps can run on the background, the amount of data that will be transmitted, the use of the app among the population, and the possibility of global interconnectivity between apps. In any case, this pandemic could see a seismic shift in how we treat patient privacy and safeguard medical data for infection control purposes.

On a similar basis as the protection of data in Electronic Health Records, frameworks need to be developed for the fair use and data protection for the apps mentioned above, as these could also be susceptible to breaches. Due to the rapid development of new technologies in our time, bureaucracy often fails to catch up with new developments in this landscape, which prevents their fast and appropriate use in scenarios where they would be useful. To combat this issue, delegates could consider the creation of a worldwide technology tracking and ethics team collaborating with governments and the technological industry, with an aim to identify new developments and try to bridge the gap between development and worldwide political action, as well as evaluating the ethical standards under which different software products can operate, especially with regards to the dichotomy between privacy and public health that is blurred by such technologies.

Subtheme 5: Artificial Intelligence in Medicine

The availability of clinical data has exploded in the past few years, thanks to highly sophisticated technological advances that have allowed the generation and storage of large amounts of medical information. Parallel to that, software developers are designing increasingly powerful tools that can analyse this data and use it in many different applications. Artificial Intelligence has arisen from these advances: through the combination of powerful algorithms together with large amounts of data, machines can mimic human intelligence by performing different 'cognitive' tasks such as learning, decision making and problem solving.[97]

Current developments and innovations - how have they changed the healthcare landscape?

AI is estimated to address around 20% of unmet clinical need demand by 2026.[98] AI is changing every area of the medical landscape, from research to drug development and caregiving, aiming to improve how healthcare is delivered and optimise treatment outcomes. Many different applications are currently being explored but the entire potential of AI in healthcare is yet to be discovered. Here are a couple of examples where AI can be applied in healthcare[99]:

- **AI in drug discovery and development**. AI can be used to speed the development of new drugs, which can take up to 15 years and cost around $2B. Improving the efficiency of drug discovery and development is therefore an attractive field. By identifying novel disease targets and drug candidates, optimising analytical processes through suitability predictions and accelerating clinical trials, AI can be used at many stages of the development process. Moreover, unleashing new potentials for already existing drugs (i.e. drug repurposing) is an area that has shown interest to many pharmaceutical and biotechnology companies.
- **AI in disease diagnostics**. AI systems can be trained to recognise imaging and other types of health data used to diagnose conditions, and therefore highlight relevant disease signals that appear to differ from healthy states. These insights can then be used by physicians and help them in the decision-making process.
- **AI in the clinic**. In the top 10 AI applications, virtual nursing assistants are leading the path. By virtually assessing patients' symptoms, AI systems inform and alert clinicians when needed, thereby reducing the burden put on healthcare professionals – this, of course, does not mean they can replace physicians, but they can assist them by aiding diagnosis and management.[100] Robotic surgery can be explored by AI systems as well. Moreover, automation of manual tasks can also be achieved with AI systems, thereby saving human resources and improving productivity. Finally, AI could predict patients' response to a given therapy and personalise treatment according to individual characteristics.
- **AI in individuals' lives**. Wearable devices can track health data in real-time and inform individuals on their health and disease status. Accurate disease risk models can be generated, thereby giving individuals targeted advice and disease management solutions.
- **AI in public health**. By analysing data in real-time and surveying diseases at a global scale, AI systems can play a role in global health protection and health promotion. AI can also be used to analyse cultural health trends and therefore inform governments on different regulations and policies to put in place to improve global health.

These represent only a handful of the many applications of AI in the medical sector, and a lot more are expected to come and revolutionise the way healthcare is delivered. However, many social, economic and legal challenges remain. These include issues around data privacy, safety and efficacy of AI systems as well as "black box" concerns around AI systems decision process.[101] These need to be tackled to ensure proper implementation and optimal outcomes of this new technology.

Robots as personal carers and improved access to medical technology - a revolution in care for the elderly, frail, and disabled?

