For professional investors - Marketing communication - November 2020

US HEALTHCARE IN A POST-PANDEMIC WORLD

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INTRODUCTION

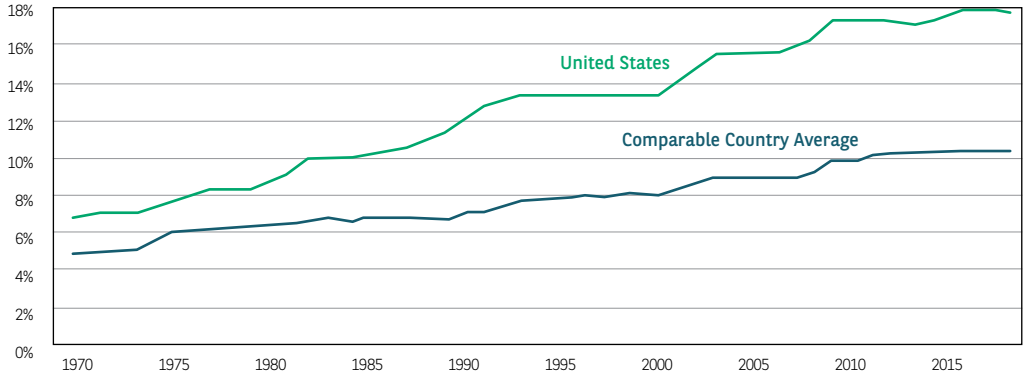
The Covid-19 pandemic has had profound and wide-ranging impacts on our healthcare systems. With the virus raging throughout the developed world, healthcare systems had to shut down and patients were reluctant to seek care for fear they may become infected. This resulted in massive delays in surgeries, diagnostic testing and even emergency room visits for acute events such as strokes and heart attacks. It has also contributed to declining global vaccination rates; the Gates Foundation said vaccination rates have dropped to levels not seen since 1990). There is no doubt that these issues will have profound implications for patients as delays in care will inevitably adversely affect long-term patient outcomes, and lower vaccination rates will leave many people vulnerable to avoidable diseases.

The pandemic has also exposed – and exacerbated – the extent of inequities in access to care within the US healthcare system as socioeconomic factors have been crucial determinants of who becomes infected, and how severely. This is a critical issue since data shows that social determinants of health (such as job, income, exercise, nutrition, housing, etc.) account for 80% of a population's health issues. Those who are deprived in the context of these social determinants are most at risk of getting infected. They are also more likely to have underlying medical conditions predisposing them to increased disease severity. In addition to having significant care gaps, the US health reimbursement system incentivises treatments more than preventative care - which has led to major system-level cost overruns. The US healthcare sector is thus ripe for disruption: Costs are increasing at unsustainable rates as demand grows in line with demographic trends. This white paper assesses the principal structural issues in the US health system and solutions that could help build a better, more resilient health-ecosystem.

HEALTHCARE AFFORDABILITY: THE IMPACT OF SOCIAL DETERMINANTS OF HEALTH & ACCESS TO CARE

Healthcare costs have justifiably been a point of political debate for some time as, measured as a percentage of GDP (see Figure 1), expenditures have risen steadily for many years, in the world as a whole, but particularly so in the US. Much of the focus of cost discussions has centred on unit pricing and yet much evidence suggests the issue is far more complex. While unit pricing is indeed an important component, we believe that social determinants of care, access to care and reimbursement incentives are much more problematic issues. We believe the Covid pandemic has unveiled some of these issues.

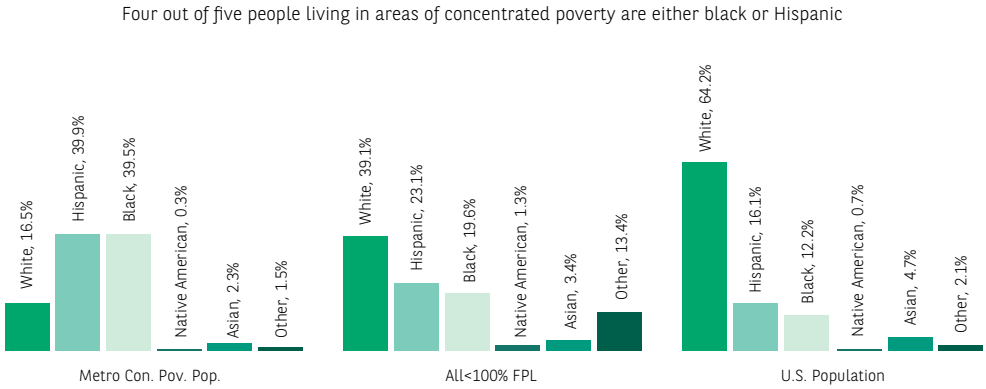
Figure 1: Healthcare expenditure as a percentage of GDP, 1970-2018



Source: KFF analysis of OECD and National Health Expenditure (INHE) data

When the Covid-19 pandemic started, it led to widespread 'shelter at home' guidelines, which worked well for those who had a safe shelter and employment conducive to remote work. According to the Centers for Disease Control and Prevention (CDC), the incidence of Covid-19, hospitalisation and ultimate recovery in the United States was markedly different among those at the lower socioeconomic end of society, which tend to be disproportionately minority populations. Socioeconomic status, access to healthcare, multi-generational households and occupation significantly influenced health outcomes. The charts below show (Figure 2) the rate of poverty across racial populations and (Figure 3) Covid-19 hospitalisation and death rates by ethnicity in the US. The African-American, Latin and Native American populations have experienced significantly worse health outcomes compared to the white population during the pandemic.

