THE DIGITAL CURE: Advancing Health for People and the Planet

How technology can help reduce carbon emissions, improve health outcomes, and increase access to care

accenture

DECEMBER 2023 | V1

Table of Contents

Table of Figures

About This Paper

Despite its healing mission, the healthcare sector is responsible for 5% of global greenhouse gas (GHG) emissions, contributing to the greatest public health crisis of the century. At the same time, the sector lags in its decarbonization efforts, with the fewest net zero targets across all sectors, highlighting the need for the sector to act with urgency.

The healthcare sector has a unique opportunity to implement climate solutions that will not only decarbonize their operations, but also improve clinical outcomes and increase health access. Most healthcare sustainability efforts to date have been focused on energy efficiency, waste reduction, and smart buildings, but we are now seeing a new focus on changing business models and low-carbon care pathways that will also help solve the pressures of increased demand and staffing shortages.

Leveraging technology will enable the healthcare industry to deliver more efficient, affordable, equitable, and sustainable care. In this paper, we present technological interventions and case studies across the patient journey (prevention, detection and diagnosis, treatment, recovery, and monitoring) that demonstrate all those outcomes. Due to the nascency of this field, not all the chosen case studies have estimated the reduced emissions associated with their interventions. In those cases, we have provided projected carbon reduction estimates based on other published data.

The paper concludes with key considerations and a future vision of a technology-driven, low-carbon, climate-resilient health system.

A note on the abbreviations used throughout this paper:

MtCO2e: metric ton of carbon dioxide equivalent. 1 MtCO2e is equivalent to emissions from an average car traveling from New York to Las Vegas.

CO2e: carbon dioxide equivalent, or the number of metric tons of CO2 emissions with the same global warming potential as one metric ton of another greenhouse gas

CO2: carbon dioxide. Accounts for 79% of all US greenhouse gas emissions

GHG: greenhouse gas

Executive Summary

Climate change is the greatest threat to public health that we face in the 21st century.[1] Populations across the globe are already experiencing elevated mortality and morbidity due to extreme weather events, deteriorating air quality, shifting infection patterns, and disruptions to the food and water supply. Recent studies report extreme weather accounted for 9.4% of all deaths globally between 2000 and 2019, and project that climate change will cause 83 million excess deaths by 2100 due to temperature-related mortality alone. [2,3]

Though no one is immune, climate change hits our most vulnerable populations even harder. Low-income groups, indigenous communities, children, and the elderly face a disproportionate amount of negative health outcomes due to inequity, lack of resources, and difficulty accessing health services.[4] The time to take action is now. If we can begin to decrease emissions by 2025 and achieve a reduction of 43% by 2030, we may be able to avoid the most catastrophic impacts of climate change.[5]

Health systems are facing significant challenges delivering care to an increasing population due to a tightening number of healthcare professionals. The World Bank predicts global demand for health professionals will rise to 80 million by 2030, while supply is only expected to reach 65 million.[6] Climate change exacerbates these issues, increasing healthcare demand and costs, and exposing workers to hazards. Extreme weather events damage healthcare facilities, disrupt operations and supply chains, and strain public infrastructure, leading to interruptions in healthcare services. Additional increased expenses arise as a result of overtime pay and emergency supply premiums, putting further stress on operating margins.[7]

The healthcare sector has a commitment to "first, do no harm." However, the sector is a significant contributor to climate change, responsible for about 5% of global greenhouse gas (GHG) emissions.[8] Despite the unique challenges of decarbonization in healthcare, there is a growing recognition of the need for sustainability. Healthcare providers are increasingly motivated to transition to sustainable practices due to regulatory pressure, financial incentives, and talent recruitment benefits tied to reputation. Decarbonization has been identified as a CEO priority, more companies are setting net zero targets, and there is increased participation in initiatives like the Health Care Climate Challenge and the Race to Zero campaign.[9]

Technology has already proven to be a valuable tool across the health industry. It has been transformative when it comes to enhancing patient outcomes and improving access to care, information, and services. These tools and technologies can also transform sustainability efforts. The same telehealth platforms, mobile health applications, and wearable devices that have expanded reach to underserved populations, enable patients to receive virtual consultations and monitoring without traveling, and empower individuals to actively engage in their health management can also significantly reduce emissions.[10] In fact, multiple case studies have shown that virtual care leads to a lower carbon footprint, with studies included in this paper reporting a range of 3.1 kg carbon dioxide equivalent (CO2e) to 59.2 kg CO2e compared to an in-person visit.

It is common knowledge throughout the industry that preventive care improves health outcomes. However, perhaps less commonly known is that it can also save up to 3% of healthcare-related carbon emission by 2050.[11] The use of both telehealth and technological tools across the patient journey can reduce GHGs and increase patient satisfaction, without sacrificing quality of care.[12] Mobile health applications and wearable devices improve personalized care, make it possible to support remote recovery and monitoring, and have a positive effect on the environment.[13] Together, these solutions have the trifold effect of improving health outcomes, increasing equity and access, and reducing emissions, with the end result being higher patient satisfaction, lower costs, and a more sustainable healthcare industry.

In this paper, we look at case studies describing technological interventions across all phases of the patient journey: prevention, detection and diagnosis, treatment, recovery, and monitoring. We will illustrate how technological interventions can work to not only improve patient outcomes and expand health equity, but also decarbonize the healthcare value chain.

Example case studies across the patient journey

Prevention

- **Providence: Identifying Climate-Vulnerable Patients** Providence's early identification of climate-vulnerable patients[50] is expected to reduce Emergency Room (ER) visits, with potential emissions savings up to 117,000 kg CO2 annually from avoiding Emergency Room visits at just one Providence facility (estimated by Accenture, see Appendix A).
- **PureHealth: Healthcare in the Cloud** PureHealth's Pura app along with their "Healthcare in the Cloud" model is furthering long-term sustainability by focusing on prevention. This focus helps avoid emissions incurred along the patient journey, ultimately enabling PureHealth to achieve their goal of net zero by 2040.[15]

Detection & Diagnosis

- **Autonomous AI for Diabetic Eye Exam** Artificial Intelligence (AI) diabetic eye exams performed at the point of care can save up to 80% of GHG emissions.[16]
- **Kaiser Permanente Northwest: Impact of Telehealth** Kaiser Permanente estimates an avoided 9,604 MtCO2e of emissions from patient transportation due to the adoption of telehealth in 2020.[17]

Treatment

- **Stanford Health Care: Virtual Visits Across Specialties** The use of telemedicine in place of clinic visits enabled Stanford Health Care to avoid approximately 17,000 MtCO2e of GHGs in 2021.[18]
- **Sanitas: Digital Health Adoption** Sanitas, part of Bupa Group, avoided a total of 6,655 MtCO2e in 2020 through a combination of digital appointments and digitized medical reports.[12]

Recovery

- **Nottingham University Hospital: Digital Care Pathway** Nottingham University Hospital estimates annual savings of 4,000 MtCO2e for patients participating in their digital care rehab program for Total Knee Replacement.[19]
- **Kaiser Permanente: Home-based Cardiac Rehabilitation** Kaiser Permanente's home-based virtual cardiac rehab program was estimated to have saved approximately 30,015 kg CO2e from emissions associated with outpatient visits and 13,000 kg CO2e from avoided hospital readmissions (estimated by Accenture).[20]

Monitoring

- **Octagos Health: Remote Cardiac Monitoring** Octagos Health's remote monitoring of cardiac devices from July 2020 through June 2022 resulted in a diminished need for travel and a decrease in paper printouts, reducing GHG emissions by 12,518 MtCO2e and 78 MtCO2e respectively.[21]
- **Moffit Cancer Center: Telemedicine Visits** National Cancer Institute estimated that telemedicine visits conducted at the Moffitt Cancer Center between April 2020 and June 2021 enabled them to reduce emissions by 3,169 MtCO2e.[22]

Patients and providers have demonstrated a willingness to adopt new digital technologies and recognize the benefits of convenience, cost savings, and increased access in underserved areas. An Accenture survey conducted in 2020 found that 9 out of 10 patients were satisfied with the quality of care delivered through virtual care and want to continue using it.[23] Despite clear benefits, there are important considerations when implementing new technologies. As rates of technology adoption increase and newer technologies like AI become more common, healthcare providers must ensure they are using these tools responsibly and equitably.[24] Training must be provided for clinicians and patients, data privacy must be protected, and the environmental impact of the technologies themselves should be considered.

Looking ahead, technology will play a pivotal role in reshaping both the business model and the physical infrastructure of healthcare facilities. Future healthcare delivery will transcend the typical boundaries of hospitals through a *Care Anywhere* model.[25] This model leverages technology to enable the delivery of care in the most appropriate and effective locations, unlocking value across the patient experience, increasing healthcare access, and improving sustainability. The evolution into new care delivery models will reduce the need for acute care facilities, with those remaining incorporating new approaches to design and architecture. We are already seeing virtual hospitals and project that physical hospitals will also transform, using approaches like modular building designs.[26]

For healthcare organizations, the path to sustainability is a journey, which starts with understanding the carbon footprint, and committing to decarbonization targets, coupled with a plan to implement key interventions along the patient journey. This requires a shift in mindset where sustainability practices are adopted by design across the whole organization, from strategic planning through execution and operations.

Sustainability presents a unique opportunity for healthcare organizations to reinvent their care delivery models, transform the patient experience, and help shape new industry boundaries, all powered by digital. This Digital Cure will not only improve health outcomes for people, but also drive towards more sustainable outcomes for the planet.

The Imperative

Health Impacts of Climate Change

Climate change poses the most substantial health threat of the 21st century.[1] Populations across the globe are already experiencing elevated mortality and morbidity due to extreme weather events, deteriorating air quality, shifting infection patterns, and disruptions to the food and water supply. Recent studies report that extreme weather accounted for 9.4% of all deaths globally between 2000 and 2019 and project that climate change will cause 83 million excess deaths by 2100 due to temperature-related mortality alone.[2,3] According to the Intergovernmental Panel on Climate Change, we must begin to decrease emissions by 2025 and achieve a 43% reduction by 2030 to limit warming to 1.5°C (2.7°F) and avoid the most catastrophic impacts of climate change.[5]

Climate change disproportionately impacts populations already suffering health inequities. Low-income communities, people with disabilities, children, the elderly, and people with underlying health conditions are among the most exposed and the most sensitive. Low-income populations are more likely to live in areas that are more vulnerable to climate change. These areas often lack the infrastructure, access to healthcare, and other resources, which can make it hard for them to adapt and recover. Indigenous peoples' traditional ways of life have been disrupted by climate change, making it more difficult for them to access food and water. And children, who are at a higher risk due to their ongoing development, are more likely to experience health effects from climate change and have an increased chance of exposure to air pollution and other environmental dangers.[4]

The frequency of **heat-related deaths for people over 65 increased by 68%** between 2000-2004 and 2017-2021.[27]

Extreme heatwaves in 2020 were associated with **98 million more people suffering annually from food insecurity** than in 1981-2010.[27]

The World Bank predicts that, by 2030, global demand for health professionals will rise to 80 million, while supply is only expected to reach 65 million over the same period.[6]

Impact of Climate Change on the Healthcare Industry

The global healthcare sector is facing significant challenges in delivering care to an increasing population due to a tightening number of healthcare professionals. The World Bank predicts that by 2030, global demand for health professionals will rise to 80 million, while supply is only expected to reach 65 million over the same period.[6] Climate change further worsens the situation by disrupting healthcare delivery and increasing the demand for healthcare services, adding to staffing pressures.[7]

The business of healthcare along with the ability to deliver quality care is also at risk. Healthcare systems, already challenged by rising costs and aging populations, are further strained by the increase in the number of people suffering from illness or injuries due to extreme weather events, heat stress, and other climate-related health risks.[28] Extreme weather events can also damage healthcare facilities, leading to hospital evacuations, and cause power outages and hamper transportation systems, making it difficult for patients to get care.[29] And, when they do get care, the quality of that care may be compromised due to surges in emergency departments, overcrowding, and supply chain disruptions.[30]

As global temperatures continue to rise, so does the cost of healthcare. Providers are facing higher expenditures for cooling facilities and preserving refrigerated items. They are also spending more on the supplies and equipment needed to meet the increased demand for healthcare services.[31] This is further exacerbated during extreme weather events, which often force staff to work overtime, operations to be suspended or closed (especially for elective procedures), and a premium for emergency supplies, resulting in both an increase in costs and a decrease in revenue.[32]

Current State – Healthcare Decarbonization

Drivers Towards Decarbonization

Healthcare providers have a mandate to heal and a commitment to "first, do no harm." However, at present, the global healthcare sector is responsible for around 5% of global GHG emissions.[8] If the sector was a country, it would be the fifth largest emitter on the planet, contributing to the climate-induced illness and injuries it aims to treat.[8] Healthcare institutions and providers have a responsibility to decarbonize to mitigate the negative impact the industry has on climate and the population's health.[8] Decarbonization can be challenging, especially when it comes to healthcare: facilities are energy-intensive, there is a reliance on single-use plastics, and transportation demands are high. That said, there has been a growing recognition of the need for sustainability and environmental stewardship within the healthcare sector, and momentum is building to address these challenges.