It is now well established that the geriatric population is increasing: the number of people older than 65 years is projected to rise from 703 million in 2019 to 1.5 billion in 2050.[102] This ever-growing societal concern will result in an increasing demand for care services, thereby raising the need to find scalable and effective solutions. One of them could be using robots as personal carers. Different examples of this are highlighted below:

- Robots could be used to **combat loneliness and cognitive decline** associated with it, such as Mobile Robotic Telepresence systems.[103] These robots are composed of a video screen built on wheels whereby relatives and friends or even artificial individuals or pets can interact with the elderly thanks to the robot which mimics human's or animal's movements.
- Other examples include humanoid robots that can **perform simple household tasks** such as picking up things and reminding individuals to take their medication, thereby offering the elderly the opportunity to remain independent and reducing the burden put on care workers. Through interactive interfaces, robots could raise disease awareness and improve access to medical technology by offering individuals online learning and intellectual sessions.
- Other applications could be identifying abnormal behaviours and signs of illness from the patient and remotely reporting them to doctors so that they can act. Indeed, robots can **generate real-world data** about the individual's health that can be used to track health status as well as to monitor treatment adherence and efficacy. This would allow healthcare workers and clinicians to focus only on individuals who need it most.

Some of these robots are already available, such as PARO, which focuses on animal therapy to improve mental health, or Pepper, a humanoid robot that can perform many of the above functions.

In the future and with advances made with AI, these robots may feature human-like thoughts and behaviours, and mimic human forms and interactions in ways that are similar to reality. While the use of robotics could save the healthcare system a tremendous amount of money, affordability and global availability is a concern that needs to be addressed. Similarly, important legal, regulatory and ethical considerations need to be considered when building these robots, such as data ownership and privacy questions, as well as liability issues. Proper frameworks are necessary and will be key to adoption and wide implementation.

Personalised medicine - How feasible is it and what are the barriers to its implementation?

The aim of personalised medicine is to offer the right customised treatment to the right person at the right dose, thus maximising efficacy and minimising toxicity for each individual patient.
Personalised medicine will be a paradigm shift in the practice of medicine and transform the healthcare system as we know it.[104] It has become a new approaches to better manage patients' health and target therapies, thus achieve the best outcomes in the diagnosis and treatment of a patient's disease or predisposition to a disease, rather than a 'one size fits all' approach to the treatment and care of patients with a particular condition.[105] Thus, personalised medicine will provide opportunities to improve how we treat disease. We are all unique. Our health is determined by our inherent differences combined with our lifestyles and environment.[106] By combining and analysing information about our genome, with other clinical and diagnostic information, patterns can be identified that can help to determine our individual risk of developing disease; detect illness earlier; and, determine the most effective interventions to help improve our health, be it medicines, lifestyle choices, or even simple changes in diet, as illustrated in Figure 8.

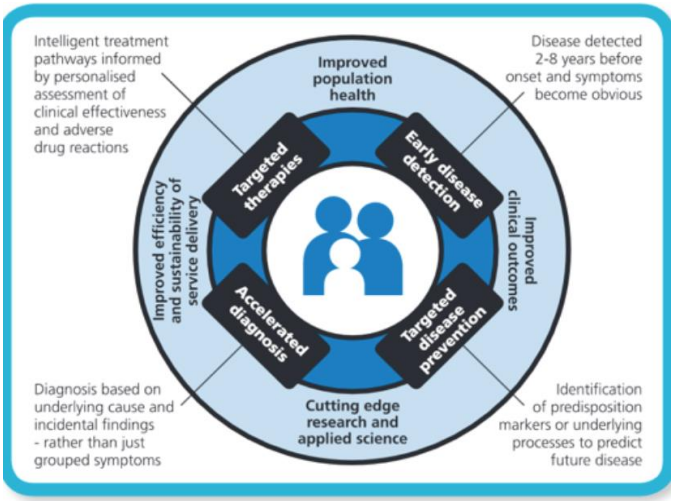

Figure 8: An outline of the most useful interventions in medicine and potential areas for personalisation of medicine. Courtesy of the NHS.