Figure 2: Covid-19 hospitalisation in the US and death by ethnicity



Source: CDC

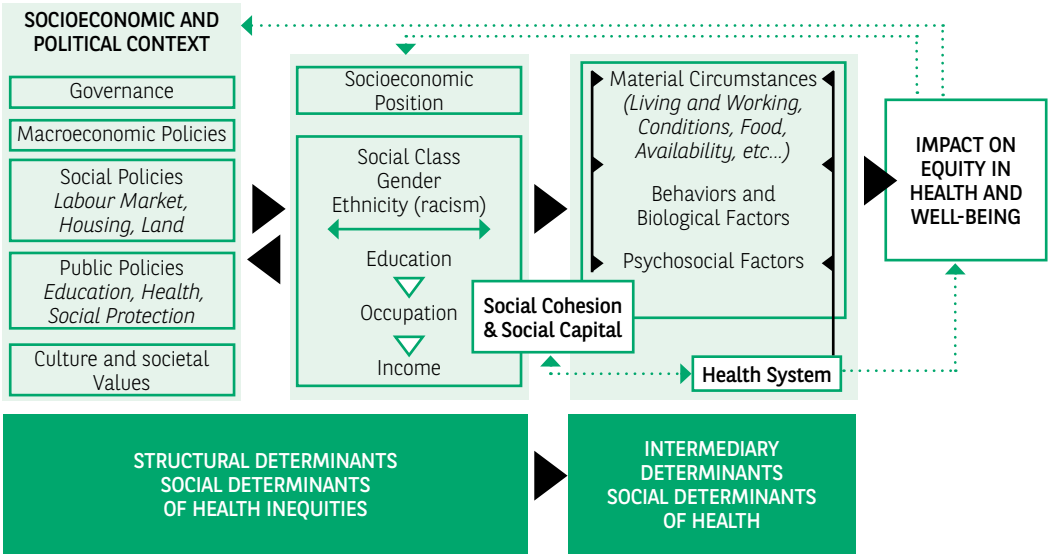
Figure 3: Covid-19 hospitalisation and death by ethnicity in the US

Rate ratios compared to White, Non-Hispanic Persons	American Indian or Alaska Native, Non-Hispanic persons	Asian, Non-Hispanic persons	Black or African American, Non-Hispanic persons	Hispanic or Latino persons
Cases[1]	2.8 x higher	1.1 x higher	2.6 x higher	2.8 x higher
Hospitalization[2]	5.3 x higher	1.3 x higher	4.7 x higher	4.6 x higher
Death[3]	1.4 x higher	No Increase	2.1 x higher	1.1 x higher

Source: CDC[1]

While Covid-19 provides a clear new example of the impact that social determinants have on healthcare outcomes and the resulting burden on our societies, these factors had already been well documented. According to the World Health Organization, the social determinants of health are the conditions in which people are born, grow, live, work and age. These circumstances are shaped by the distribution of money, power and resources at global, national, and local levels. While access to clinical care is important for population health, ~80% of population health outcomes are based on factors that have nothing to do with clinical care. Societal determinants, which include the physical environment as well as social and economic factors, determine 50% of health outcomes. Health behaviours, which include alcohol/drug/tobacco use, diet and exercise, have a 30% impact on health outcomes (see Figure 5). These are complex issues affecting patients who have complex needs and the current episode-based reimbursement structures (as opposed to value-based) lack any incentive to address them.

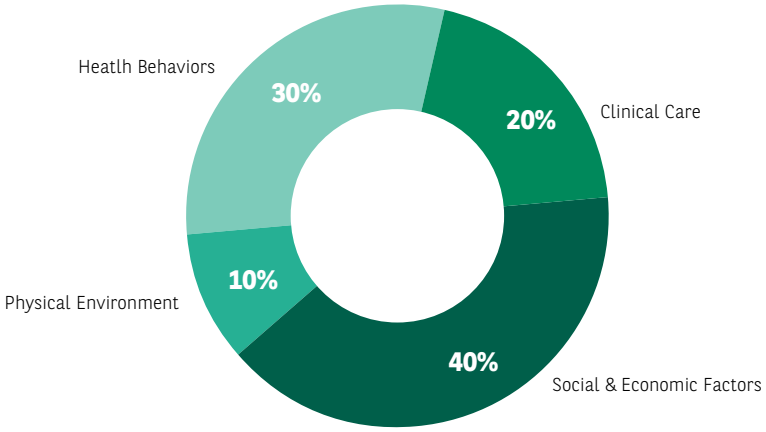
Figure 4: World Health Organization conceptual framework on social determinants of health



Source: University of Wisconsin Madison, Institute for Research on Poverty

[1]1. Data source: Covid-19 case-level data reported by state and territorial jurisdictions. Case-level data includes about 80% of total reported cases. Numbers are unadjusted rate ratios.
2 Data source: COVID-NET (https://www.cdc.gov/coronavirus/2019-ncov/covid-data/covidview/index.html, accessed 08/06/20). Numbers are ratios of age-adjusted rates.
3 Data source: NCHS Provisional Death Counts (https://www.cdc.gov/nchs/nvss/vsrr/COVID19/index.htm, accessed 08/06/20). Numbers are unadjusted rate ratios.
Source = https://aspe.hhs.gov/report/overview-community-characteristics-areas-concentrated-poverty/racial-and-ethnic-minorities are-overrepresented-concentrated-poverty-population-and-concentrated-poor-communities-metropolitan

