



Klecha & Co.

Insights Report

*Digital Health Tech:
Paving the way for a healthier future*

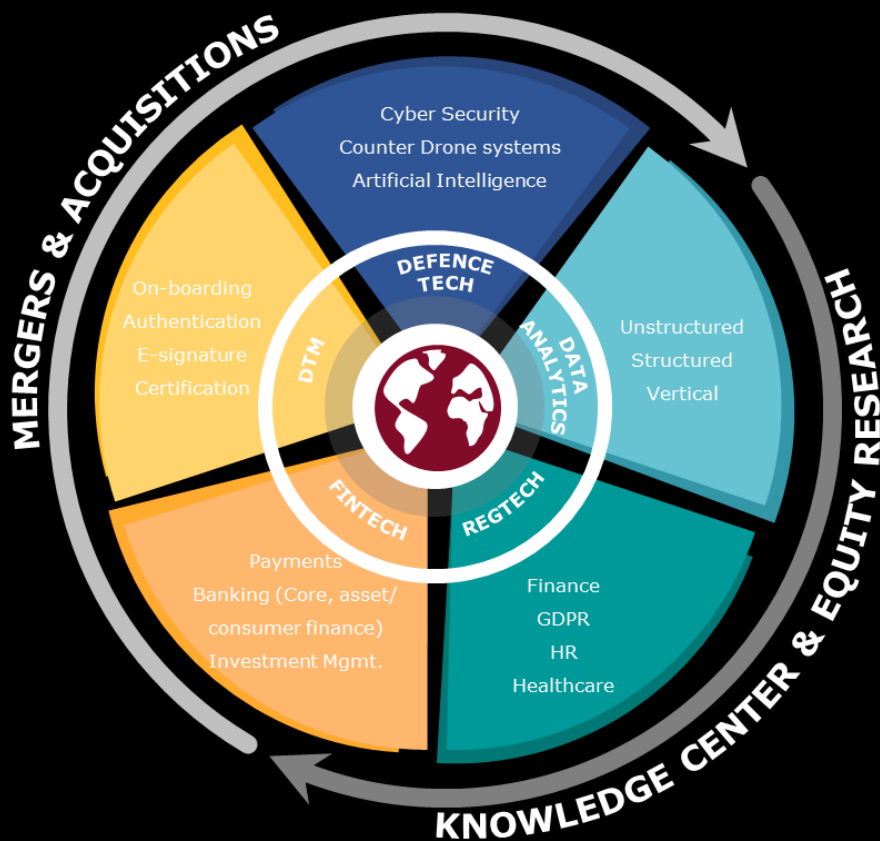
May 2022

ABOUT US

Klecha & Co.

Klecha & Co. is a private investment bank focused on Technology, including Software, IT Services, Hardware and IoT. Our clients are private sector companies, active contributors to the data revolution or solution providers to the opportunities and challenges arising from the digitalization of business processes. We support our clients from the definition of their strategy through to post M&A integration.

The depth of our industry expertise, sector focus and M&A experience make us truly unique in the market.



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Key stats driving digital health¹

US\$ 8 trillion

Estimated size of the healthcare ecosystem based annual spend

40%

of health consumers will continue to use telehealth, up from 11% (pre-pandemic)

US\$ 1.5 trillion

Estimated size of the global digital health market by 2030

25%

of total healthcare expenditure is wasted every year due to administrative complexity

US\$ 41 billion

Enterprise value of European digital health start-ups as of February 2021

€ 5 billion

Allocated towards digital health initiatives by the European Commission

93%

Of OECD countries use electronic in primary care

18 million

Shortage in number of health care workers in the world by 2030

Key Considerations

Since the time of Hippocrates, for the last 2,400 years, healthcare has been about blending science and art. Whereas the art is expressed through a caregiver's empathy for a patient, the science is visible in the inventions that have helped save millions of lives over the last century. Looking forward to the next 100 years, the expanding capacity of science and technology will complement empathy more and more. In many ways, the future of healthcare will resemble the past, with clinicians visiting patients at home, although digitally, and following them throughout their lives. To provide tailored and equitable care, and always being there to the individual at their time of greatest need.