Personalised medicine and healthcare are not new concepts. Clinicians have been working to tailor care to people's individual health needs throughout the history of medicine. However, we have never before been able to predict how each of our bodies will respond to specific interventions or identify which of us is at risk of developing an illness. New possibilities are now emerging as we bring together novel approaches, such as whole-genome sequencing, data and informatics, and gene editing.[107] Greater targeting of treatments has the potential to revolutionise healthcare delivery through improved effectiveness, reducing the numbers needed to treat (NNT), reducing side-effects increasing the numbers needed to harm (NNH), as well as potentially reducing costs (Figure 9).[108]

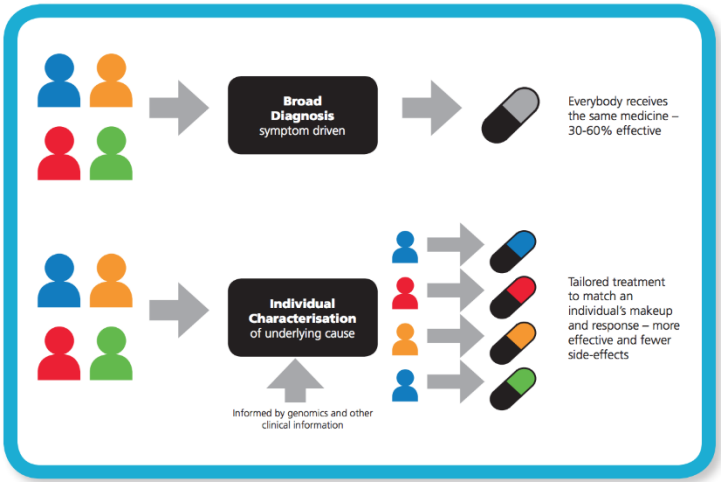

Figure 9: Visualisation of the personalised medicine strategy and its benefits. Courtesy of the NHS.

It has been evident that patients respond differently to medicines due to various biological, environmental and genetic factors. For instance, a patient's genomes account for 20-95% of the

variation in response to drug disposition, translating into considerable differences in response to treatments.[109] The personalised medicine revolution, will with increased accuracy:

- predict and prevent disease
- precisely diagnose disease
- offer increasingly personalised treatments
- embrace a more participatory role for patients in their care

However, the early promise of personalised medicine has not always translated into improved care for patients. Payers have concerns that current tests can be costly, requests for funding specific tests have subsequently been reversed as more information becomes available, and there is currently fragmentation in the funding of diagnostic tests.[110] Payers also have concerns that pharmaceutical companies are exploiting the situation by seeking orphan status for their new targeted medicines driving up requested prices.[111] It is also not clear who should fund biomarkers that accompany new expensive medicines. This is changing as the cost of tests come down, and payers develop new models to optimise the managed entry of new medicines as well as evaluate potential prices for new medicines for orphan diseases.[112] There are also developments with 'big data' offering a new understanding of disease complexity to enhance pipeline productivity and diagnosis as well as ongoing developments with drug resistance testing and research into the role of microbiomes to improve future health.[113] Moreover, current challenges and concerns are being addressed. This will continue to improve patient care.

Genetic testing and the generation of biobanks also has some significant ethical pitfalls that must be considered, namely the ownership of the patients' genomic data. When DNA is taken for testing, the company undertaking the test retains the rest of the information about the patient's genome, which can then be sold to pharmaceutical companies. There are some very tangible benefits to this type of transaction and biobank formation; thanks to biobanks, basic science observations in large numbers of reproducible samples can be linked to their clinical relevance, while these large pools of data can help potentiate research collaborations between different researchers, ethicists and other professionals. However, one must carefully consider whether it is ethical to hold personal information under private ownership for the greater good (particularly for research, personalised medicine, and public health purposes). An example of this was seen in Iceland in 1998, when the national DNA database was sold to deCODE genetics, a private company,[114] a move that raised the questions about privacy and commercialisation of personal data discussed above.