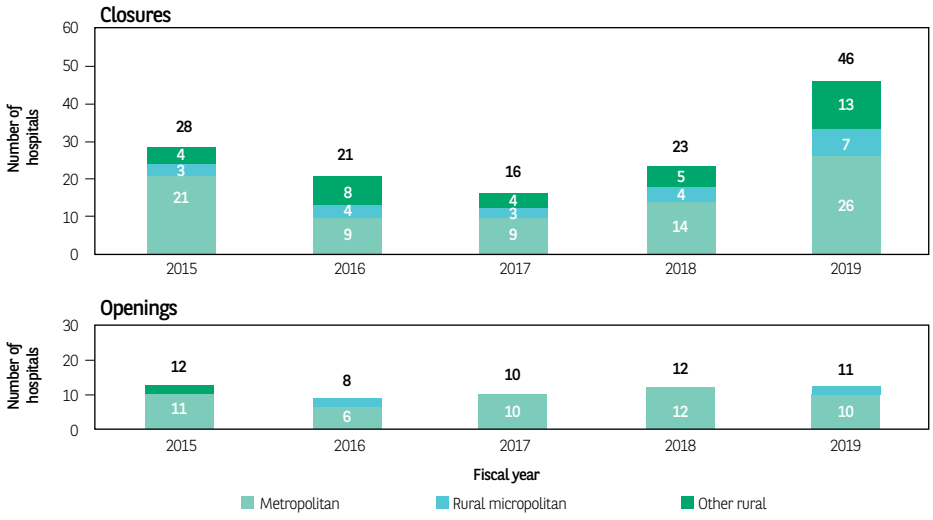
Figure 5: Factors affecting population health outcomes



Source: Federal Reserve Bank of Atlanta, University of Wisconsin health ranking model

In addition to the socio-economic and racial divide, healthcare access in the US varies widely depending on location. The urban versus rural healthcare-access divide is a critical issue that faces the nation. There are 6 146 hospitals in the US, of which 29.5% or 1 821 are rural community hospitals. Rural hospitals face increasing pressures with physician shortages, low patient volumes, an older population base and higher percentage of Medicare and Medicaid beneficiaries. Rural hospital closures look set to continue over the near to medium term and this will exert greater pressure on local communities. As shown in Figure 6, new rural hospitals have not opened at the same pace as there have been closures over the past five years. A hospital is often a major employer in a local community, so closures can adversely affect an area's economy, which in turn will likely exacerbate the social determinants of healthcare. The hollowing out of medical infrastructure in such areas results in significant care gaps at all levels (primary care, specialty care, hospital care) for people living there.

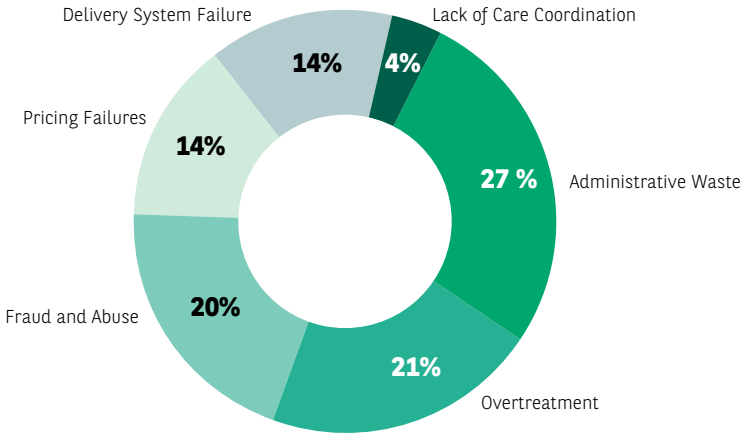
Figure 6: The number of general, short-term acute care hospitals that ceased and commenced inpatient services, 2019



Source: Medpac

The reimbursement structure within the healthcare system is an under-appreciated problem. Fee for service (FFS) is the current predominant payment system in the US. For example, nearly two-thirds of Medicare beneficiaries and the vast majority of commercial membership are in FFS-based insurance plans. In the FFS system, healthcare services are unbundled and paid for separately. Reimbursement is proportional to the services patients receive and so there is a perverse incentive to provide more services – as evinced by the significant cost of fraud, abuse and over-treatment (see Figure 7). Furthermore, there is no economic incentive for insurers to lower the total cost of care by garnering price concessions, leading patients to seek care in the most cost-effective setting. And it also means insurers are disinclined to address social determinants of healthcare expense or to close care gaps. It is a problem that begs for a better model – value-based payment.

Figure 7: Healthcare waste in the US



Source: Citigroup

Value-based care seeks to create an alignment of incentives across patients, physicians and payers by connecting provider reimbursement with the health outcomes achieved. When a significant proportion of reimbursement is linked to outcomes, providers and payers have an incentive to invest in addressing the principal drivers of medical cost – site of care, underlying health status and preventive interventions. Historically, this has been challenging because insurers have lacked the technological capabilities to evaluate relative cost effectiveness of site of care, returns on investments in preventive care and monitoring technologies. However, the convergence of innovative trends within the healthcare and technology sectors are coalescing to enable such comparable evaluations. Importantly, the transition to value-based care is already happening, as shown by the rising proportion of Medicare, Medicaid and commercial membership being managed under value-based reimbursement. The transition to value-based reimbursement has vast implications on care delivery models, healthcare technology adoption and purchasing patterns for medical devices and therapeutics.