Nearly 70% of respondents said that a company's sustainability plan would affect their decision whether to stay with that company long term.

FAST COMPANY, 2019

Healthcare providers are increasingly motivated to decarbonize and transition to more sustainable practices. Regulatory pressure, financial upsides, and reputation-driven talent recruitment and retention benefits make decarbonization efforts not only good for the planet, but also for the bottom line.[33] Tax incentives and penalties play a pivotal role in incentivizing sustainable practices. The Inflation Reduction Act in the United States (US) offers $369 billion in funding and tax credits over the next decade for clean energy programs, and the EU has been spending $74 billion in renewable energy subsidies annually since 2015.[34] Unsurprisingly, these provide strong incentives for companies to invest in renewable energy. Additionally, 46 countries have put a price on emissions through carbon taxes or emissions trading, pushing to increase carbon taxes to $75 per ton by 2030 in major emitting countries.[35, 36]

The adoption of sustainability practices positively impact an organization's financial health. In fact, an Accenture analysis found that companies with higher sustainability standards have 21% higher EBITDA margins compared to those with lower sustainability standards.[37] And, when it comes to attracting and keeping good employees, workers across the globe say that a firm's environmental record is a consideration when deciding whether to take a job, with rates as high as 73% in India and China and 70% in the US.[38,39] Even further, a Fast Company survey of 1,000 employees at large US companies found that nearly 70% of respondents said that a company's sustainability plan would affect their decision whether to stay with that company long term.[40]

Healthcare Sector Decarbonization Efforts

The healthcare sector has lagged in terms of decarbonization and net-zero efforts. According to an Accenture report that analyzed the net zero targets and progress by the top 2,000 public and private companies in the world by revenue, the health sector had the lowest proportion of net zero goals across all industries. Only 4% of health companies had set net zero targets in 2021, compared to other industries, which ranged from 24% to 49%.[41]

On a positive note, almost all industries, including the health sector, saw the proportion of net zero targets rise from 2021 to 2023. In 2023, 23% of surveyed health companies had set net zero targets, an increase of 19% over two years.[41]

We are also seeing increased participation by healthcare organizations in industry and cross-sectoral initiatives. The Health Care Climate Challenge, launched by Global Green and Healthy Hospitals, has garnered more than 350 participating healthcare institutions.[42] The Race to Zero campaign, in conjunction with its official health sector partner Health Care without Harm, announced in May 2023 that more than 70 healthcare institutions, representing more than 14,000 hospitals and healthcare facilities from 25 countries, have joined the global campaign aiming to mobilize businesses, cities, regions, educational institutions, and healthcare systems to take ambitious and immediate actions to achieve net-zero emissions by 2050.[43]

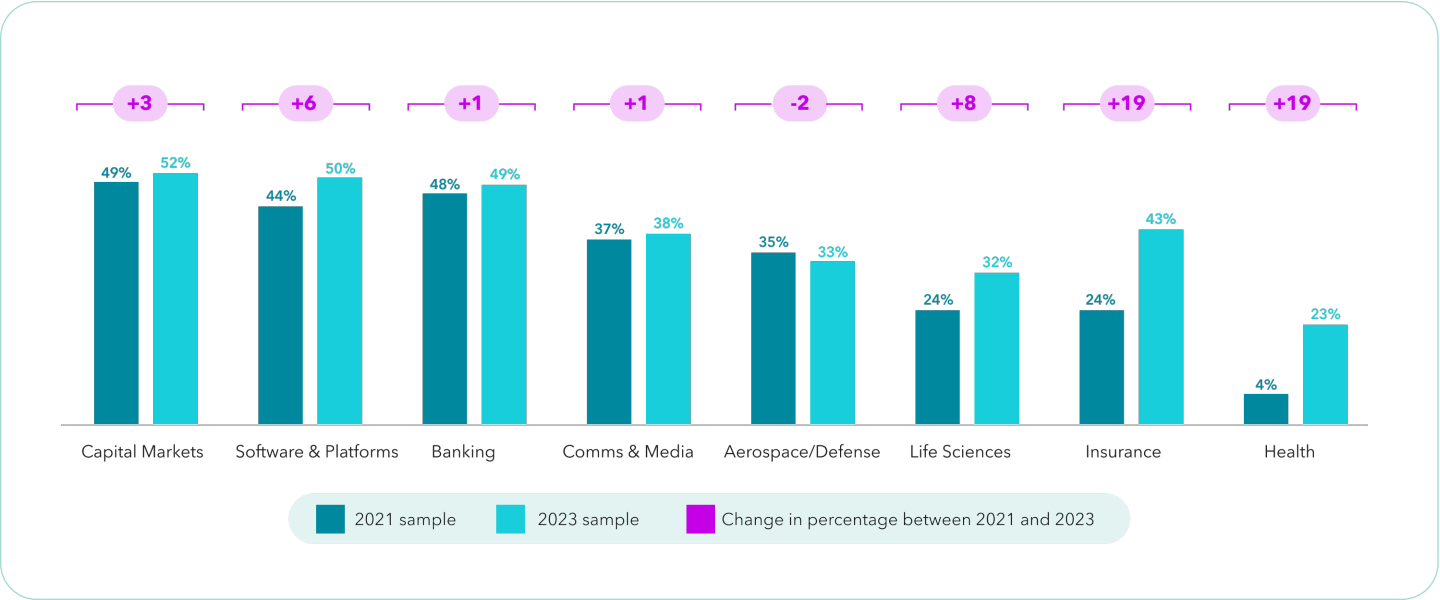

FIGURE 1: Percentage of top 2,000 companies by revenue with net zero targets by industry, 2021 to 2023

Source: Accenture, Destination Net Zero, November 2023. https://www.accenture.com/us-en/insights/sustainability/reaching-net-zero-by-2050.

And many health systems have committed to the United Nations' Sustainable Development Goals (SDGs), which include a call for urgent action to combat climate change and its impacts.[44]

Another promising development is that sustainability is at the top of the CEO agenda. According to the 12th United Nations Global Compact – Accenture CEO Sustainability Study, which surveyed more than 2,600 CEOs across 18 industries in 128 countries, 98% of all CEOs, and 100% of health sector CEOs, unequivocally feel it is their role to make their business more sustainable. And, in 2022, nearly three-quarters of CEOs agreed they were accountable for their firm's sustainability performance—up from just 19% in 2013.

Top sustainability priorities for health sector CEOs include constructing a responsible supply chain, investing in sustainability skills development, introducing new sustainable products and services, and reducing waste from products and operations. Many are looking to technology to help achieve these goals, in hopes that innovation can help deliver faster, more affordable, and more sustainable care. Over 80% believe the combination of innovation in digital health services delivery and the use of Artificial Intelligence (AI) to transform precision medicine and diagnosis will have a moderate-high impact on transforming the industry's ability to contend with global challenges.[9]

100% of Health CEOs feel it is their role to make their business more sustainable:

64%
of Health CEOs are constructing a responsible supply chain.

51%
of Health CEOs are introducing new sustainable products and services.

50%
of Health CEOs are reducing waste from products and operations.

Source: United Nations Global Compact-Accenture CEO Study, January 2023

The Patient Journey: Framework for Technology Interventions

To date, the primary focus of decarbonization in the healthcare sector has been on buildings and operations. Healthcare organizations have implemented energy efficiency, clean energy, sustainable procurement, and better waste management initiatives in hopes of lowering their carbon footprint.

However, while perhaps less of a focus to date, delivery of patient care can be another powerful lever when it comes to decarbonizing the sector. Harnessing technology to enable changes in care models will not only help healthcare organizations decarbonize and achieve net zero commitments, it will also help them build more resilient, accessible healthcare systems.

In this paper, we use the framework of an end-to-end patient journey to discuss how technological interventions can aid in sustainability efforts at every step of the health value chain. As such, we share case studies from health systems around the world as examples of how these technological interventions can be applied across each phase of the health journey. From prevention and detection to diagnosis and treatment to recovery, and monitoring.

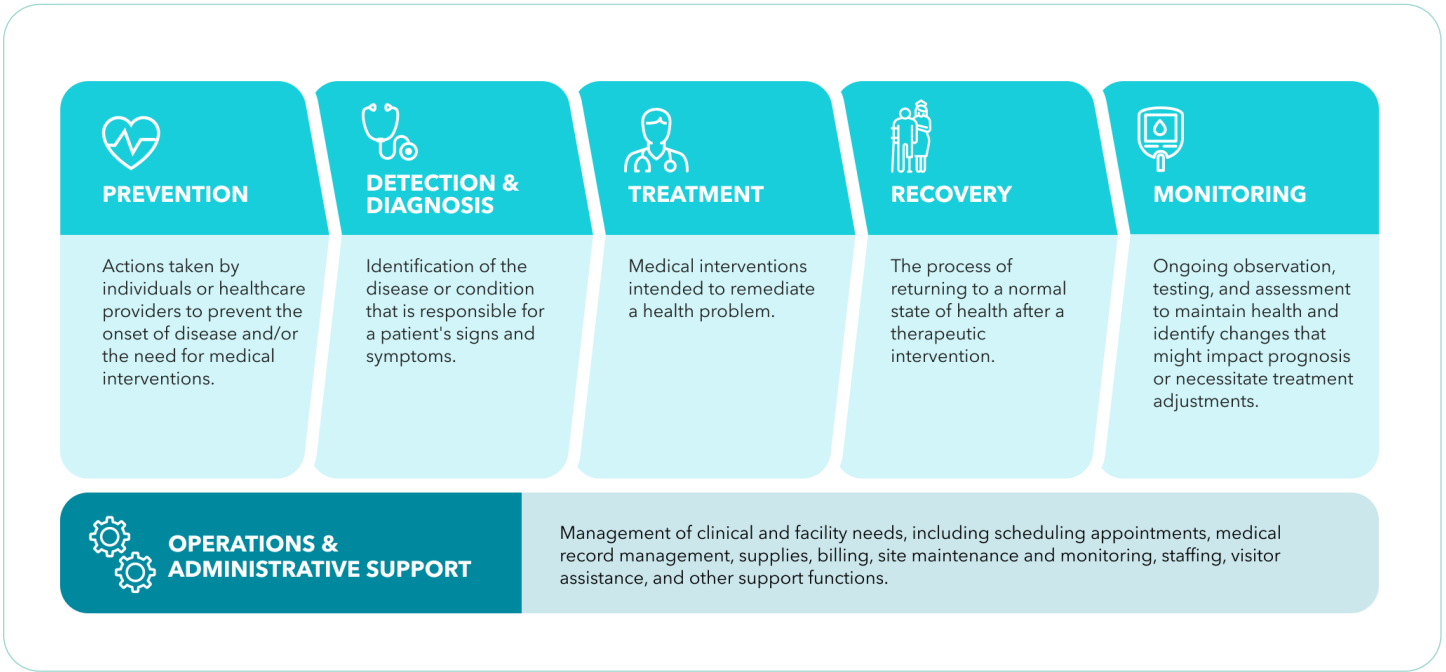

FIGURE 2: The patient journey

Key Technology Interventions

Technology Contributions to Improving Outcomes and Increasing Access

Technology has the ability to play a transformative role in enhancing patient outcomes and achieving health equity. It can be used to improve access to healthcare information and services, facilitate health education and awareness campaigns, and empower individuals with crucial information so they can make informed decisions about their wellbeing. Already, telehealth platforms are expanding reach to underserved populations, allowing remote patients to receive virtual consultations and monitoring, and bridging the geographical divide by helping to overcome transportation challenges.[10] Similarly, mobile health apps and wearables are empowering individuals to actively engage in their health management, promoting preventive care, and supporting early intervention. Innovations like advanced data analytics and AI-driven algorithms are helping do everything from identifying disparities in healthcare delivery to enabling targeted interventions and personalized treatment plans. This expansion of healthcare access, tailoring of treatments, and promotion of health literacy is proof of just how instrumental technology can be in driving improved patient outcomes and fostering health equity across diverse communities.[45]