Barriers to implementation of personalised medicine into clinical practice

Though the field has greatly matured over the past decade in terms of its technical capabilities, there are several challenges ahead before personalised medicine can be successfully implemented. For instance, the development of high-throughput, data-intensive biomedical research assays and technologies have created a need for researchers to develop strategies for analysing, integrating and interpreting the massive amounts of data they generate. Although several algorithms have been developed to analyse big data, AI technologies have shown to be a more appropriate method. In order to successfully implement AI in medicine in the future, it must be done both in a safe and ethical manner.[115] Equally important will be collaborations that have formed and the knowledge exchanges that have taken place between members of this global consortium of researchers.

Similarly, Artificial Neural Networks (ANNs), which are highly interconnected processors able to perform parallel computations for data processing that consist of computational analytical tools inspired by the nervous system, are now a very popular technique in medicine. ANNs can exploit the intricate variations between variables to accurately classify and recognize patterns and are therefore very useful in predicting outcomes for many different conditions.

This also begs a crucial question: how should developing countries and the resource-limited regions of developed countries invest in genomic medicine? Although a full-scale investment in infrastructure from discovery to the translational implementation of genomic science is ideal, a simple "transplantation of genomics" from developed to developing countries is unlikely to be feasible at all times,[116] nor should developing countries be seen as simple recipients and beneficiaries of genomic medicine developed elsewhere, because important advances in genomic medicine have materialised in developing countries as well. Moreover, education on personalised medicine and genetics and genomics for both healthcare professionals and the general public is essential to successfully integrate personalised medicine into mainstream healthcare systems. A mid-stream entry into innovation can enhance collective learning from other innovators' mistakes upstream in discovery science and boost the probability of success for translational and implementation science when resources are limited.[117] Hence, this à la carte model of global innovation offers multiple entry points into the global genomics innovation ecosystem for LMICs, whether or not extensive discovery infrastructure is already in place.

Genetic data is being generated in ever-escalating volumes at faster speeds thanks to the rapidly evolving sequencing technology. However, a gulf has evolved between the speculated potential of genomic data and the yields that it was delivered clinically.[118] To help address this, the systems available are undergoing a revolution with for instance IBM Watson working with a number of institutions to use cognitive computing capability to develop OncoKB, an Oncology knowledge base to generate new understanding, diagnostic and treatment options for individual cancer patients.[119]

It will also become increasingly important for regulatory agencies to collaborate on the development and establishment of harmonised guidelines for genotyping and biomarker testing. However, it is acknowledged many challenges and difficulties are achieving this. Thus, to achieve this, there needs to be a body of coordination between the different legislator domains in the healthcare system.

Ethical Issues

- Screening programmes and risk of disease

An example of an ethical issue with screening programmes concerns the use of ANNs discussed above. ANNs have been used in clinical diagnosis, image analysis in radiology and histopathology, intensive care, and epilepsy. PAPNET is a commercial example of a computer screening system used to perform cytological cervical screening. Being able to accurately identify patients considered high-risk can facilitate targeted aggressive adjuvant therapy, which is able to prolong survival. ANNs is able to use non-linear interactions between variables and therefore can be used to analyze complex data such as that related to cancer. As not everything can be considered black or white in medicine, “fuzzy logic” has been developed, a system which recognizes that most things fall somewhere in the

grey zones. This technique has been used successfully in cancer detection. Hybrid intelligent systems could soon be devised to work in a complementary manner.

- What is the role of humans in administering healthcare services in an increasingly computer dominated system?

AI programs are intended to help the clinician formulate a diagnosis, make therapeutic decisions and predict outcomes. Their main role is to support healthcare workers, especially when accessing and manipulating data and knowledge, at a time when medicine is faced with having to acquire, analyse and apply a large amount of data to solve complex clinical cases. An AI system can provide health professionals with constant, possibly real-time updates of medical information from various sources including journals, textbooks, clinical practices and patients to improve patient care. Medical education should also focus in incorporating AI in the curriculum, especially on how to use AI machines in practice. However, technology will never be able to replace humans; limiting factors such as the lack of human characteristics (e.g. compassion) and unavailability of health data, as well as rare/novel diseases, mean that AI can only be used as a tool to improve healthcare for patients.

- What are the ethical problems of using robots in healthcare?