INNOVATION IS DRIVING BETTER CARE

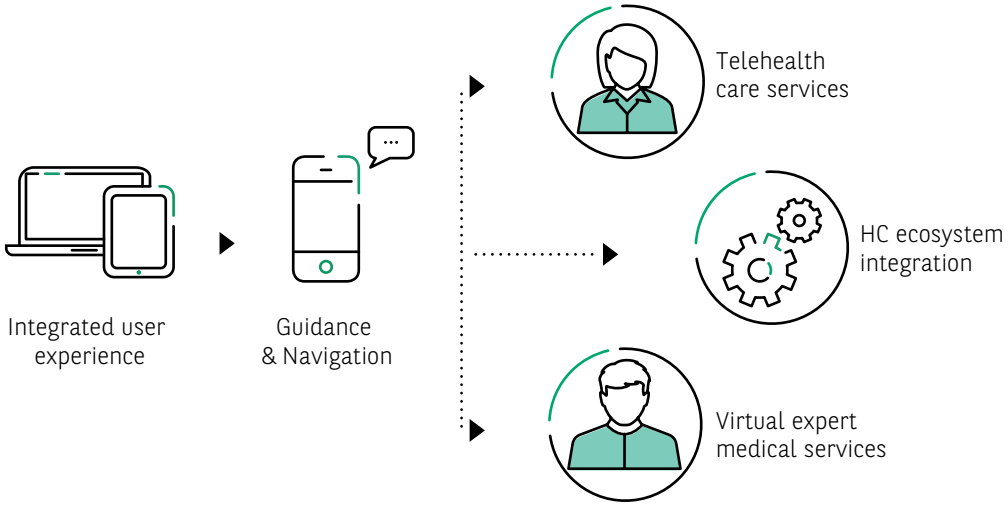
As affordability issues force a sea change in healthcare reimbursement methods towards value-based payment, payers and providers are becoming increasingly discerning purchasers of healthcare technology, services, medical devices and therapeutics. For this reason, we foresee healthcare technology investments being directed at data interoperability, increased connectivity, remote monitoring, infectious disease surveillance and analytics. On the device side, we would expect an increasing number of wearable diagnostics and intervention technologies. Within therapeutics, we expect payers to apply increasing pressure on pricing of competitive (older) drug classes in order to make room to invest in disease-modifying therapies in areas of unmet medical need.

The virtualisation of healthcare is a great example of the trend towards increased connectivity, data interoperability and analytics

Until recently, there has been very little innovation with regards to the manner in which physicians deliver healthcare. Regular check-ups would occur at the doctor's surgery, meaning patients taking time out of their day to travel there and fill out paperwork prior to seeing a physician for what would often turn out to be a quick check-up. Meanwhile, urgent care needs were typically addressed by patients going straight to a local emergency room irrespective of the severity of the underlying health issue. This resulted in higher overall medical costs, the potential for duplicative diagnostic testing (due to lack of integrated medical records), wasted time for both patients and caregivers, and patients being subjected to risk of infection. Furthermore, there have been material issues related to access to primary care services in certain rural regions, access to specialist care and an inability to coordinate care within the medical setting.

Telemedicine has recently emerged as a disruptive solution which addresses these specific issues by enabling licensed physicians and nurse practitioners to connect with patients and specialists to deliver and triage care. Over the last few years, the number of patients and physicians using this care alternative has been growing significantly and major payers have begun incorporating this approach into their plan designs. However, there was no widespread adoption as the key constituents needed to build greater confidence in this approach and indeed the whole telemedicine ecosystem needed to be further strengthened. This changed dramatically with the onset of the Covid-19 pandemic.

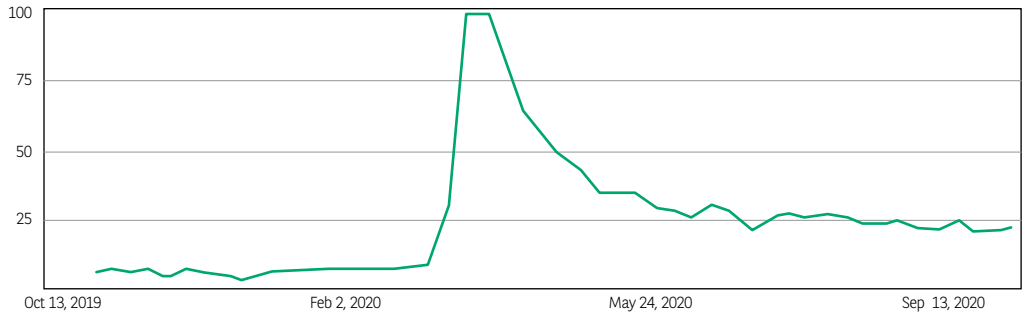
Figure 8: Interrelation of telehealth services components – for illustrative purposes only



Source: Teladoc

Covid-19 infection rates skyrocketed in many areas before the availability of widespread diagnostic infrastructure, leading to major segments of the healthcare delivery network being forced to shut down to mitigate the risk to the general public. As healthcare demand persisted, caregivers and patients were forced to rapidly adopt telemedicine. As can be seen in Figure 9, Covid-19 induced a skyrocketing of Google searches for the term 'telehealth' around the beginning of March and although volumes have dropped from peak levels, they remain at ≈3-4x pre-Covid levels. Telehealth vendors were forced to rapidly ramp up their onboarding of physician/nurse practitioners to scale up what they could offer, while an influx of new patients gained early experience of the service.

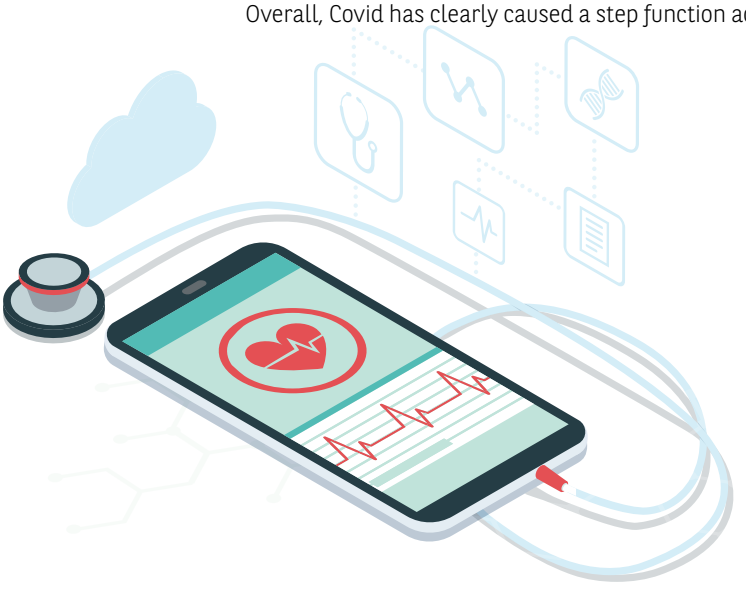
Figure 9: Incidence of Google searches for "telehealth", 13 October 2019 to 12 October 2020