Virtual Care Technologies

Virtual care is a key driver for the reduction of GHG emissions throughout the healthcare sector. Road travel undertaken by patients, visitors, staff, and suppliers accounts for about 14% of the National Health Service (NHS) in England's total emissions, with 5% of that coming from patient travel alone.[11] Many medical appointments across the patient journey do not require a physical examination, making virtual care a more efficient alternative. This is not only a more sustainable option, but also a preferred choice by patients as options like telephone and video consultations, remote monitoring, and patient portals can save patients both time and money by negating the need to travel and incur any associated costs.[11]

Multiple case studies have shown that virtual care leads to lower carbon footprint than healthcare visits:

The NHS estimates that holding **350,015 hospital appointments online** over one year in Devon saved **2,503 MtCO2e.**[46]

The Ohio State University Wexner Medical Center estimates saving **17,500 MtCO2e** between FY2020 and FY2022 with **768,970 telehealth visits.**[47]

UC Davis Health estimates that moving **18% of 16.8 million outpatient visits** across 5 University of California healthcare systems saved **21,466 MtCO2e** over 2020-2021.[48]

CommonSpirit Health calculated **1.5 million virtual visits** conducted by its clinics between March 2020 and April 2021 prevented **15,092 MtCO2e of emissions.**[49]

Avoided emissions per visit reported in the literature vary widely, influenced by the distance patients need to travel (e.g., rural versus urban facility), medical specialty, and type of visit. A standardized approach to these calculations has yet to be established, resulting in divergent methodologies across various studies. The 8 telehealth studies included in this paper report a range of 3.1 kg CO2e to 59.2 kg CO2e savings compared to an in-person visit.

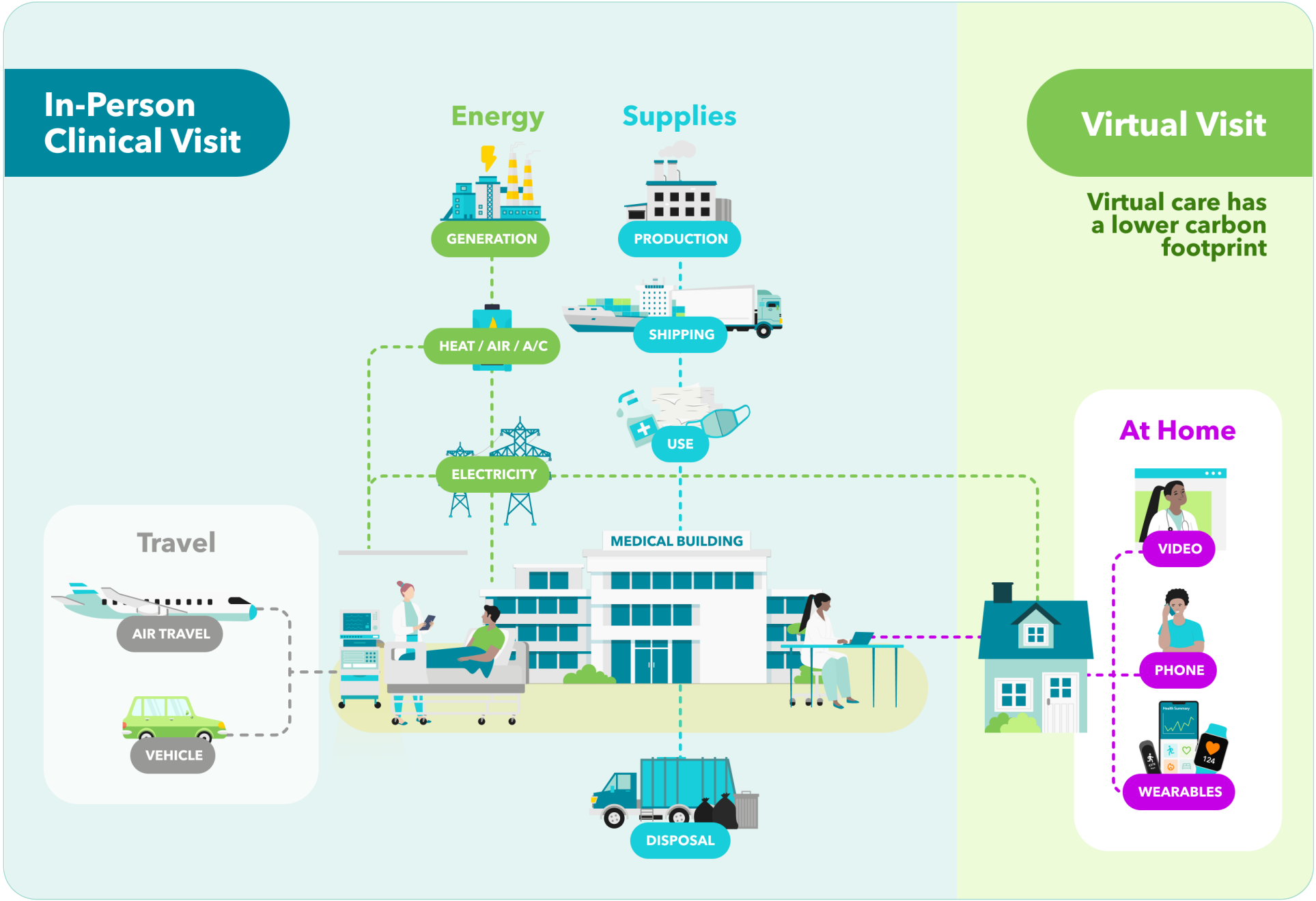

FIGURE 3: Emissions sources for in-person versus virtual visits

Source: Adapted from a diagram from Thiel C, Mehta N, Sejo C, Quresi L, Moyer M, Valentino V, & JS. Telemedicine and the environment: life cycle environmental emissions from in-person and virtual clinic visits. npj Digit Med. 2023.

Prevention

An NHS study estimates that preventive measures alone could **save around 3% of healthcare-related carbon emissions by 2050.**

Preventive care holds the promise of delivering a two-fold benefit on both the individual and societal levels: enhancing life expectancy and curbing financial and environmental burdens. In fact, an NHS study estimates that preventive measures alone could save around 3% of healthcare-related carbon emissions by 2050.[11] At the individual level, technology-enabled preventive care, including both lifestyle modifications using health applications (apps) and wearable devices, and cutting-edge innovations like precision medicine and digital twin technology, work to empower personalized care and facilitate early disease detection. On the societal front, prevention hinges on enacting policies and global agreements to promote sustainable technologies that mitigate air pollution and greenhouse gas emissions. These interventions have the potential to prevent millions of premature deaths and hospitalizations.[13]

Providence: Identifying Climate-Vulnerable Patients

Providence, a nonprofit healthcare system operating 51 hospitals and over 1,000 medical clinics across 7 states in the US, has implemented a dashboard visualization tool within their existing Community Pathways to Health platform to identify patients most at risk in extreme weather conditions.[15] 16 different risk factors and social determinants of health were defined with the ability to cross-reference patients by zip code. This allows identification of patients at risk during climate and/or environmental events. The platform will also enable Providence caregivers to identify people with mobility or respiratory issues so that early assistance can be provided when evacuation is needed.[50] Though not discussed by the authors, it can be assumed that this type of early identification of climate-vulnerable patients could lead to a significant reduction in greenhouse gas emissions due to the avoided emergency department visits. Based on the literature, an emergency room visit is associated with 45 kg CO2e emissions, and in extreme weather events, hospital room emergency visits may increase up to 5%. [25,51] In Providence's case, emergency visits in one facility numbered approximately 52,000 in 2021, so it can be assumed that by avoiding the 2,600 additional visits (5% of the total visits) attributed to extreme weather events, Providence would save up to ~117,000 kg CO2e for 1 facility annually.[52] *See Appendix A for calculation details.*

Vietnam's Ministry of Education and Training: Fit for the Future

In 2019, Vietnam's Prime Minister approved a national project led by the Ministry of Education and Training to combat non-communicable diseases (NCDs) among adolescents. The project, titled "Fit for the Future: Leveraging Data and Frontier Technologies to Build an NCD Program for Youth, with Youth," leverages technology, including AI-driven mobile and web applications, to provide tailored NCD prevention resources to students, parents, teachers, and school administrators. It offers 20 e-lessons covering mental health, NCD-related risk behaviors, and guidance on behavior change. The application can also track user behaviors, generate NCD-related behavior reports with helpful notifications and tips, and enable Q&A with AI-generated prompts. Ultimately, the project's alignment with Vietnam's 2015-2025 National Strategy on NCD Prevention and Control, along with its adoption of a user-centered approach, encourages students who may be personally affected by NCDs and in doing so shapes effective health programs for the present and future.[53]

PureHealth: Healthcare in the Cloud

PureHealth, the largest integrated health system in the UAE, has embarked on redefining prevention, wellness, and longevity for its patients by embracing a "Healthcare in the Cloud" concept. In a recent discussion with PureHealth, their Chief Strategy Officer explained how integrating systems and solutions across their organization enables them to share data and collaborate more easily, and ultimately, bridge care delivery between hospitals, clinics, and homes. The Pura app furthers this mission by leveraging data-driven insights to create a hyper-personalized experience. The super app, designed to provide a one-stop solution, will have broad capabilities including an AI-driven health coach, a wellness and disease management aid, a virtual care platform, and an online pharmacy, all rolled into an intuitive and user-friendly interface.

The Pura app will utilize advanced digital tools and a uniquely innovative approach. Digital twin technology, or a virtual simulation of a physical object, in this case the patient, connects to real-time data on vitals, responses to treatment, and large medical records data sets. This will make it possible for PureHealth to monitor, assess, and analyze patients in real time. In the future, PureHealth anticipates adding new features to allow the integration of medical testing (including genomic sequencing and AI-enabled imaging) to deliver more personalized treatment alongside predictive insights that provide a window into possible treatment outcomes. PureHealth also plans to integrate a wellness program that will include gamification tools and community channels that cultivate peer-to-peer motivation. All told, the Pura app will enable PureHealth to re-envision care, with the patient at the center. It puts both preventive and curative treatment at the patient's fingertips and bolsters automated processes and self-service tools with communication channels that facilitate information sharing and two-way communication between providers and patients.

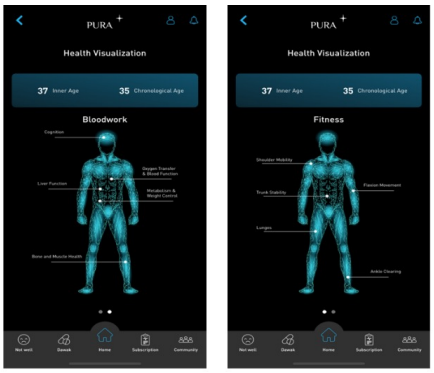

FIGURE 4: Screenshots of digital twin, a feature that will be part of PureHealth's Pura app

Source: Email correspondence from PureHealth, September 2023

In addition to their ability to transform the patient experience into one that's more efficient, effective, and empowered, PureHealth's "Healthcare in the Cloud" also furthers long-term sustainability. The focus on prevention will help avoid emissions from the patient journey such as travel to clinic visits, a reduced need for tests, and optimization of resource use, all helping PureHealth achieve their goal of net zero by 2040. This is further evidenced by the fact that in 2022 alone, PureHealth was able to avoid ~49,000 MtCO2e by moving just 12% of total visits to teleconsultations. Even more promising, they estimate an additional 8.82% reduction in CO2 emissions as a result of virtual care services over the next 5 years.[15]

"Capitalizing on the 4th industrial revolution, we anticipate a transformative shift in the way care is delivered, which will act as a driving force toward our decarbonization efforts by enabling us to optimize our operational infrastructure and make a considerable contribution for achieving our net zero target by 2040."