With the use of AI in healthcare different issues could arise, such as the following:

- *Legal issues:* medical malpractice and product liability especially, as it is not always possible to provide a logical explanation of how the algorithm was obtained.
- *Policy gaps:* policy gaps regarding patient protection could lead to threats to privacy and confidentiality, informed consent and patient autonomy. There should be renewed efforts to ensure that AI is developed and used in a transparent and accountable way that is consistent with public interest, and therefore does not represent an added risk to the patient.
- AI can be very costly and time consuming (e.g. datasets that require manual annotation from healthcare professionals).
- Restrictions may arise, due to unavailability or difficulty to collect the required data.
- There may be occasions in which machine learnt algorithms do not provide accurate predictions of outcomes across race, gender or socioeconomic status.

Future perspectives

Personalised medicines, including targeted treatments, should bring considerable benefits to patients and healthcare systems with increasing knowledge of genomics and pharmacogenomics. To attain this, there must be greater coordination of bodies, including payers, to fund new medicines and diagnostic tests of value. Alongside this, there is greater scrutiny over requested prices for new targeted medications, especially for cancer and orphan diseases.[120] Pharmaceutical companies should consider more realistic pricing for new targeted treatments to enhance reimbursement with reduced need for extensive marketing and advertising. The technological and scientific advances will continue to develop and improve medical practice. Although we are seeing personalised medicine being embedded in mainstream healthcare, we must also think about ensuring everyone benefits from this – regardless of where they live, the illnesses they have, or where their care is provided.

Subtheme 6: Adverse health effects of technology

Although technology can be an asset in our pursuits for improving healthcare access and standards worldwide, the transition to a society so dependent on technology can have important health ramifications. The increasing role of social media and computers, television, and video games in our entertainment, work, and everyday tasks has made us physically and emotionally dependent on them in many ways. We are becoming more sedentary and overweight, while the overuse of social media and video games can have devastating psychological effects to the point of addiction and even physical and mental harm. Although there has been progress by corporations and governments on those fronts, research must be carried out and more measures need to be taken to fully realise the scope of the problem and move towards appropriate solutions.

Video game and online gambling addiction

The increased availability of video games over the past few decades has led to a rise in video game addiction (otherwise known as gaming or internet gaming addiction), which is increasingly common in children, adolescents, and adults alike. This can take a number of different forms, but is most likely to present with depression, social withdrawal, and excessive video game playing for very long periods of time. There is currently some debate regarding whether gaming addiction is a separate clinical condition or a way for underlying psychiatric disorders to manifest themselves, though there should be rehabilitation and management of the condition regardless.

Like many other forms of addiction, video game addiction has many diagnostic features, which are based on The APA has come up with 9 proposed indicators of Internet Gaming Disorder[121], which has led to the development of the Internet Gaming Disorder (IGD-20) Test as a diagnostic test:

1. Pre-occupation (spending a lot of time thinking about the game)
2. Withdrawal symptoms (restlessness, irritability, anger, anxiety, sadness)
3. Tolerance (increase in gaming activity/more exciting games needed for excitement)
4. Reduction/stopping of the activity (self-awareness regarding cutting down on gamimg)
5. Giving up other activities
6. Continuing the activity despite problems caused by it (e.g. spending too much money, school/work problems, too little sleep)
7. Deception/covering up of the activity
8. Escaping adverse moods
9. (Risk of) loss of relationships/opportunities

In terms of its status as a psychological condition, it has been added to the latest version of the WHO International Statistical Classification of Diseases (ICD-11), which will be in force from 2022, while the American Psychological Association has added it to the list of "conditions requiring further study" of the 5th version of the Diagnostic and Statistical Manual of Mental Diseases (DSM-V), as there was insufficient evidence over its status as a mental disorder. The DSM-V does have a section on Internet gaming addiction as a mental illness. There are also specialist centres for the treatment of video game addiction, though these have often been fraught with controversy – in China, where government clinics to treat "internet addiction" are popular, there have been many allegations of

violence, use of pain and shock therapy as methods to treat the addiction, and militaristic management of the centres.[122] As such, delegates should consider the establishment of a set of criteria or accreditation for rehabilitation centres for video game addiction, to ensure the safety and quality of care provided to the individuals managed by those centres.