Source: Google Trends data 13 October 2019-12 October 2020

Furthermore, the Covid-19 pandemic has forced health system managers to contemplate virtual outreach and collaboration tools offered by telemedicine companies. No longer could healthcare providers rely strictly on traditional methods of reaching out to their patients or coordinating with other experts. It became clear that providers needed virtual engagement/collaboration solutions to remain viable during periods of uncertainty because they offer the advantages of convenience and efficiency. Furthermore, these virtual engagement tools required a centralised network to integrate electronic medical record data from diverse sources and vendors in order to be able to inter-operate. Quantifying the absolute spike in RFP activity (or interest) for these initiatives is difficult, but publicly traded vendors have noted a step function increase in demand for these solutions.

There are clear advantages from having a virtual gateway into your health system. First, it enables providers (who are increasingly reimbursed via value-based payment models) to direct more urgent care in the most cost-effective way, resulting in near-term cost savings. Second, it fosters better engagement with patients, which could drive savings over the long term from better care management. Third, it fosters a more patient-centric data repository for patient records, which should aid in care coordination among providers. Fourth, it enables greater care outreach to patients who do not live close to key care providers. All of these factors provide synergies within an increasingly value-based reimbursement framework. Overall, Covid has clearly caused a step function acceleration in the adoption of this critical capability tool.



Emerging diabetes devices highlight the kind of innovation that is necessary in an increasing value-based reimbursement landscape

Over recent decades, significant advances in medical device engineering, connectivity and software have enabled the development of small, on-body continuous glucose monitors and insulin pumps, which are becoming increasingly integrated.

Diabetes is a disease whereby the body is incapable of producing sufficient levels of insulin, the key hormone responsible for glucose (sugar) regulation in the body. Patients require daily insulin injections (or continuous infusions through insulin pumps) to maintain steady blood glucose levels. Glucose monitoring is a critical component of disease control as it informs appropriate insulin dosing. Inadequate glucose control causes significant clinical complications. Perpetually high glucose levels generally result in long-term cardiovascular complications and elevated infection risks, which can result in limb amputation. Conversely, hypoglycaemia can cause patients to go into diabetic shock, which can cause seizures and coma. Therefore, it should not be surprising to learn that diabetes is an extremely difficult and highly costly disease to manage. In fact, the American Diabetes Association estimated in 2017 that the annual cost of diagnosed diabetes totalled approximately USD 327 billion in the US (equivalent to one-seventh of all US healthcare expenses). Of this, USD 237 billion went on direct medical expenses while USD 90 billion related to reduced productivity. Furthermore, approximately 30% of the direct medical expenses related to hospital inpatient care (https://www.diabetes.org/resources/statistics/cost-diabetes). Under a value-based reimbursement structure, there are clear pharmaco-economic benefits for payers and caregivers to seek technological solutions that can enable diabetics to gain better control over their disease in order to reduce downstream medical costs.

To address this need, medical device manufacturers are harnessing a confluence of innovation in engineering, connectivity (WIFI & Bluetooth) and software to create automated insulin delivery (AID) devices. Decades ago, the glucose monitoring and insulin pumping technologies would have been so large that patients using them would have been confined to bed (Figure 10, photo on left) – which was not realistically viable. However, the development of highly accurate patch technologies (called continuous glucose monitors – or CGM) can generate continuous glucose readings. These can be transmitted via Bluetooth to an on-body pump powered by algorithms that calculate the appropriate insulin dose. All data is also automatically fed to a personal diabetes manager device (or increasingly to a smartphone application uploaded for the purpose). This data can be monitored closely in real time by patients, family members and caregivers (Figure 10, right). Data shows that these combined technologies enable patients to keep their blood glucose levels within their target ranges for a significantly greater proportion of the day, especially at night when they are at increased risk of hypoglycaemic shock. This should ultimately reduce inpatient admission costs associated with hypoglycaemic shock, reduced long-term vascular complication rates (translating to fewer coronary interventions) and fewer limb amputations. Furthermore, it allows patients a greater sense of independence since the burden of disease management is greatly reduced.

Figure 10: Concept of automated insulin delivery – decades ago & today

Source: Mark De Boer Presentation (https://www.cecentral.com/assets/14234/Artificial%20Pancreas%20Technologies_Mark%20DeBoer.pdf) & Insulet 2018 Investor Presentation

The application of Artificial intelligence (AI) to healthcare innovation

Artificial intelligence is playing an expanding role in healthcare innovation. AI systems are being developed and deployed to speed drug discovery, enhance the analysis of medical images, and to assist diagnosis via pattern recognition of clinical data.