From groundbreaking heart therapies in the 1950s to current advances in face and uterine transplant surgery, medical innovators have frequently looked to technology. Some of these advancements in treatment are helped by specific instruments, like surgical robots. A broader role for technology in safety, quality, and clinical transparency is enabling data collecting to help advise and decide the most appropriate treatment plan.

It's been a long time since hospitals went paperless, causing delays in clinical information to frontline caregivers. Using devices and applications, physicians can access test results and other clinical information in real time at the bedside. This improves healthcare quality and puts the patient first. Integrated technologies like Electronic Medical Records (EMRs) relieve caregivers of data collection duties and allow them to directly counsel patients. For patients, having rapid access to their medical data via an app is a significant convenience. People are used to technology-enabled, transparent customer service in everyday life and expect the same in healthcare. Appointment reminders, payment, and medical information can all be accessed via patient apps.



Contrary to popular belief, technology can help doctors. Technology can help patients and doctors get to where they need to go faster. Technology can also improve security. Individually wrapping and tracking medication by barcode to the patient's bedside reduces human error. For example, as one of the biggest gainers within this field, telehealth allows people to obtain care without having to travel to a clinic. Remote patient monitoring is also gaining popularity. This now includes wearable equipment with astonishing capabilities, from remote monitoring of vitals to remote echocardiograms. Without the pandemic, the healthcare industry would have taken another decade to reach its current state.

The epidemic boosted healthcare technology advancement and acceptance. For patients, obtaining medical services outside of a typical medical facility is increasingly more convenient and accessible. Despite our technological shortcomings, recent breakthroughs have put the industry in a position to innovate and improve. Healthcare technology businesses can aid both patients and doctors by introducing the correct tools. In the coming year, we see increased patient openness, integrated data exchange, and predictive analytics as critical in healthcare.

Digital Health: An overview

Digital health technologies use computing platforms, connectivity, software, and sensors for health care and related uses. These technologies have a wide range of applications, ranging from general wellness to medical devices. They can be used as a medical product, in a medical product, as companion diagnostics, or as an add-on to other medical products (devices, drugs, and biologics). They could potentially be used to test or create medical devices. Mobile health (mHealth), health information technology (IT), wearable devices, telehealth, and personalized medicine are all examples of digital health.

Through data access, digital solutions are providing clinicians with a more holistic perspective of patient health and allowing people greater control over their health. Digital health has the potential to significantly improve medical outcomes and efficiency.

These technologies have the potential to empower consumers to make better health decisions and provide new options for aiding prevention, early identification of life-threatening diseases, and chronic condition management outside of traditional health care settings. Digital health technologies are being used by providers and other stakeholders to:

- Reduce inefficiencies,
- Improve access,
- Reduce costs,
- Increase quality, and make medicine more personalized for patients

Patients, health care practitioners, researchers, traditional medical device sector firms, regulators, and mobile application developers, are some of the stakeholders in digital health activities.



Smartphones, social networks, and internet applications are changing not only how we communicate, but also creating creative ways for us to monitor our health and well-being and providing better access to information. These developments are bringing people, information, technology, and connection closer together to improve health care and outcomes. Digital technology has been driving a change in health care, from mobile medical apps and software that assist clinical decisions doctors make every day to artificial intelligence and machine learning. Digital health tools have enormous potential for improving our ability to effectively detect and treat disease, as well as improving individual health care delivery.

The need for digital health

In today's world, health care spending is increasing at a faster rate than economic growth. The need for digital health stems firstly from the fact that the need for long-term care and other therapies is increasing due to an aging population and the development of chronic diseases (75% of the global healthcare expenditure is related to treating chronic diseases²). Secondly, a standard that provides access to the greatest medical care, as well as a system that relieves pressure and stress on healthcare personnel, is required. A primary care physician, for example, works an average of 11.2 hours a day³. Technology is attempting to reduce this workload while also providing new opportunities. The sector's transition has resulted in the emergence of new opportunities, within large companies (Google, Amazon, Microsoft, IBM, Uber, Facebook, etc.) and emerging start-ups (Mediktor, Pharmacelera, RheoDX, Top Doctors, etc.), resulting in a new map of interactions and alliances. The reasons for growth in the adoption of digital health are listed below.