Figure 10: Courtesy of LaPolitica.gr

On the other hand, online gambling addiction is much better defined as a mental illness, as it is closely related to gambling addiction that manifests itself in real-life scenarios (mostly in the form of casinos). The rise of online gambling addiction started with the move of many casino games, such as poker and blackjack, to online platforms (e.g. Zynga). The same or similar legislation usually exists as with physical casinos to help protect the users and providers claim to be vigilant in protecting people from addiction if they notice concerning behaviour, but there is still a significant number of people losing significant sums of money every year as a result of their gambling addiction. Similar guidelines to the Internet Gaming Disorder exist for pathological gambling by the APA[123], which can be reliably applied to online gambling as well as physical gambling.

Something that has been observed is that, because of the anonymity and privacy it provides, online gambling can be much more damaging and addictive than normal gambling in casinos or similar locales. Research has shown that online gamblers tend to bet much more than gamblers in physical casinos and have a much easier access to their money, and are thus at a much greater risk of racking up significant losses and pursuing dangerous behaviours related to online gambling.[124] Certain features of online casino, such as the promise of free bets or odds against the player when real money is used, further exacerbate the problem and can cause further problems and money loss stemming from gambling addiction.[125]

Due to the growing severity of the issue, many governments have either issued outright bans against online gambling companies or limited the maximum betting amount per bet, with the United Kingdom having suggested a limit of £2 per bet for certain categories of games.[126] There is also legislation to help protect minors, such as requesting ID and only allowing people to use the services if they are over 18 or 21 (depending on the region), and severe fines are in place to ensure compliance.[127] In addition, many companies have committed to the welfare of their players by identifying signs of addiction (such as irrationally large bets) and imposing limits on their ability to bet, though these are often easily circumvented and have largely been seen as inadequate measures to limit the effects of online gambling addiction. Another issue with the current legislation is the lack of uniform laws in different countries, such as in the European Union, where in some countries there is a blanket ban and in others there are certain pathways to allow online gambling, which makes reaching consensus more complicated.[128]

Although the area of gaming and Internet gambling addiction still requires significant research, the level of usage of both video games and the Internet nowadays means that billions of people are

potentially at risk of developing addiction. As a result, it is integral that the international community develops measures for supporting addicts and to ensure research continues in this area.

Social media and psychological wellbeing

The advent and widespread use of social media has completely revolutionised our social contacts with other individuals, by allowing others to contact us at all times and enabling everyone to create an image to present to other individuals. Although this constant accessibility and ability to communicate with others is clearly beneficial for many users of social media, the presence and frequent use of social media is also considered to have detrimental effects on the users' mental health and wellbeing. The ubiquity of social media nowadays means that people have significantly reduced face to face contact with each other, which for many results in a lack of empathy and a diminished ability to form close relationships in real life.

Figure 11: Courtesy of Wondershare FamiSafe

As with video games, social media and the Internet can adversely affect the users' everyday lives. 'Social media addiction' has been observed in multiple studies and is thought to affect about 5% of young people. It is often observed as an 'urge' to check and refresh one's social media, which might be linked to dopamine production (the brain signal associated with reward) and instant gratification.[129] This compulsive use also has the drawback that, if instant gratification is not experienced, the person might think that it's because they are not popular or unfunny, which then lowers their self-esteem and causes them to reflect negatively on themselves. This can amplify feelings of loneliness and anxiety, which can be compounded by a lack of sleep or poor sleep quality which may be associated with social media use. Poor sleep is also a detrimental factor contributing to mental health, as there is a vicious circle; poor sleep causes poorer mental health and vice versa. Like other addictions, the social media addiction presents with usual addiction symptoms, such as an increased tolerance, tendency to relapse, and mood disturbances related to the use of or withdrawal from social media.

Another important aspect to be considered is the phenomenon of 'fear of missing out' (FOMO), which may be experienced when a person feels that others are having fun or taking part in activities without them.[130] This has been linked to intensive social media use and is often a sign of lower mood and life satisfaction, as humans are social beings and the feeling of social exclusion can be very psychologically damaging. There is a specific condition called "social anxiety" or "social phobia", which can present with fear of embarrassment or being judged by others, and often affects social media users[131] and contributes to the worsening of in-person communication skills.