Archana Venkataraman, an associate professor of electrical and computer engineering at Johns Hopkins University, is using machine learning (a branch of AI) and other computational techniques to diagnose and treat neurological disorders. Her team has created an algorithm that uses electroencephalogram (EEG) data to detect the onset of epileptic seizures. The goal is to create alternative therapies for the one in three epileptic patients who do not respond to medication. In a short talk at the MIT EmTech conference in September 2019, Venkataraman said her team is also working on spinal cord injury, schizophrenia, autism and other conditions. The long-term goal is to improve patient care. (https://engineering.jhu.edu/ece/faculty/archana-venkataraman/)

AI solutions in the realm of the Covid pandemic can be categorised into three areas: Predict, screen, and track & assess. In terms of prediction, AI systems can detect the emergence and monitor the spread of infectious diseases. Within screening, applications include analysing vital signs and symptoms for early diagnosis. The leading provider of cloud and AI technology in China created an AI algorithm that can interpret computed tomography (CT) scan data and make a Covid-19 diagnosis in 20 seconds, many times faster than possible by a human. For track & assess, AI is used for contact tracing and exposure notification, to identify viral hot spots, and to assess the effectiveness of social distancing policies.

In a powerful recent example, AI was used to predict the outbreak of the novel coronavirus that causes Covid-19. The AI system developed by a small private company founded by infectious disease specialist, Dr Kamran Khan, successfully identified the emergence of a pneumonia-like disease in Wuhan, China. This enabled the company to alert its government and corporate clients on 31 December 2019 – which was before the US Centers for Disease Control detected the virus and prior to any official announcements from the Chinese government. Importantly, Blue Dot's system predicted the spread of Covid-19 within and beyond China by analysing airline ticketing data, enabling the company to alert officials in the soon-to-be-impacted regions and countries. As well as AI playing a crucial role in providing an early warning ahead of traditional diagnostic methods, it is also being used to mitigate the impact of the virus over time. For example, the Canadian government is using Blue Dot's system to help guide its policy response to the coronavirus, including the use of anonymised mobile phone location data to monitor the effectiveness of, and adherence to, social distancing directives. (https://www.wired.com/story/ai-epidemiologist-wuhan-public-health-warnings/) (https://www.utoronto.ca/news/u-t-infectious-disease-expert-s-ai-firm-now-part-canada-s-covid-19-arsenal).

One drawback with AI is the potential for biased data to result in models with unintended consequences. For example, if a genetic database is built primarily from data collected from people of European descent, any healthcare conclusions may be biased when applied to people of Asian or African ancestry. It is critically important for researchers to ensure the data adequately represents the target population.

While some observers worry that AI will replace humans, AI systems so far still lack crucial human abilities such as creativity and the ability to make judgments based on context. Most AI medical systems, including diagnostics and image analysis, are designed to assist rather than replace human experts. AI can contribute to lower-cost healthcare in the future, by improving the speed and accuracy of medical processes.

Contract tracing via mobile phones

Technology can play a critical role in contract tracing, monitoring the spread of infectious diseases and alerting those who may have been exposed. In early April, the two largest providers of operating system software for smartphones announced an unprecedented partnership to make the most of smartphones' Bluetooth capability to provide a solution that best protects the privacy of users. Their exposure notification system enables governments to build contact tracing apps without using location data from

GPS or other satellite systems. Instead, the Bluetooth-based approach infers close contact by detecting which phones are in proximity to each other. If one user tests positive and self-reports, an automated alert can be sent to the smartphones of those that were exposed to the infected person. All this can be done without the government knowing who was exposed and exactly where they were at the time. No personally identifiable data or location data is collected by the system, and explicit consent is required from the smartphone owner to opt into the system.

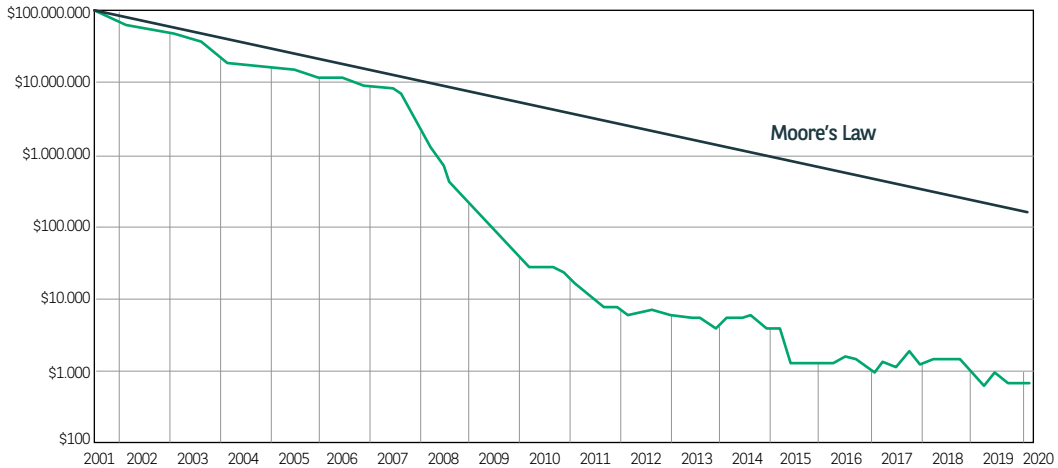
The problem, however, has been relatively slow adoption, particular in the United States, where there is no federal government program for contact tracing. As of 26 October, one of the companies reported that 13 states have implemented both companies' exposure notification system, with another five states developing apps and one more planning to participate[1]. In addition, users must opt-in to the system and self-report in order for it to be effective. Thus, local governments and health agencies that use technology-enabled exposure notification are supplementing the effort with manual contact tracing efforts.

Still, these efforts are most likely yielding measurable benefits. A recent study conducted by Oxford University and the company that is the largest provider of the Android OS found that, in a model with 15% participation of the population, technology-based exposure notification systems "could reduce infections and deaths by approximately 8% and 6%, effectively complementing traditional contact tracing."[2] There is some evidence that the rule of thumb of 60% participation to achieve effectiveness is too pessimistic.