Rise in chronic diseases: Chronic, lifestyle-related diseases strain global healthcare systems. People with diabetes, respiratory problems, and hypertension now number over 422 million⁴, 262 million⁵ and 1.1 billion⁶ respectively. These figures are expected to rise as the population ages. By 2050, the world's 60-and-over population will reach 2 billion, up from 900 million in 2015⁷. To maintain healthcare systems viable, digital health technologies are needed to detect, diagnose, and treat disease early and more effectively, or avoid chronic disease altogether.

Patients want convenient, individualized treatment: Patients' expectations of healthcare are changing as the world becomes more accessible. Patients are more proactive about their health and want convenient, tailored care. 75% of US health customers wanted more individualized care before COVID-19⁸. The pandemic has shifted patient expectations. 40% of polled consumers said they will continue utilizing telehealth, up from 11% before COVID-19⁹.

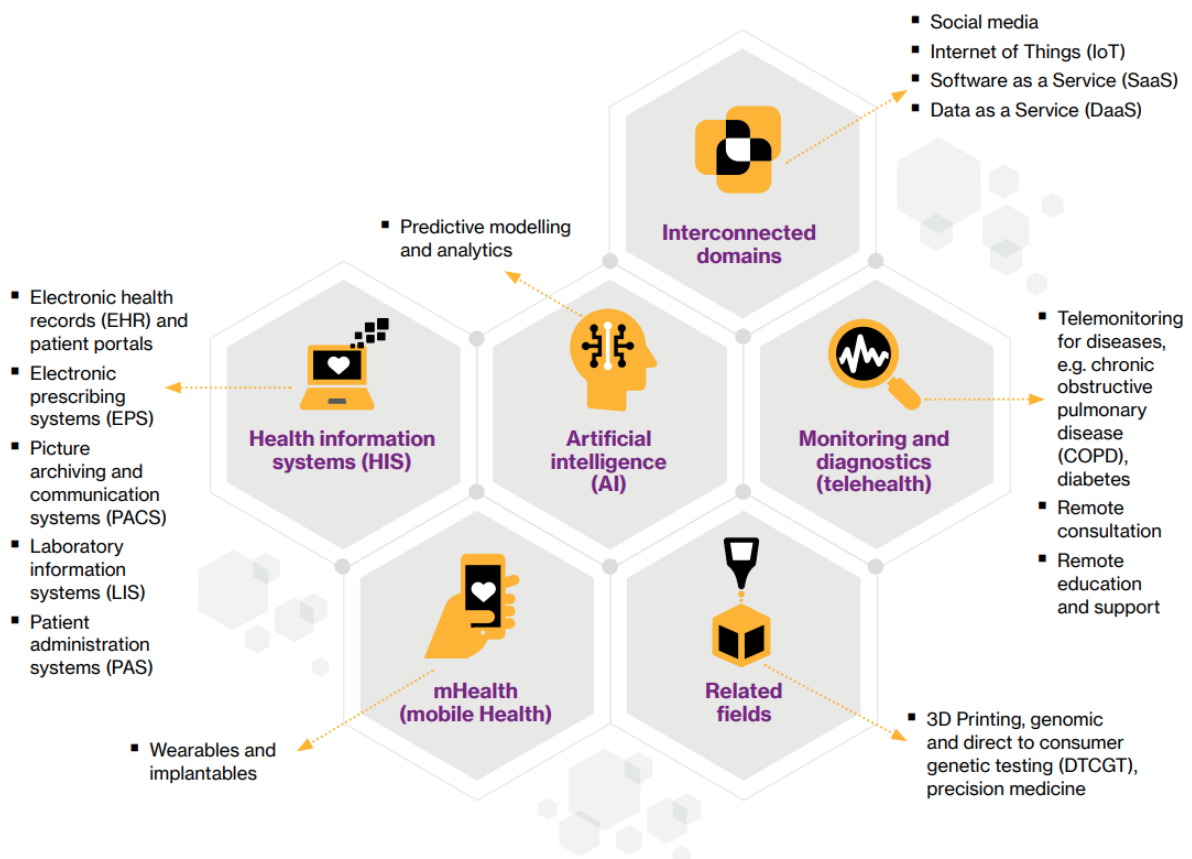
Staff shortages plague healthcare providers: As demand for care rises, healthcare providers face staff shortages worldwide. The WHO predicts a global shortage of 18 million healthcare workers by 2030¹⁰. A 2021 Medscape survey revealed that 42% of them report feeling burnout, with the COVID-19 pandemic adding to the strain for many¹¹. Digital technologies can assist automate mundane chores and simplify workflows to protect healthcare personnel' mental and physical wellbeing. Healthcare providers are also looking for ways to deliver specialized care in areas where staff is scarce.