Another negative aspect to social media is cyber bullying, most commonly experienced by adolescent users. Cyber bullying is an umbrella term including all types of bullying that can happen online or through smartphones and tablets, and comes in many forms, such as harassment and flaming, denigration, exposing personal information, cyber stalking, impersonation, or social bullying.[132] It is particularly harmful for the mental health of the victims, especially as the direct communication between the perpetrator and victim means there is less scope for other students, teachers, or parents to intervene. Cyber bullying is also sometimes associated with a degree of shame on the victim's side, as they do not always want to admit to being affected by it – minors are also in danger of sexual predators posing as individuals of their age and tricking them to meet them in person. On a larger scale, the promotion of damaging beliefs such as opposition to abortion, racist, homophobic, and sexist rhetoric, can lead to further mental health effects for the affected groups this material reaches and may contribute to existing psychological issues affecting minorities such as LGBT+ individuals, which has been termed by psychologists as 'minority stress'[133].

The widespread use of social media and ability to reach a massive audience has also led to the rise in many groups promoting fake news. One such group is anti-vaccine activists, whose actions have led to a stagnation of vaccination rates worldwide. The MMR vaccine in particular has been singled out, based on a since widely discredited study by Andrew Wakefield linking the MMR vaccine to a higher rate of autism. The movement has severely reduced herd immunity for many diseases, especially measles: in 2018, more than 140,000 people died worldwide, the US had their highest number of new cases, while countries previously considered to have eradicated measles had new incidents, including the UK.[134] This can be a significant strain to health systems, as it necessitates the allocation of funds and resources to treat diseases that were supposed to occur at a much lower rate or not at all. Another important aspect is the promotion of alternative treatments for a number of conditions and of supposed "miracle" products, which are unhelpful or downright damaging to the health of their customers and prevent them from accessing appropriate healthcare for their conditions.

Considering this, corporations have moved towards restricting the content that can be posted and ensuring companies follow online safety protocols and adhere to transparency regulations. Twitter has permanently suspended certain users for violating its Terms of Service, including alt-right activists Milo Yiannopoulos and Alex Jones and the Greek neo-nazi party Golden Dawn, while other platforms have also taken similar measures. Governmental action has also been implemented; for example, the UK established a mandatory "duty of care" for social media firms to abide by, including addressing user complaints quickly, online safety features to be incorporated in new apps and platforms by design, media literacy strategies, and stringent requirements on transparency and forbidding illegal content.[135] However, there is still a lack of comprehensive worldwide legislation to help protect users of social media, and more so children and adolescents.

Any further action by governments or international bodies is contingent on the effects of social media being more widely examined by the scientific community and social media addiction or overuse – as they are now an indispensable part of our lives and have very tangible benefits for many of their users, there have been calls to reconsider whether social media addiction is an actual disease and to learn how to use them correctly rather than vilify them.[136] In general terms, however, there are many steps that need to be taken to help protect the users of social media from their negative consequences and provide them with appropriate resources to seek help.

The dangers of a sedentary lifestyle and the inappropriate use of technology

The increasing use of electronic devices, including televisions, computers, and mobile phones, as recreational activities can have detrimental effects on their users' levels of physical activity. The shift towards technology and the lack of suitable spaces in urban areas lead to children being less active in their spare time, while school physical education does not cover their daily exercise needs. Thus, the rates of many preventable chronic diseases are increasing, placing a significant burden on the health system.

Figure 12: Courtesy of Macrovector

This impact of technology can be especially damaging for children. According to the WHO, the appropriate activity level for most individuals, both adults and children, is 1 hour of physical activity per day.[137] A study on 6,500 children between the ages of 7 to 8 in the UK showed that only 51% achieved the recommended 1 hour of physical activity a day[138], with similar studies in the US[139] and Spain[140] corroborating similar trends and indicating that children and adolescents in the Western world in particular are becoming less and less active. Childhood overweight and obesity statistics have been rapidly rising over the past few years, with deleterious effects to their future health.