A thriving biopharma industry, powered by next generation sequencing (NGS), can enable a thriving society

Biotechnology has been among the most innovative industries in the economy. This has been brought about by a convergence of scientific advancements – specifically an incredible decline in the cost of genetic sequencing (see Figure 11) and the power of AI, which enables rapid analysis of mass quantities of data derived from sequencing activities. Moore's Law speaks to the rapid improvement in microprocessing speed over time. We can all understand the real-world implications of these improvements in computing power. However, the cost of genetic sequencing has been dropping at an even faster rate than suggested by Moore's Law – which highlights the inevitable innovation that can be expected from biotechnology.

Figure 11: Cost per Human Genome



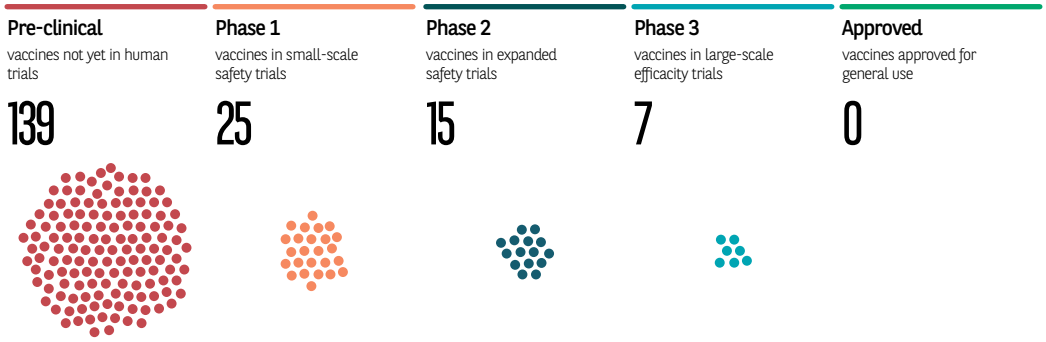
Source: National Human Genome Research Institute, genome.gov, April 2018

1 https://9to5mac.com/2020/10/26/covid-19-exposure-notification-api-states/
2 https://www.medrxiv.org/content/10.1101/2020.08.29.20184135v1

The biopharmaceutical industry grew out of the chemical dyes industry and was powered by advances in chemistry. Chemists developed huge libraries of compound molecules which were tested for potential therapeutic utility without any understanding of underlying disease biology. In terms of therapeutic efficacy, it was an approach somewhat similar to trying to find a needle in a haystack. Additionally, since the compound molecules were not specifically designed with mechanistic intent, drug toxicity was a problem. Since both toxicity and efficacy are frequently dose-related, drug toxicity limited the therapeutic potential. However, the development of mass-scale genetic sequencing instrumentation, the steep decline in cost per genome and the use of AI to rapidly analyse large reams of data have combined to revolutionise drug development. Now the process begins with an analysis of the underlying disease biology and the identification of therapeutic targets before moving to the construction of molecules which can target them. And the process can move very rapidly, as has been shown by the industry's response to the Covid-19 pandemic.

The first case of Covid-19 was officially disclosed in December 2019 and the virus was gene-sequenced within less than a month. This rapid sequencing enabled both the development of diagnostic tests to detect those with the infection and the rapid advancement of potential vaccine candidates against the virus. Very quickly a global effort to develop vaccines was initiated. Historically, vaccine development has been measured in years, with the fastest time from crisis to commercial vaccine being five years (in the case of Ebola). However, the Covid-19 vaccine efforts have been happening at warp speed with an abundance of potential candidates already into clinical trials, including at least seven of which are in Phase 3 testing. It seems increasingly likely that a vaccine will be commercially available against Covid-19 in less than one year. This is a stark example of the clear societal and economic benefits of a vibrant biopharmaceutical industry. However, the impact of biopharma innovation is much broader than this.

Figure 12: Number of Covid-19 trial vaccines at different development stages, as at 25 August 2020

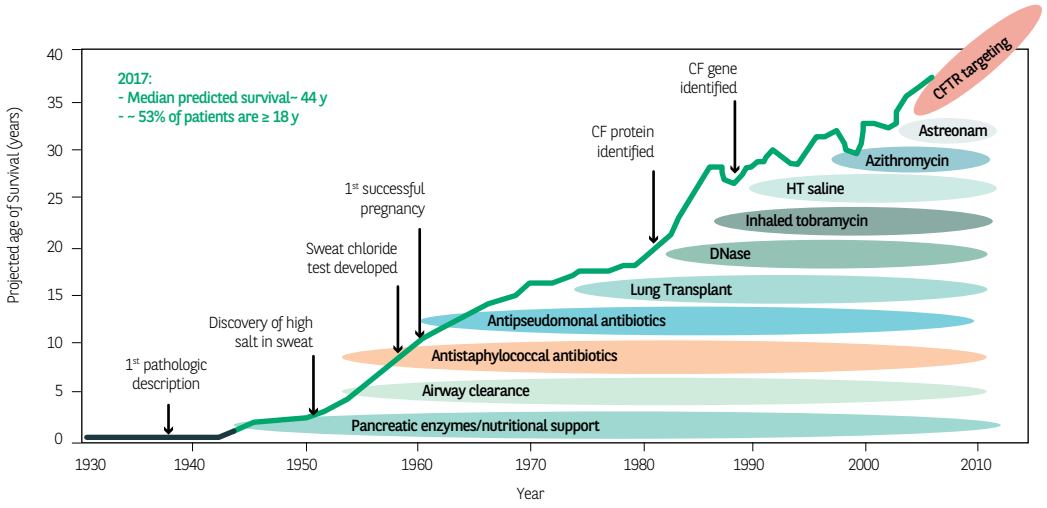


Source: WHO, last updated 25 Aug

The biotechnology industry has been developing innovative medicines that are impacting the treatment outlook for patients with cancer, orphan diseases and other illnesses, many of which had lacked treatments. One great example of the impact that genetic sequencing is beginning to have on clinical outcomes is the development of novel medicines for the treatment of cystic fibrosis (CF). CF is a chronic progressive disease in which – prior to the introduction of genetically targeted therapies in recent years – patients experienced 2%-3% annual reductions in lung function and had a life expectancy of ≈30-35 years. In 1989, scientists uncovered the key mutated receptor that was the underlying cause of this genetic disease. This enabled the development of molecules that directly targeted the core issue responsible for cystic fibrosis. The resulting clinical data showed that patients having these treatments saw dramatic improvements in lung function equivalent to 5-6 years of avoided lung function declines, which should result in significantly prolonged patient survival rates. We believe these improvements