Healthcare providers seeking efficiencies to reduce costs and waste: Healthcare systems are challenged by rising costs and declining reimbursement. Global health spending is predicted to climb 3.9% year between 2020 and 2024, faster than the 2.8% average from 2015-2019¹². More money doesn't always mean better results. Administrative complexity is the major source of wasted healthcare spending in the US, at about 25%¹³. Improving operational efficiencies and minimizing waste is a top concern for healthcare professionals, who require data-driven insights to identify opportunities.

These four trends illustrate the need for digital transformation to improve supply-and-demand matching. The future of the healthcare systems depends on it.

The digital health ecosystem

This field is referred to by a variety of terms, including digital health, medical informatics, eHealth, telehealth, and so on. A wide range of technologies and concepts make up the digital health ecosystem. Some of the digital health categories are highlighted below (which is not completely exhaustive). Since many of the technologies are inter-related, the categorization tends to overlap in some cases.



Picture 1: The broader digital health ecosystem¹⁴

Health Information Systems (HIS) store a variety of health information in digital format. An Electronic Medical Record (EMR) is created in a health care service or organization, such as a hospital, while an EHR transitions from an institution centric to a person centric digital record that ideally contains the entire history of an individual's interactions with the health system, regardless of settings, services, or organizations.

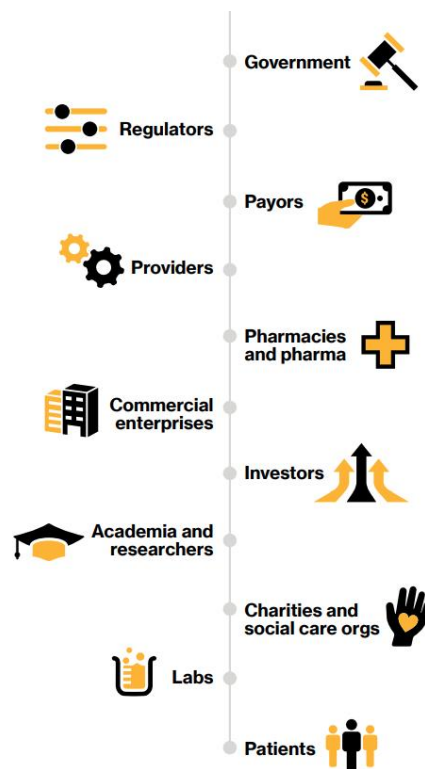
Telehealth is a set of digital solutions that allow for the delivery of clinical services and the monitoring of care and treatment over long distances and – where appropriate – asynchronously, i.e. with the involved health worker(s) and the patient connecting at different times, allowing for more flexibility. Mobile health gadgets and digital health apps are frequently used in telehealth (mHealth).

mHealth refers to the use of widely available mobile (communication) devices such as smartphones and tablet computers, as well as wearable devices such as smart watches, on which digital health apps and sensors function. Mobile equipment designed expressly for use by health care providers for service delivery and data collection, such as portable monitoring systems, are also included. The major

goal is to let patients to remain in their own homes and live independently for extended periods of time, or to return home faster following hospitalization.