The effects of physical inactivity on present and future health have been well documented in scientific literature and include high blood pressure, Type 2 diabetes, coronary heart disease, certain types of cancers, mental health problems, and an overall increased all-cause mortality rate (partly due to overweight/obesity).[141] It is unlikely that this trend slows any time soon given our continuous dependence on electronic devices, and the figures seen in children are especially worrying, as they are being set up for an adulthood and later life with a greater risk of disease and overall poor health.

In addition to the above, other physical problems can be caused by the constant use of technology – these include eye strain from the prolonged use of screens, musculoskeletal and psychological issues caused by bad posture, and joint problems (such as "texting thumb" or cubital tunnel syndrome, both of which are caused by phone overuse[142]). Technology can also directly endanger public safety as a result of driving while texting, which is estimated to cause over 1,600,000 traffic accidents worldwide and is 6 times more likely to cause a crash than driving intoxicated.[143]

To combat this issue, many apps allow their users to follow home workouts and track their diets or follow healthier lifestyles. Government initiatives to promote healthy school lunches and increase the spaces for children to exercise, as well as promote physical activity in the school curriculum, have also been met with approval by the public. Given the COVID-19 pandemic, the view of scientists and doctors has changed somewhat on the extent to which devices are used, as individuals have fewer resources for education, work, and entertainment due to lockdown and social distancing measures and therefore must depend much more on technology for their basic needs, though the full extent of this in terms of other health problems will not be evident soon.

Conclusion

Technology in healthcare and in our everyday lives in general has made huge strides over the past few decades, having completely altered our way of living and the way we see the healthcare industry. Many of these technological developments have dramatically improved the lives of people worldwide; drug development has become much quicker and simpler for many medications and new medical devices are making diagnosis and treatment of medical conditions much easier and less time-intensive than it used to be. Furthermore, new technologies such as AI, virtual reality and personalised medicine are carving new paths in making healthcare provision more holistic and individualised, while Electronic Health Records and biobanks are reducing the administrative burden on hospitals and research centres regarding the collection and storage of patient data for personal and public health purposes. However, despite all these great developments, there are many obstacles still to be dealt with; these include the ethical concerns caused by the use of technologies infringing on patient privacy for the benefit of the population as a whole, the inequitable access to healthcare (drugs, services, devices and technologies) within and between different countries and regions, the potentially deleterious effects of everyday technologies on our collective physical and mental health, and the need to make our planet more sustainable as a whole. Challenges such as the COVID-19 pandemic only serve to make these problems worse by putting further strains on healthcare systems worldwide and changing our lives in all aspects imaginable.

As demonstrated by the far-reaching effects of the COVID-19 pandemic, there will be rapid and drastic shifts in the way healthcare is delivered in the future, such as an increasing role for telemedicine, tracking apps, Electronic Health Records, and further innovations in drug research and development. Some of these will be out of a necessity to adapt to the new circumstances brought by the pandemic, while others will be borne out of a desire to make the provision of healthcare as sustainable as possible. As an international community, we need to make sure we use it "well": that is, all new technology is used to improve the lives of patients and is regulated appropriately to prevent its abuse and any ethical problems that might arise from its use. Equally essential is that we ensure these new technologies are equitably and fairly distributed to all populations and their development and use promotes a more sustainable provision of healthcare worldwide.

Most importantly, we need to ensure that this new face of healthcare adheres to the same tenets we have always tried to base healthcare provision on: ensuring the best possible standard of care for patients As a conclusion, we would like to refer to a perspective offered by author Harold Thimbleby on the principles any further technological development in the field of healthcare should abide by[144]:

"Such principles are or should be timeless; we should not plan the future by being technology-driven, but by improving along criteria behind principles (such as improving patient care or staff support). Articulating the principles of the futures we want should be a continual process, not a one-off activity; every day there is a new future to plan, and new discoveries that will change our minds about what is possible and likely. Future planning should be as much a routine part of healthcare as responsive care is. If we don't know what we need, we will get what is easy and profitable to make; as we emphasized above, what we need and what we want are often confused."

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