are highly beneficial not only for patients but for society more broadly as these patients will now be increasingly likely to live well into mid-40's and eventually beyond that as companies continue to develop better therapies.

Figure 13: Progress through New Treatments



Source: https://www.nationaljewish.org/conditions/cystic-fibrosis-cf/life-expectancy

The key genetic discovery that revolutionised CF care was made prior to the development of mass-scale genetic sequencing. However, precipitous declines in cost/genome is unlocking an accelerating cadence of innovation within the industry that is profoundly impacting the lives of patients. Over the last five to ten years we have seen: 1) evolution towards personalised cancer treatment as next generation sequencing (NGS) technology has enabled the identification of multiple specific oncogenic mutations and drug companies have developed treatments to target them; 2) the development of genetically modified cellular therapies that can harness the body's own immune system to kill cancers, enabling ≥40% cure rates for some cancers; and 3) the development of multiple gene therapies for orphan diseases which would otherwise have resulted in premature death or significant impairment. All of these innovations, and many others, are significantly improving the clinical prognosis for many patients. The pace of clinically significant innovation is so high that the Food and Drug Administration (FDA) now anticipates that by 2025 it will be reviewing/approving between 10 and 20 cell and gene therapies each year (source: https://www.fda.gov/news-events/press-announcements/statement-fda-commissioner-scott-gottlieb-md-and-peter-marks-md-phd-director-center-biologics).

CONCLUSION

The Covid-19 pandemic is clearly a major crisis which has exposed significant inefficiencies and inequities in healthcare systems in the US and elsewhere. However, as with other crises, we see the potential for this crisis to showcase certain strengths and to accelerate the adoption of effective solutions to the underlying healthcare system problems. In that regard, medical technology companies have mobilised to set up critical infrastructures for diagnostic testing; biotech companies have made swift advances in therapeutics and vaccines to treat and prevent the viral infection; and healthcare IT companies have rapidly scaled up virtual health platforms to enable the accelerated adoption of telehealth so that patients and clinicians can interact while observing social distancing rules.

Beyond the healthcare sector, information technology companies have improved the efficiency of contact tracing and offer the promise of detecting future pandemics through artificial intelligence algorithms before they become problematic. Lastly, we see the pandemic accelerating the transition to value-based reimbursement systems which create incentives to close care gaps and invest in improving the social determinants of health. Overall, we believe that the healthcare ecosystem will be more resilient coming out of the pandemic. Our portfolios are thus exposed to the themes most likely to underpin such a system transition.

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Anu is an ESG Analyst and joined the Sustainability Centre of BNP Paribas Asset Management (BNPP AM) in 2019. She is in charge of the Healthcare and ICT sectors.

Anu has over 14 years of asset management experience in thematic/ESG research, equity investing and asset allocation. Prior to BNPPAM, Anu was at Liberty Mutual Investments. As Director of Thematic Research and Portfolio Manager of Equities, she focused on long term disruptive themes in the areas of ESG, energy transition and healthcare delivery. She also was a member of the Liberty Mutual investment committee overseeing employee retirement plans. Prior to Liberty Mutual Investments, Anu worked at Essex Investment Management and Ardennes Capital LLC, as an equity research analyst.

Anu holds a Bachelor's degree in Electrical & Electronics Engineering from Calicut University, Kerala, India, and an MBA (Magna Cum Laude) from Babson College, MA, USA.

Jon Stephenson
CFA, Portfolio Manager, Health Care

Jon is the lead portfolio manager for the BNP Paribas Healthcare Innovators Strategy and helps manage the team's investments in the healthcare sector. Earlier in his career, Jon spent five years with Pioneer Investments as a portfolio manager, working on a range of growth strategies. Prior to that, Jon was Director of Research with Summer Street Research Partners. Early in his career, he worked with State Street Research & Management as a research analyst covering the healthcare sector. He gained his BA degree from the Bucknell University. A member of the CFA Institute, Jon is a CFA charterholder.

Pamela Hegarty
CFA, Portfolio Manager, Disruptive Technology

Pam is the lead Portfolio Manager for the BNP Paribas Disruptive Technology strategy and a member of the Global Specialist and Thematic Equity team within BNP Paribas Asset Management. She also manages the BNP Paribas Global Telecom Fund, and analyses US technology stocks. Pam joined the organisation from Boston Common Asset Management, where she conducted research on the global technology and energy sectors. Previously, she had worked as a research analyst for State Street Global Advisors and Baring Asset Management. Pam began her investment career conducting fundamental research on the technology sector for Janus Capital, where she was employed for over seven years. She also has eight years of direct experience working in the software, industrial equipment, and alternative energy industries.

Pam graduated *cum laude* from Harvard University with a degree in Applied Mathematics, and earned an MBA with distinction from the Johnson Graduate School of Management at Cornell University. She is a CFA charter holder and a member of the CFA Institute and the Boston Security Analysts Society.

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November 2020 - Design: Creative Services BNPP AM - P2011012

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