FARHAN MALIK
Founder & Group CEO, PureHealth

Detection & Diagnosis

AI, telehealth, and point-of-care diagnostics are powerful tools when it comes to delivering more efficient, effective, and sustainable patient care. These technologies can do everything from supporting early detection of symptoms and diagnosis to avoiding unnecessary tests to improving efficiency and accuracy when interpreting test results—all while reducing associated carbon emissions. AI algorithms are able to analyze medical images (such as X-rays, MRIs, and CT scans) with high accuracy, thereby assisting radiologists in early detection of diseases like cancer, fractures, and abnormalities. This AI-powered image analysis can reduce the need for redundant scans and improve diagnostic accuracy, thus minimizing unnecessary exposure to radiation and resource-intensive procedures. Point-of-care diagnostics reduce the need for centralized lab testing, transportation of samples, and associated emissions. Moreover, advances in DNA sequencing and molecular diagnostics enable precise disease detection and personalized treatment plans, reducing the carbon footprint associated with ineffective treatments. Coupling these advances with AI makes it possible to analyze large datasets and provides more accurate diagnoses and predictive markers for specific diseases.[54] Together, these technologies have the potential to result in significant efficiencies, improvements in patient outcomes, and considerable carbon savings.

Autonomous AI for Diabetic Eye Exam

A direct application of technology in disease detection is autonomous AI diabetic eye exams performed at the point-of-care. A 2022 study comparing the use of an autonomous AI exam at the primary care visit to an in-person exam performed by an ophthalmologist found that utilizing AI led to an 80% reduction in GHG emissions.[16] Screening for diabetic retinopathy during a primary care visit makes an additional referral visit unnecessary. This can be especially advantageous for marginalized communities with restricted access to specialized care or limited means to attend additional appointments. Deployment of autonomous AI in retinopathy screening has also been shown to be cost-effective from the patient perspective.[55] This tri-fold benefit of improved clinical outcomes, reduced costs, and lower emissions betters the overall experience for the patient, the provider, and the environment.

Kaiser Permanente Northwest: Impact of Telehealth

Telehealth can also be a powerful tool in supporting reduced emissions in detection and diagnosis. Kaiser Permanente Northwest (KPNW), an integrated healthcare system located in Oregon and Southwest Washington serving more than 600,000 members, measured the impact of telehealth adoption during the COVID-19 pandemic. Looking at data from 2015-2020, KPNW found that telehealth visits increased 39.3% per year through 2019, and then by 108.5% in 2020. The emissions per visit were inversely correlated with the number of telehealth visits, allowing KPNW to lower emissions in outpatient care while providing more visits. In 2015, telehealth made up 8% of 2.30 million total visits resulting in 18,473 MtCO2e emissions, whereas in 2020, when telehealth made up 55% of 2.67 million visits, total emissions dropped by 43% to 10,537 MtCO2e. And, while it is true that telehealth is not carbon neutral, KPNW found emissions reduction from transportation far outweighed the increase in emissions associated with telehealth communications. The authors estimated they avoided 9,604 MtCO2e of emissions from patient transportation in 2020, compared with a slight increase of 55 MtCO2e from computer and internet use.[17] It is also important to note that while the adoption of telehealth may have been spurred by the COVID-19 pandemic, it has now become the norm. The study authors shared that though there was an increase in the number of in-person appointments at KPNW after 2020, telehealth still accounted for 50% of total visits in 2021 and 41% of total visits in 2022. This demonstrates the high acceptance rate of virtual care by patients and providers.[56]

	Telehealth Visits	Total Emissions
2015	8%	18,473 CO_2e
2020	55%	10,537 CO_2e

EMISSIONS DROPPED BY 43%

Kaiser Permanente Northwest: Impact of Telehealth (continued)

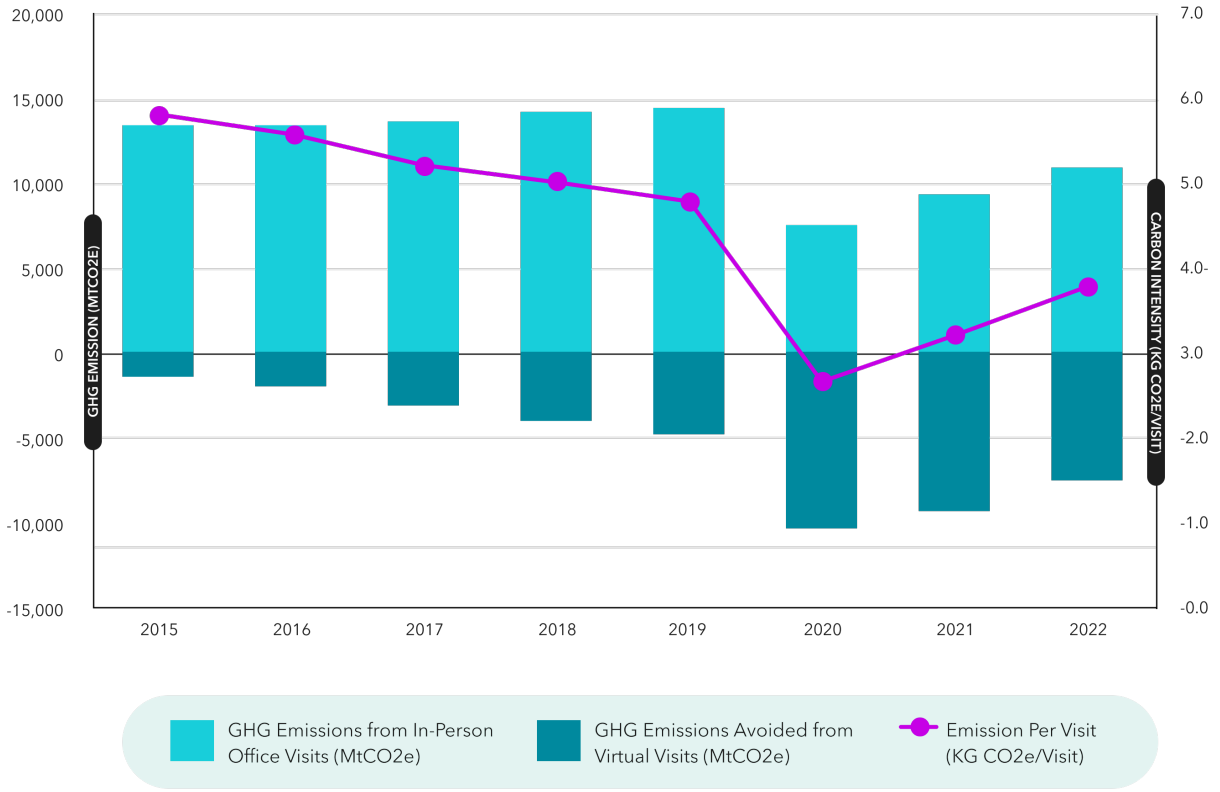

FIGURE 5: Kaiser Permanente Northwest's greenhouse gas emissions due to transportation for primary care, specialty care, and mental health visits 2015-2022.

Source: Email correspondence from Kaiser Permanente, September 27, 2023

"Physicians can make a difference in mitigating carbon emissions simply by being flexible in how we provide care to our patients. Telehealth not only improves patient satisfaction and decreases the amount of time they need to take off for an appointment, but it also adds up to real reductions in tailpipe emissions."

COLIN CAVE, MD
Medical Director of External Affairs, Government Relations, and Community Health
Northwest Permanente Medical Group

Treatment

The healthcare industry has already begun implementing many technological solutions in the treatment phase of the patient journey. Though the primary goal of these innovations may be to better the patient and provider experience, most (if not all) have the added benefit of reducing carbon emissions. Surgical robots can be used to perform minimally invasive procedures with higher precision. This reduces recovery times, hospital stays, and the associated carbon emissions. Electronic health records (EHRs) streamline the sharing of patient information among healthcare providers. The ability for all treating physicians to have a full picture of a patient's medical history negates the need to run duplicate tests or file the same paperwork more than once. This not only minimizes carbon footprint, but it also makes care more efficient and effective. Technology can also be used to support and track medication adherence, reducing the overuse of medications, minimizing waste, and preventing hospitalization. For example, NHS estimates that their use of a supporting digital service for patients with asthma (i.e., using smart connected inhalers) has the potential to eliminate 60% of preventable hospitalizations.[57]

Patient transportation is the dominant source of per-visit emissions in healthcare settings and reducing it via virtual care has the potential to lower emissions significantly. Though it's impossible to completely eliminate physical visits, there are specialties like psychiatry and pain management that do not require a physical examination and can transition to virtual visits without sacrificing the quality of care.

Stanford Health Care: Virtual Visits Across Specialties

At Stanford Health Care (SHC), a study was conducted to estimate carbon emissions from virtual visits across several specialties. These virtual visits included mostly video visits (91%) and phone visits (9%), with adoption of the technology varying across SHC departments.

Emissions per patient visit for both in-person and virtual visits at SHC were determined using life cycle assessment of clinical data from 2019-2021. SHC found that virtual visits generated less than 1% of the emissions of an in-person visit, ranging from 0.02 to 0.08 kg CO_2e per visit compared to an average in-person visit emission of 20 kg CO_2e. The cancer and psychiatry departments presented the largest opportunity for decarbonization based on the potential for emissions reduction, appropriateness of digital appointments, and the overall number of appointments. In the cancer department, 47% or close to 98,700 consultations in 2021 were done virtually with 33.9 kg CO_2e avoided per visit; and in the psychiatry department, virtual visits represented 88% or close to 70,400 visits with 32.7 kg CO_2e avoided per visit.

Overall, SHC saw a 13% increase in clinic visits from 2019 to 2021, but due to the rise in telemedicine services, GHG emissions from these visits decreased by 36%, helping SHC avoid approximately 17,000 $MtCO_2e$ in 2021.[18] In an interview, the study authors noted that virtual visits did not appreciably decrease after the pandemic. They credit the continued high telehealth rates to a positive patient and provider experience with a strong technology platform. Meagan Moyer from SHC's digital health integration team noted that virtual care is a way to improve access and efficiency, particularly when physical space is limited and costly. To ensure high-quality visits, SHC has embedded virtual care into operations and provided training resources for their clinicians like the 'Tele-Presence 5 practices,' to support fostering meaningful connections with patients during virtual visits.[58]

2019 - 2021

13%⇧
in clinic visits

36%⇩
GHG emissions

due to the rise in telemedicine services, helping SHC **avoid approximately 17,000 $MtCO_2e$ in 2021.**

Stanford Health Care: Virtual Visits Across Specialties (continued)

"It was wonderful to see how much telehealth expanded at SHC over the study years resulting in the ability to serve so many more patients while reducing emissions."