Interconnected domains are a collection of digital health apps and other software services that can be used within the other domains that help collect and process data.

Artificial Intelligence (AI) and analytics using data and technologies such as Artificial Intelligence to automate, predict, and support decision making. AI is a machine-based system that can make predictions and suggestions based on a set of operator defined objectives. AI systems are built to have varied degrees of autonomy. Machine learning (ML) enables digital systems to achieve goals without explicit instructions by analyzing patterns in training data, which must be correctly prepared, including or excluding labeling. Deep learning is the subfield in which the digital system achieves this goal by discovering distinguishing properties of data sets in a hierarchical manner.



Picture 2: Different stakeholders in digital health¹⁴

Looking Ahead: Digital health in 2025?

Due to rapid developments in healthcare and technology, making solid predictions even five years in the future is difficult. Many eventualities that would have looked impossible merely a decade ago today appear to be feasible. Consider these examples:

- Based on hundreds of your facial photos acquired over a decade and a DL model, your tablet warns you about the impending development of depression.
- An ambient IoT device in your car detects a possible heart problem in your passenger.
- Hereditary traits and genetic monitoring alert your doctor that you may have contracted an illness before symptoms show.
- Using accumulated speech data to test your cognitive function and establish a mental state assessment score, your healthcare provider flags a possible Alzheimer's diagnosis.

- Caregivers utilize spatial heatmaps to see where their loved ones spend their time and to spot changes in their gait that could indicate a future health problem.
- Noninvasive sensors in your parents' house warn you about potential concerns based on their usual habits.
- Virtual assistants and machine learning algorithms learn the optimal time to remind you to take your medicine.
- Multiple AI-based studies support the idea that aging is a treatable condition, encouraging you to get more involved in your health.
- All stakeholders can see how care is delivered, and access to services can be coordinated in real time with all parties in accordance with all contracts.
- As computing becomes more integrated into our travel, work, and living environments, healthcare on the move allows an elderly population to travel with peace of mind.

Add to the mix: Surgical robots; new drugs; better treatment plans; more accurate diagnosis; lower diagnostic and treatment error rates; more interactive and individualized healthcare. In the coming years, AI-supported healthcare in clinics, hospitals, homes, and assisted living facilities will all be a reality.

Opportunities and challenges of digital health going forward

At the economic, social, and even environmental levels, the digital transformation of the health industry presents a wide range of potential. The transition is already here, from the humanization of medicine to improved efficiency in industry processes, including the ability to discover new insights and improve patient quality of life.

Opportunities and their scope going forward..

Collaboration: The industry, as well as how stakeholders interact, is changing. Collaboration, communication, and transparency among the numerous stakeholders have been proved to be critical to the sector's economic growth. Partnership agreements, start-up acquisitions, mergers, and technology transfer processes are becoming increasingly popular in the sector as a means of developing.

Agility and efficiency: The industry's transition and adoption of new technologies are enabling for more automation and efficiency in the design of healthcare procedures, resulting in cost savings and even a positive influence on the environment. In the research and development of medicinal products, as well as the launch of new items on the market, new technologies allow for more simplified operations.

The patient at the core: The ability to monitor and collect fresh data, as well as the development of clever algorithms and data analytics, are paving the way for extreme personalization of health care and better decision-making. New technology will also enable incorporating patient feedback to promote enterprise continuous improvement and patient empowerment – shifting from a treatment-focused to a prevention-focused healthcare system – as well as enhancing patient diagnosis and progressing to possible consequences.

Humanization of healthcare: By minimizing red tape and improving the amount of time allocated to each patient, the integration of voice-based technologies and AI is predicted to enable a 360-degree turn in the patient-healthcare professional interaction.

Providing access: Remote treatment, as well as patient monitoring and tracking equipment, are ushering in a new era of patient-provider interaction. They also enable medical care to be delivered to areas where access to healthcare is limited, as well as the establishment of a global standard of healthcare quality.