CASSIE THIEL, PhD
Assistant Professor, NYU Langone Health, and study author

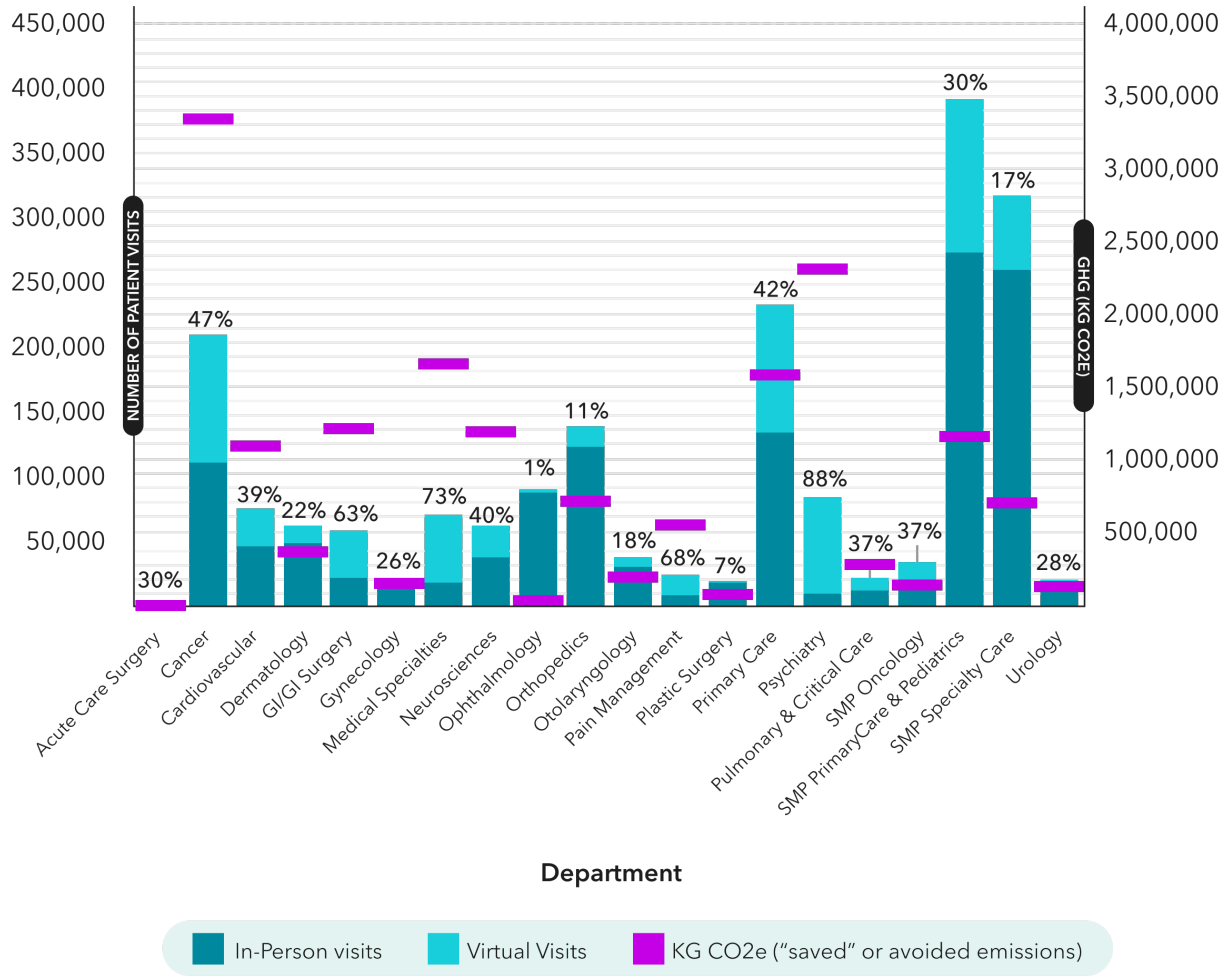

FIGURE 6: Stanford Health Care's comparison of in-person and virtual patients visits by department and GHG emissions, 2021

Source: Adapted from a diagram from Thiel C, Mehta N, Sejo C, Quresi L, Moyer M, Valentino V, & JS. Telemedicine and the environment: life cycle environmental emissions from in-person and virtual clinic visits. npj Digit Med. 2023;6(87).

Sanitas: Digital Health Adoption

Sanitas, part of Bupa Group, also measured the impact of digital health solution adoption. Similar to other healthcare providers around the world, Sanitas moved to virtual visits to enable continuity of care during the COVID-19 pandemic. This shift enabled them to reduce the need for patient travel, thereby avoiding a total of 6,655 MtCO2e in 2020. This included the 21% of medical appointments moved to digital format, (avoiding an estimated 1,957 MtCO2e) as well as the 4,698 MtCO2e avoided by making medical reports available digitally, eliminating the need for patients to pick them up in person. Perhaps just as important as Sanitas' ability to reduce emissions is the fact that doing so proved to be a safe and effective alternative to in-person care. This is evidenced by the fact that in 90% of cases, the digital visit was sufficient, with no need for an in-person visit within the following week. Sanitas patients and providers experienced all the benefits of using digital solutions as reported in the literature, including ease of use, flexibility, comfort, savings in time and money, and a better work-life balance on the part of providers. Sanitas patient satisfaction with digital options was high, with 48.7% choosing to engage in another digital encounter. [12]

90% of digital visits
did not require an in-person visit within the following week.

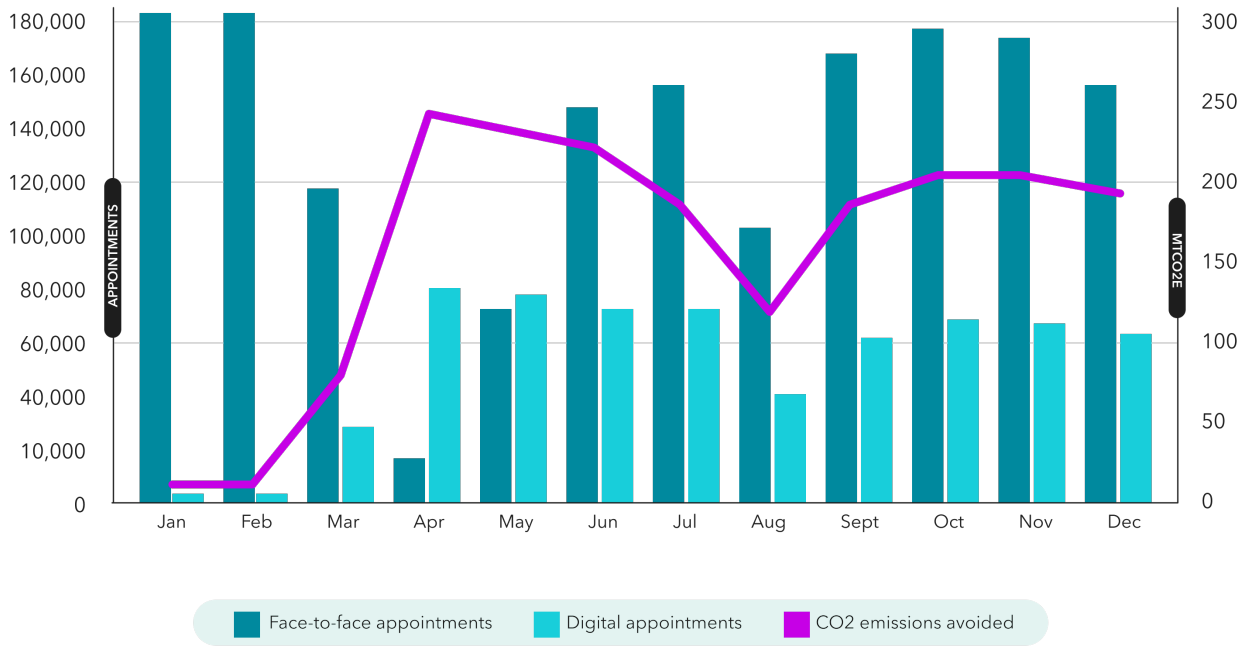

FIGURE 7: Avoided CO2 emissions through face-to-face and digital appointments for Sanitas insurance policyholders in Spain, 2020

Source: Morcillo Serra C, Aroca Tanarro A, & Cummings, Ce. Impact on the reduction of CO2 emissions due to the use of telemedicine. Sci Rep. 2022;12.

Recovery

The process of recovering health and strength after an illness or surgery can demand a significant amount of time and resources. Technology can improve recovery efficiency and effectiveness. For example, wearable devices, such as fitness trackers and health monitors, can help patients track their vital signs and activity levels during the recovery process. This data can then be shared with healthcare providers so they can make better-informed decisions and/or remote adjustments to treatment plans. Technology-driven rehabilitation programs, including virtual physical therapy and tele-rehabilitation, can provide additional support to patients during recovery from surgeries or injuries. These programs reduce the need for in-person visits and can be tailored to individual patient needs.

One such application is the use of digital tools for recovery from stroke. Using robotic devices resulted in a higher probability of achieving independent walking at the end of the training sessions and at follow-up appointments. And interactive video gaming devices, which already are highly accepted by patients, have been shown to significantly increase the amount of arm movements elicited compared to the traditional therapy for patients with chronic stroke.[59]

Nottingham University Hospital: Digital Care Pathway

Nottingham University Hospital (NUH), one of England's largest acute teaching trusts, analyzed 100 adult patients who had undergone total knee replacement (TKR) surgery in a UK NHS hospital, comparing the environmental impact of the care pathway with and without the application of digital technology. The digital care pathway program, called Care4Today, featured modified joint school, accelerated physiotherapy, a patient website, an Allied Healthcare Professional website, a multi-media patient education pack, and the ability to stream video content online across the care pathway. Care4Today improved recovery time, reduced length of stay post TKR surgery, and lowered associated costs and environmental impact of the procedure. The Sustainable Healthcare Coalition (SHC) estimates GHG emissions savings of 50 kg CO2e per patient—a reduction of approximately 12.5%. Moreover, NUH projected that if Care4Today was used by all patients undergoing TKR surgeries in the NHS, it would result in an annual savings of 4,000 MtCO2e.[19]

Kaiser Permanente: Home-based Cardiac Rehabilitation

In 2019, Kaiser Permanente, an integrated health system headquartered in California, introduced an innovative home-based virtual cardiac rehabilitation program spanning 8 weeks, to support patients with cardiovascular disease (CVD), which represented 32% of all global deaths in 2019.[60] The program combined wearable technology—Samsung smartwatches (Gear S3 and Galaxy Watch), which were paired with the HeartWise 1 app—with support from an assigned healthcare team. The smartwatches sent exercise reminders, tracked patient activity and heart rate during workouts, and uploaded data to physicians' dashboards for goal-setting and progress monitoring. Weekly virtual meetings with care managers were held on Kaiser Permanente's digital platform to discuss progress and lifestyle modification. After completing the program, patients were enrolled in online courses like nutrition classes and received 8-12 weeks of wellness coaching in an effort to help them maintain a healthy lifestyle.[20]

Eighty-seven percent of the 2,300 enrolled program participants completed the program, compared with a national average of less than 50%. Hospital readmission rates were less than 2%, compared with average hospital readmission rates of 10-15% for similar conditions.[20] This shift to virtual rehabilitation not only improved patient outcomes, but also reduced GHG emissions by avoiding travel to outpatient visits and hospital readmissions. While emission reductions were not calculated by the study authors, estimates from the literature suggest the program contributed to saving approximately 30,015 kg CO2e from emissions associated with outpatient visits and 13,000 kg CO2e from avoided hospital readmissions.[61,62] *See Appendix B for calculation details.*

Monitoring

From ingestible sensor-equipped pills to wearable technological devices, remote monitoring plays a crucial role in the management of chronic illnesses. Monitoring devices gather data that can be analyzed and used as a basis for treatment alterations and prognosis. For example, for patients with diabetes, remote monitoring is key—using a home monitoring device, a personal glucometer, and insulin delivery allows patients to improve diabetes control and receive timely medical assistance.[63] Remote monitoring can also reduce the need for medical visits and help decrease morbidity and mortality rates by acting as an early warning system for caregivers and physicians.

Remote monitoring plays a crucial role in the management of chronic illnesses

Gather data that can be analyzed and used as a **basis for treatment alterations and prognosis.**

Decrease morbidity and mortality rates by acting as an **early warning system** for caregivers and physicians.

Octagos Health: Remote Cardiac Monitoring

Octagos Health, a remote device management company based in the US, performed advanced modeling on data from 32,811 patients at 67 device clinics from July 2020 through June 2022. In total, these patients had 7,666 implantable loop recorders (ILRs), 5,589 implantable cardioverter-defibrillators (ICDs), 15,599 pacemakers, and 3,957 cardiac resynchronization therapy defibrillators (CRT-Ds). ILR patients were followed up monthly and patients with pacemakers, ICDs, and CRT-Ds were followed up quarterly.[64,65] Remote monitoring of cardiac devices saved 31.7 million travel miles, reducing GHG emissions by 12,518 MtCO2e. A total of 14.2 million paper printouts were also avoided, leading to 78 MtCO2e in reduced emissions and an estimated cost saving of 50,000 USD per clinic per year. In addition, patients were more satisfied as they appreciated the convenience of at-home monitoring, actively participated in their care, and enjoyed personalized attention.[21]

Moffit Cancer Center: Telemedicine Visits

The National Cancer Institute (NCI), the federal US government's principal agency for cancer research and training, looked at the impact of telemedicine visits conducted at the Moffitt Cancer Center (MCC) from April 2020 through June 2021. The chosen period captures the impact of increased telemedicine implementation driven by the COVID-19 pandemic. In this study, virtual care included real-time care delivered through synchronous video conferencing. Digital appointments were used at MCC when deemed appropriate by the clinical team, i.e., when there was no need for physical examination beyond what could be assessed during a telemedicine visit. NCI estimated that emissions were reduced by 3,169 MtCO2e during the study period, with 87% of the reduction resulting from avoided travel for patients living beyond 60 minutes from MCC. [22]

Operations & Administration

Healthcare operations and administration support every phase of the patient journey and benefit greatly from the adoption of digital technology. Digital technologies like blockchain, advanced analytics, and AI make it possible to deliver better, more efficient care, as well as an improved experience for patients and staff. These tools allow healthcare systems to do more with less, reducing resource use, costs, and emissions, without sacrificing the quality of care or experience.

Optimized Operations

Strategic integration of technology across healthcare operations might include solutions like EHRs, telemedicine, data analytics, and AI-powered algorithms.[66] These technologies help streamline patient information management, reduce paperwork, enhance clinical decision-making, and improve accessibility, while at the same time reducing unnecessary hospital visits and laboratory testing. Organizations might also implement automated scheduling systems to optimize resource allocation and staff productivity, and advanced billing and coding software to help with revenue management, ensuring financial stability. Investing in a strong digital infrastructure that includes 5G technology can ensure connectivity and support real-time data transmission.[67] Overall, these digital solutions work together to help healthcare organizations optimize processes, enhance efficiency, improve patient outcomes, and manage costs effectively.[24]

Because most emissions within healthcare stem from the energy and resources used within healthcare facilities, health systems have concentrated their initial decarbonization endeavors on enhancing energy efficiency and incorporating smart building technologies. Utilizing smart technologies like building management systems, remote monitoring sensors, heating, ventilation and air conditioning setbacks, and motion sensor lighting not only reduce emissions from building energy usage, but also enhance the experiences of staff and patients. The electrification of acute care facilities, exemplified by projects like the Canberra Hospital Expansion in Australia and the University of California Health Irvine hospital, slated to open in 2024 and 2025 respectively, presents a viable solution to further diminish our dependence on fossil fuels and advance sustainability within healthcare infrastructure.[68,69]

Streamlined Administration

The complexity of administrative tasks and the extensive interconnected network of providers, payers, and regulatory agencies involved in healthcare provision necessitates smart solutions. Technologies like machine learning (a subset of AI) can be used to uncover patterns across large swaths of data. Algorithms can be utilized to improve workflows. Digital management tools can be used to automate tasks (e.g., billing), assign work more efficiently, and execute planning.

Digital solutions can also improve direct care and patient experience. Decision-support algorithms can be used to predict the expected number of patient admissions, discharges, and transfers. These algorithms can also predict employee absences, enabling an organization to better allocate team staffing. AI can be used to optimize scheduling of surgical procedures and radiology scans, as well as give an estimated duration of a procedure.

Digital technologies like blockchain, advanced analytics, and AI make it possible to deliver better, more efficient care, as well as an improved experience for patients and staff. These tools allow healthcare systems to do more with less, reducing resource use, costs, and emissions, without sacrificing the quality of care or experience.

Blockchain technology shows great potential in the healthcare sector due to its encryption and decentralized nature. Itlt not only enhances the security of patient records but also improves interoperability among healthcare providers, and addresses the issue of counterfeit medicines.[70] Blockchain technology by itself may not be directly associated with savings in carbon emissions, however its applications within the healthcare industry can directly yield sustainability benefits for healthcare institutions, contributing to more efficient and environmentally friendly practices.

Key Takeaways and Considerations

In this white paper, we have underscored the importance of an approach that combines technology and environmental responsibility to address sustainability issues, prioritize health outcomes, and increase access. When we look at leading organizations in healthcare sustainability, there is a common understanding that a sustainability strategy is not just an ethical obligation, but a necessity in the face of climate change.

These leaders have a long-term vision for decarbonization, a strategy for investing in sustainable practices and technology-driven interventions, and a commitment to carbon accounting and reporting. They understand the importance of digital transformation, the power of technology, and are supported by dedicated and forward-looking teams.

Technological innovations have the potential to support decarbonization while improving clinical outcomes and access to care. Both patients and providers have demonstrated a willingness to adopt new digital technologies, recognize the benefits, and in many cases, prefer it. An Accenture survey conducted in 2020 found that 9 out of 10 patients were satisfied with the quality of care delivered through virtual care and want to continue using it.[23]

As more digital technologies become available, it is crucial that they are adopted responsibly and integrated equitably into the healthcare journey of both patients and providers. In order for this to happen, institutional policies and protocols need to be revisited to ensure they aid in the adoption of these technologies, prioritizing patient safety and facilitating innovation and access for all.[71] Insurance payers must also take changing care delivery models into account, and provide coverage for new innovations and technologies, especially for low-income individuals who may not otherwise have access.

As with all new innovations in healthcare, there will be a learning curve for patients, providers, and healthcare administrators. As such, digital literacy programs are essential, especially for elderly and underserved populations. These programs can help bridge the gap and empower people to feel comfortable using new tools and technology effectively. Healthcare providers will also need training to competently use and integrate new technologies into their practice. Finally, data privacy concerns cannot be overlooked. Healthcare organizations need to make sure that stringent measures are in place to safeguard patients' sensitive information.

The environmental impact of the technologies themselves must also be considered. Software, equipment, and data centers can use large amounts of energy, and healthcare organizations need to think about how to make this use as efficient as possible. This can start with the adoption of energy-efficient and green practices across the software development lifecycle, from selecting platforms and programming languages to designing software architecture and user interfaces. This becomes particularly important with the increasing use of AI. An AI model with 213 million parameters generates more than 313 MtCO2e emissions, equivalent to 315 flights from New York to San Francisco. End-user devices such as laptops and desktop computers should be optimized for energy and resource efficiency across the equipment life cycle. Moving data centers from on premises to the Cloud also makes a significant impact, potentially reducing annual global CO2 emissions from IT systems by 59 million MtCO2e, equivalent to taking 22 million cars off the road.[72]

Healthcare organizations have a unique opportunity to leverage technological solutions that both improve the health of our communities and sustain the health of our planet. However, achieving a more sustainable and accessible healthcare system for our growing global population necessitates that we decouple the growth in healthcare provision from increasing environmental impacts.

Looking Ahead: A Future of Care Anywhere

Even beyond targeted interventions, it has become evident that technology will continue to play a pivotal role in reshaping both the business models and the physical infrastructure within healthcare. From a business model standpoint, the future of healthcare delivery will be one that transcends the typical boundaries of our hospitals, enabling the Accenture *Care Anywhere* model. *Care Anywhere* leverages technology to support the delivery of customized care in the most appropriate and effective locations. This approach increases healthcare access, experience, and outcomes, while at the same time optimizing costs.

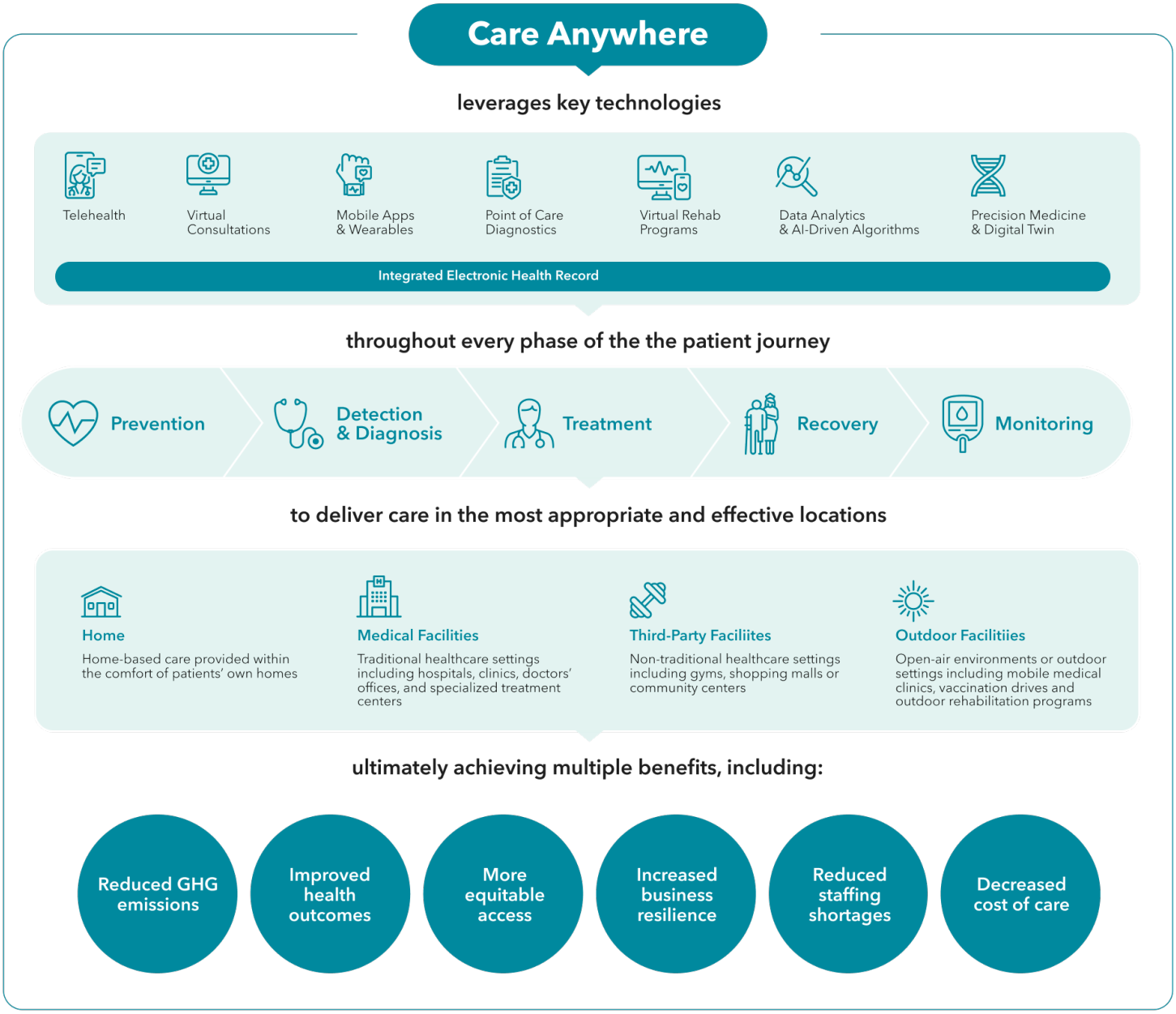

FIGURE 8: Accenture *Care Anywhere* Model

The Accenture *Care Anywhere* model not only unlocks value across the patient journey, but also supports a more sustainable healthcare industry. *Care Anywhere* shifts care to more convenient, less resource-intense settings. This, in turn, minimizes patient and clinician transportation, reduces staffing needs and resource use at facilities, and provides more personalized care management. The shift to *Care Anywhere* will be underpinned by a strong digital foundation, utilizing digital and AI solutions for streamlined clinical workflows and operational excellence. For example, Emirates Health Services (EHS) in the UAE has launched the EHS Intelligence Platform, which uses AI to proactively reduce carbon emissions. The Platform integrates sustainability goals by using AI to identify scheduled consultations that can be switched from in-person to virtual care. This minimizes unnecessary travel and reliance on physical facilities while also improving patient outcomes and increasing access to care.[73] *Care Anywhere* also has the potential to help relieve the healthcare staffing shortage, which for nurses alone is forecasted to be 13 million globally between 2025 and 2030.[74] Based on internal projections by Accenture, implementing *Care Anywhere* in the US could save 9.7 million MtCO2e annually, which equates to the emissions from generating electricity to power 2 million US homes for one year.[25]

Embracing the evolution into new care delivery models will reduce the need for acute care facilities. Those that remain will incorporate new approaches to design and architecture. We are already seeing the rise of virtual hospitals such as Mercy Virtual Care Center serving 600,000 patients in 7 different American states, 24-hours a day, from a naturally wooded, 40-acre site.[75] Similarly, in Saudi Arabia, the Seha Virtual Hospital is connected virtually to 130+ MoH hospitals around the country, conducting its operations entirely through virtual care technologies, electronic health records, and real-time interactive dashboards. The hospital has more than 30 virtual specialized services and can serve a capacity of 400,000 beneficiaries.[76]

"The Accenture Care Anywhere model not only unlocks value across the patient journey, it also supports a more sustainable healthcare industry."

Potential outcomes of implementing *Care Anywhere* in the US

9.7 million
MtCO2e saved annually

which equates to the emissions from generating electricity to power

2 million
US homes for one year.

Physical hospitals will also transform. A more modular building design approach will enable prefabricated modules to be constructed off site and then later assembled on location. This allows for quicker construction at a lower cost and provides health systems the flexibility needed to meet changing healthcare needs. The Maisonneuve-Rosemont Hospital recently opened a 2-floor, 36-room cancer ward in Montreal, Canada, stemming from the collaboration between traditional and modular construction.[26] A prototype for a low-rise hospital in Al Daayan Health District in Doha, Qatar consists of a modular structure of 2-story high units that can be reconfigured and expanded with minimal disruption to ongoing care, allowing the facility to be reimagined and adapt.[77]

As we move forward, the convergence of technology, sustainability, and healthcare innovation presents both a responsibility and an opportunity for the healthcare sector to lead in decarbonization efforts, while at the same time enhancing patient care and wellbeing.

Appendices

Appendix A: Calculation Assumptions for Providence Case Study

MEASURE	VALUE	REFERENCE	REMARKS
Number of estimated ER visits at 1 facility in Oregon within Providence network in 2021	51,929 ER visits per year	Top ten largest hospitals in Oregon by bed size in 2021[52]	-
Percent increase in ER admissions during extreme weather events	5%	A comparison of the effect of weather and climate on emergency department visitation in Roanoke and Charlottesville, Virginia[51]	Number of ER visits that could be avoided in extreme weather events 51,929*5% = 2,596
Estimated ER carbon emissions per visit	45 kg CO2e	Accenture Care Anywhere study[25]	Savings in CO2 emissions from avoided ER visits 2,596*45kg CO2e=116,840 kg CO2e at 1 Providence facility

Appendix B: Calculation Assumptions for Kaiser Permanente Home-Based Cardiac Rehab Case Study

MEASURE	VALUE	REFERENCE	REMARKS
Number of patients enrolled in the virtual cardiac rehabilitation program	2,300	Virtual, Home-based Cardiac Rehabilitation Case Study by Kaiser Permanente[20]	-
Average Completion Rate of Virtual Cardiac Rehabilitation Program	87%	Virtual, Home-based Cardiac Rehabilitation Case Study by Kaiser Permanente[20]	Number of patients who completed the virtual cardiac rehabilitation program calculated as 2300*87%= 2001 patients
Average Completion Rate of Traditional (face-to- face) Cardiac Rehabilitation Program	50%	Virtual, Home-based Cardiac Rehabilitation Case Study by Kaiser Permanente[20]	-
Savings in CO2 per remote monitoring cycle	15kg of CO2e	Carbon footprint as a marker of environmental impact in patients included in a remote monitoring pacemaker programme[61]	Savings in CO2 emissions from the remote cardiac rehabilitation program calculated as 2001*15= 30,015kg CO2e per remote monitoring cycle
Average readmission rate from virtual cardiac rehabilitation program	2%	Virtual, Home-based Cardiac Rehabilitation Case Study by Kaiser Permanente[20]	Number of readmitted patients calculated as 2300*87%*2%= 40 patients
Average readmission rate from traditional rehabilitation program	10-15% (assumed 12.5%)	Virtual, Home-based Cardiac Rehabilitation Case Study by Kaiser Permanente[20]	Number of readmitted patients calculated as 2300*50%*12.5%= 144 patients
CO2 emissions saved for each in-patient admission	125 kg CO2e per bed-day	Health care's response to climate change: a carbon footprint assessment of the NHS in England[62]	Savings in CO2 emissions from hospital related admissions by shifting from traditional cardiac monitoring to remote cardiac monitoring calculated as (144-40)*125= 13,000 kg CO2 emission per bed day

References

1 The Lancet Respiratory Medicine. Climate change crisis goes critical. Lancet Respir Med. 2023;11(3):213. doi:10.1016/S2213-2600(23)00056-5.

2 Zhao Q, Guo Y, Ye T, et al. Global, regional, and national burden of mortality associated with non-optimal ambient temperatures from 2000 to 2019: a three-stage modelling study. Lancet Planet Health. 2021;5(7), e415-e425. https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(21)00081-4/fulltext. Accessed October 2023.

3 Bressler RD. The mortality cost of carbon. Nat commun. 2021;12(1), 4467. https://www.nature.com/articles/s41467-021-24487-w#:~:text=The%20DICE%20baseline%20emissions%20scenario,the%20end%20of%20the%20century. Accessed October 2023.

4 Smith GS, Anjum E, Francis C, Deanes L, & Acey C. Climate Change, Environmental Disasters, and Health Inequities: The Underlying Role of Structural Inequalities. Curr Environ Health Rep. 2022;9, 80-89. doi:10.1007/s40572-022-00336-w.

5 Intergovernmental Panel on Climate Change. The evidence is clear: the time for action is now. We can halve emissions by 2030. 2022. https://www.ipcc.ch/2022/04/04/ipcc-ar6-wgiii-pressrelease/. Accessed August 17, 2023.

6 World Bank Group. Global Health Workforce Labor Market Projections for 2030. 2016. https://documents1.worldbank.org/curated/en/546161470834083341/pdf/WPS7790.pdf. Accessed October 2023.

7 Fierce. Climate impact: How the business of healthcare is changing with climate change. 2019. https://www.fiercehealthcare.com/special-report/how-business-healthcare-changing-climate-change. Accessed October 2023.

8 Health Care Without Harm. Health Care's Climate Footprint. Health Care Without Harm. 2019. https://noharm-global.org/documents/health-care-climate-footprint-report. Accessed October 2023.

9 Accenture. Want business growth tomorrow? Act on climate today. 2023. https://www.accenture.com/ph-en/insights/sustainability/ungc. Accessed October 2023.

10 Gajarawala SN, Pelkowski JN. Telehealth Benefits and Barriers. J Nurse Pract. 2021;17(2), 218-221. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7577680/. Accessed October 2023.

11 NHS England. Delivering a 'Net Zero' National Health Service. 2020. https://www.england.nhs.uk/greenernhs/wp-content/uploads/sites/51/2020/10/delivering-a-net-zero-national-health-service.pdf. Accessed October 2023.

12 Morcillo Serra C, Aroca Tanarro A, Cummings Ce. Impact on the reduction of CO2 emissions due to the use of telemedicine. Sci Rep. 2022;12. https://pubmed.ncbi.nlm.nih.gov/35869274/. Accessed October 2023.

13 Candanosa RM. Reducing Emissions to Lessen Climate Change Would Yield Dramatic Health Benefits by 2030. 2021. https://climate.nasa.gov/news/3134/reducing-emissions-to-lessen-climate-change-would-yield-dramatic-health-benefits-by-2030/. Accessed August 25, 2023.

14 White R, Anderson, S, Booth J. The unprecedented Pacific Northwest heatwave of June 2021. Nat commun. 2023;14. https://pubmed.ncbi.nlm.nih.gov/36759624/#:~:text=In%20late%20June%202021%20a,temperature%20of%2049.6%20%C2%B0C. Accessed October 2023.

15 PureHealth Group. UAE Health System Setting Ambitious Climate Goals. 2023.

16 Wolf RM, Abramoff MD, Channa R, Tava C, Clarida W, Lehmann HP. Potential reduction in healthcare carbon footprint by autonomous artificial intelligence. 2022;5(62). https://www.nature.com/articles/s41746-022-00605-w. Accessed October 2023.

17 Dacones I, Cave C, Furie G, Ogden C, Slutzman J. Patient transport greenhouse gas emissions from outpatient care at an integrated health care system in the Northwestern United States, 2015–2020. J Clim Change Health, 2021;3. https://www.sciencedirect.com/science/article/pii/S2667278221000225#:~:text=The%20carbon%2Dintensity%20of%20outpatient,%2C%20a%20reduction%20of%2051%25. Accessed October 2023.

18 Thiel C, Mehta N, Sejo C, et al. (2023). Telemedicine and the environment: life cycle environmental emissions from in-person and virtual clinic visits. npj Digit Med. 2023;6(87). https://www.nature.com/articles/s41746-023-00818-7#:~:text=In%202021%2C%20SHC's%20average%20in,0.04%20kg%20CO2e%20on%20average. Accessed October 2023

19 Johnson & Johnson. Environmental Impact and Benefits of Care4Today Total Knee Replacement (TKR) Care Pathway. Sustainable Healthcare Coalition. 2018. https://shcoalition.org/environmental-impact-and-benefits-of-care4today-total-knee-replacement-care-pathway/#:~:text=In%20this%20study%2C%20the%20data,50%20kg%20CO2e%20per%20patient. Accessed October 2023.

20 Kaiser Permanente. Reducing secondary cardiac events with virtual cardiac rehab. ScienceDaily. 2019. https://www.sciencedaily.com/releases/2019/08/190828143100.htm. Accessed October 2023.

21 Lappegård KT, Moe F. Remote monitoring of CIEDs-for both safety, economy and convenience? Int J Environ Res Public Health. 2021;19(312). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8751026/. Accessed October 2023.

22 Patel KB, Gonzalez BD, Turner K, et al. Estimated Carbon Emissions Savings With Shifts From In-Person Visits to Telemedicine for Patients With Cancer. JAMA Netw Open. 2023;6(1). https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2800847#:~:text=For%20patients%20living%20within%20a,vehicles%20driven%20for%201%20year. Accessed October 2023.

23 Accenture. Patients Want to Continue to Use Virtual Care Even After the Pandemic Ends, Accenture Survey Finds. 2020. https://newsroom.accenture.com/news/patients-want-to-continue-to-use-virtual-care-even-after-the-pandemic-ends-accenture-survey-finds.htm#:~:text=NEW%20YORK%3B%20July%209%2C%202020,oncology%2C%20cardiology%2C%20or%20immunology%20patients. Accessed October 2023.

24 Sapci AH, Sapci HA. Innovative assisted living tools, remote monitoring technologies, artificial intelligence-driven solutions, and robotic systems for aging societies: systematic review. JMIR aging. 2019; 2(2), e15429.

25 Accenture. Accenture Internal Research – Care Anywhere and Sustainability. 2023.

26 Mecart. Modular hospital buildings: a healthcare revolution. 2021. https://www.mecart-cleanrooms.com/projects/case-studies/prefab-modular-hospital/. Accessed October 2023.

27 Romanello, M., Di Napoli, C., Drummond, P., Green, C., Kennard, H., Lampard, P., . . . Belesova, K. (2022). The 2022 report of the Lancet Countdown on health and climate change: health at the mercy of fossil fuels. The Lancet, 400(10363). Retrieved from https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(22)01540-9/fulltext

28 Andreae S. Climate change and global health: What actions are healthcare leaders taking? World Economic Forum. 2022. https://www.weforum.org/agenda/2022/11/climate-change-global-health-actions-healthcare-leaders/. Accessed October 2023.

29 Filho WL, Balasubramanian M, Purcell W, Paz S. Handling the health impacts of extreme climate events. Environ Sci Eur. 2022;34. https://enveurope.springeropen.com/articles/10.1186/s12302-022-00621-3. Accessed October 2023.

30 Seervai S, Gustafsson L, Abrams MK. The Impact of Climate Change on Our Health and Health Systems. The Commonwealth Fund. 2022. https://www.commonwealthfund.org/publications/explainer/2022/may/impact-climate-change-our-health-and-health-systems. Accessed October 2023.

31 McGrail S. Climate Change, Fossil Fuel Boosts Healthcare Costs to $820B. 2022. https://lifesciencesintelligence.com/news/climate-change-fossil-fuel-boosts-healthcare-costs-to-820b. Accessed October 2023.

32 Health Care Without Harm. (2018). Safe Haven in the Storm: Protecting Lives and Margins with Climate - Smart Health Care. 2018. https://noharm-uscanada.org/sites/default/files/documents-. Accessed October 2023.

33 Lee VS, Gerwig K, Hough E, Mate K, Biggio R, Kaplan RS. Decarbonizing Health Care: Engaging Leaders in Change. NEJM Catal Innov Care Deliv. 2023;4(5). https://catalyst.nejm.org/doi/full/10.1056/CAT.22.0433. Accessed October 2023

34 Bravo R. Europe Banks on Its €72 Billion to Counter Biden's Green Payouts. Bloomberg, Ed. https://www.bloomberg.com/news/articles/2023-02-26/europe-incentives-on-clean-energy-rival-biden-s-green-subsidies?embedded-checkout=true#xj4y7vzkg. Accessed October 2023

35 Black S, Parry I, Zhunussova K. More Countries Are Pricing Carbon, but Emissions Are Still Too Cheap. 2022. https://www.imf.org/en/Blogs/Articles/2022/07/21/blog-more-countries-are-pricing-carbon-but-emissions-are-still-too-cheap. Accessed October 2023.

36 IMF. Fiscal Monitor: How to Mitigate Climate Change. 2019. https://www.imf.org/en/Publications/FM/Issues/2019/09/12/fiscal-monitor-october-2019. Accessed October 2023.

37 Accenture. Shaping the Sustainable Organization. 2022. https://www.accenture.com/us-en/insights/sustainability/sustainable-organization?c=acn_glb_buildingsustainbusinesswire_12364631&n=mrl_0921.html?c=acn_glb_buildingsustainbusinesswire_12364631&n=mrl_0921.html. Accessed October 2023.

38 Fyfe-Mills K. Sustainability Influences Hiring and Retention. 2019. https://www.td.org/magazines/td-magazine/sustainability-influences-hiring-and-retention. Accessed October 2023.

39 Beck D. Climate Change Branding Can Lift Recruitment and Retention. 2022. https://www.shrm.org/resourcesandtools/hr-topics/talent-acquisition/pages/climate-change-branding-can-lift-recruitment-and-retention.aspx. Accessed October 2023.

40 Peters A. Most millennials would take a pay cut to work at an environmentally responsible company. 2019. https://www.fastcompany.com/90306556/most-millennials-would-take-a-pay-cut-to-work-at-a-sustainable-company. Accessed October 2023.

41 Accenture, Destination Net Zero, November 2023. https://www.accenture.com/content/dam/accenture/final/accenture-com/document-2/Destination-Net-Zero-2023-Report.pdf#zoom=40

42 GGHH. Health Care Climate Challenge Participants. 2023. https://greenhospitals.org/HCCC-Participants. Accessed October 2023.

43 UNFCCC. Race to Zero Campaign. 2023. https://unfccc.int/climate-action/race-to-zero-campaign. Accessed October 2023.

44 UN SDG. Tackling Climate Change. 2023. https://www.un.org/sustainabledevelopment/climate-action/#:~:text=Goal%2013%20calls%20for%20urgent,well%20below%202%20degrees%20Celsius. Accessed October 2023.

45 Richardson S, Lawrence K, Schoenthaler AM, Mann D. A framework for digital health equity. npj Digit Med. 2022;5(1), 119. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9387425/. Accessed October 2023.

46 NHS. Virtual hospital appointments in Devon save 13.5 million patient miles. 2021. https://www.england.nhs.uk/south/our-work/greener-nhs-south-west/devon/virtual-hospital-appointments-in-devon-save-13-5-million-patient-miles/. Accessed August 25, 2023.

47 Jercich K. Telehealth can play a vital role in reducing carbon emissions. 2022. https://www.healthcareitnews.com/news/telehealth-can-play-vital-role-reducing-carbon-emissions. Accessed August 25, 2023.

48 Yehya NA. (2023). Telehealth cuts health care's carbon footprint and patient's costs during pandemic. 2023. https://health.ucdavis.edu/news/headlines/telehealth-cuts-health-cares-carbon-footprint-and-patients-costs-during-pandemic/2023/01. Accessed August 25, 2023.

49 Muoio D. CommonSpirit Health accelerates COVID-19 rebound with $539 M in operating gains. 2021. Fierce Healthcare. https://www.fiercehealthcare.com/hospitals/commonspirit-health-1-5m-ambulatory-virtual-visits-saved-1-7m-gallons-fuel-15-000-. tons#:~:text=CommonSpirit%20calculated%20that%201.5%20million,carbon%20dioxide%20from%20being%20released. Accessed October 2023.

50 Providence. Environmental Stewardship Report. 2022. https://foundation.providence.org/national/about-us/our-stories/providence-releases-2022-environmental-stewardship-report. Accessed October 2023.

51 Davis R, Markle E, Windoloski S, et al. A comparison of the effect of weather and climate on emergency department visitation in Roanoke and Charlottesville, Virginia. 2020;191. https://www.sciencedirect.com/science/article/abs/pii/S0013935120309622#:~:text=Females%20in%20Roanoke%20were%20more,lower%20temperatures%20than%20did%20females. Accessed October 2023.

52 Hospital Management. Top ten largest hospitals in Oregon by bed size in 2021. 2022. https://www.hospitalmanagement.net/features/largest-hospitals-oregon-2021/. Accessed October 2023.

53 Nguyen Hai T, Meyer L, McGuire H, Nguyen Thi Hong H, Nguyen Thi L. Frontier digital technology: Transforming noncommunicable disease prevention among youth. Lancet Reg Health West Pac. 2022. https://pubmed.ncbi.nlm.nih.gov/36605883/. Accessed October 2023.

54 Fernandez-Luque L, Herbish A, Shammari R, et al. Digital Health for Supporting Precision Medicine in Pediatric Endocrine Disorders: Opportunities for Improved Patient Care. Front Pediatr. 2021;9. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8358399/. Accessed October 2023.

55 Wolf Re. Cost-effectiveness of Autonomous Point-of-Care Diabetic Retinopathy Screening for Pediatric Patients With Diabetes. JAMA ophthalmol. 2020;10(138), 1063-1069. https://jamanetwork.com/journals/jamaophthalmology/fullarticle/2770183. Accessed October 2023.

56 Accenture. Accenture – Kaiser Permanente communication: Featuring KP case study. 2023.

57 Simpson I, Bhandari V. Considering the Sustainability Impact of Connected Inhalers in the Treatment of Asthma". ONdrugDelivery. 2022;(139), 42-48. https://ondrugdelivery.com/considering-the-sustainability-impact-of-connected-inhalers-in-the-treatment-of-asthma/. Accessed October 2023.

58 Moyer MA. Interview with Study Authors. September 7, 2023.

59 Chua KS, Kuah CW. Innovating With Rehabilitation Technology in the Real World Promises, Potentials, and Perspectives. Am J Phys Med Rehabil. 2017;96(10), S150-S156. https://pubmed.ncbi.nlm.nih.gov/28708632/. Accessed October 2023.

60 World Health Organization. Cardiovascular Diseases (CVDs). 2021. https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds) Accessed October 31, 2021

61 Diaz P, Diaz J, Sobrino H, et al. Carbon footprint as a marker of environmental impact in patients included in a remote monitoring pacemaker programme. Eur Heart J. 2021;42. https://academic.oup.com/eurheartj/article/42/Supplement_1/ehab724.0409/6394164. Accessed October 2023.

62 Tennison I, Roschnik S, Ashby B. Health care's response to climate change: a carbon footprint assessment of the NHS in England. Lancet Planet Health. 2021;5, e84-92. https://www.thelancet.com/action/showPdf?pii=S2542-5196%2820%2930271-0. Accessed October 2023.

63 Kirkland EB, Johnson E, Bays C, et al. Diabetes Remote Monitoring Program Implementation: A Mixed Methods Analysis of Delivery Strategies, Barriers and Facilitators. Telemed Rep. 2023; (4), 30-43. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10027345/. Accessed October 2023.

64 Schaffer R. Remote monitoring of cardiac devices during pandemic cut greenhouse gas emissions. Healio. 2023. https://www.healio.com/news/cardiology/20230315/remote-monitoring-of-cardiac-devices-during-pandemic-cut-greenhouse-gas-emissions#:~:text=unknown%2C%20Lakkireddy%20said.-,Remote%20monitoring%20of%20more%20than%2032%2C000%20patients%20with%20cardiac%20impl. Accessed October 2023.

65 Bawa D, Ahmed A, Douglas D, et al. Impact of Remote Cardiac Monitoring on Greenhouse Gas Emissions: Global Cardiovascular Carbon Footprint Project. JACC Adv. 2023;2(3). https://www.jacc.org/doi/abs/10.1016/j.jacadv.2023.100286.

66 Dhaka M, Sharma DP, Sharma SK, Dixit A. An Analysis of Electronic Health Record System in Healthcare Services in Cloud: A Review Perspective. December 2021. In 2021 International Conference on Computational Performance Evaluation (ComPE) (pp. 886-892). IEEE.

67 Devi DH, Duraisamy K, Armghan A, et al. 5g technology in healthcare and wearable devices: A review. Sensors. 2023;23(5), 2519.

68 Media, Newsroom. Five Stars for Australia's First all-electric Building at Canberra Hospital. Canberra Daily. Published June 5, 2023. https://canberraweekly.com.au/five-stars-for-australias-first-all-electric-building-at-canberra-hospital/. Accessed October 2023.

69 UCI Health. All-electric hospital will be the country's first when it opens in 2025. 2023. https://www.ucihealth.org/news/2023/04/electric-carbon-neutral-hospital. Accessed October 2023.

70 Abid H, Mohd J, Ravi Pratap S, Rajiv S, Shanay R. Blockchain technology applications in healthcare: An overview. Int J Intell Syst. 2021. https://www.sciencedirect.com/science/article/pii/S266660302100021X. Accessed October 2023.

71 FDA. Artificial Intelligence and Machine Learning (AI/ML)-Enabled Medical Devices. 2022. https://www.fda.gov/medical-devices/software-medical-device-samd/artificial-intelligence-and-machine-learning-aiml-enabled-medical-devices. Accessed October 2023.

72 Accenture. Uniting Technology and Sustainability: How to get the Full Value From Your Sustainability Tech Strategy. https://www.accenture.com/content/dam/accenture/final/a-com-migration/pdf/pdf-177/accenture-tech-sustainability-uniting-sustainability-and-technology.pdf#zoom=40. Accessed October 2023.

73 Emirates Health Services. Innovation: Using AI to reduce Carbon footprint of health systems in UAE [video]. Gartner. https://www.gartner.com/en/about/awards/healthcare-eye-on-innovation. Accessed November 1, 2023.

74 Accenture. How talent and technology can help solve the nursing shortage. 2023. https://www.accenture.com/content/dam/accenture/final/accenture-com/document/Accenture-Solving-The-Nursing-Shortage-For-The-Future.pdf#zoom=40. Accessed October 2023.

75 Mercy. Mercy Virtual Care Program. 2023. https://www.mercy.net/about/virtual-care-program/. Accessed October 2023.

76 MOHSA. SEHA Virtual Hospital: Our Future is Today. 2023. https://www.moh.gov.sa/en/Ministry/Projects/Documents/Seha-Virtual-Hospital.pdf. Accessed October 2023.

77 OMA. Al Daayan Health District Masterplan. 2022. https://www.oma.com/projects/al-daayan-health-district-masterplan. Accessed October 2023.

Authors

Rich Birhanzel
Managing Director, Global Health Industry Lead

Raymond Makhoul
Managing Director, Middle East Health & Public Service Lead
Strategy & Consulting

Jessica Wolff, MBA, MSN
Principal Director, Global Health Sustainability Lead
Strategy & Consulting

Marc Koyess
Managing Director, Middle East Health & Public Service
Strategy & Consulting

Research Team
Dr. Nawaf Albali, Rachel Btaiche, Layla Jabre, Anna Kondas, Chris Magas, Agata Szczotka-Sarna

Acknowledgements

Care Anywhere Team

Greg Smith, Ryan Zayance

Special thanks to the case study authors who provided feedback and additional input on their work including:

- **Bupa** - Glyn Richards, Group Director of Sustainability
- **Northwest Permanente Medical Group** – Dr. Colin Cave, Medical Director of External Affairs, Government Relations and Community Health
- **PureHealth** - Dr. Marwan Ali Mohammed Al Kaabi, Chief Critical Infrastructure Management & Response
- **Providence** – Elizabeth Schenk, Executive Director of Environmental Stewardship
- **Stanford Health Care** - Meagan Moyer, Digital Health Operations Manager; Cassie Thiel, Assistant Professor, NYU Langone Health

accenture