Sustainability: Early detection and patient education with a clear focus on prevention are increasingly being shown to be approaches for addressing this situation and developing a more sustainable system, given that disease evolution and expense rises are the fundamental problems of the healthcare system. As a result, technology will enable us to assess the performance and cost-effectiveness of the healthcare system, benefiting both the system and the healthcare providers.

A few challenges to take on..

Confidentiality and data security: Among the major global debates surrounding the advancement of Digital Health will be confidentiality and data security. Not just in terms of the data owner, but also in terms of the excess of information available to patients and the fragmentation of the various healthcare systems as a result of data interoperability.

Cultural differences: The digital change is cultural as well as technological. As a result, it will be critical to address the worries and apprehensions that the upcoming changes may engender. It will also be critical to improve professional and decision-maker knowledge of new competences and skills, which will become increasingly important as health care transforms.

Intense regulation: The sector's strict regulation will be visible in every small movement. It will be crucial to monitor how topics like data ownership and digital service purchases are regulated. The problem - Working within regulatory frameworks that aren't yet in sync with the usage of new technologies, as well as addressing the ethical dilemmas that technology and its new possibilities have posed.

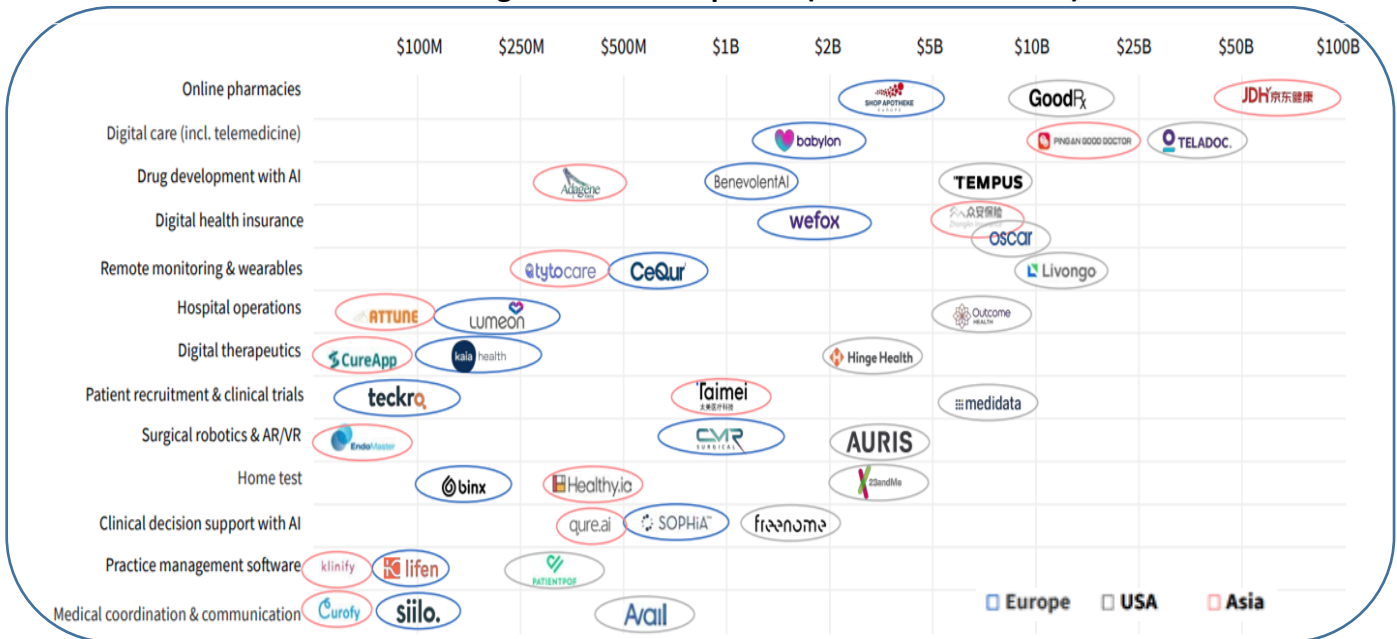
Building Digital competencies: The disparity in digital capabilities among stakeholders may obstruct communication and, as a result, present and future collaborative connections. It will also be necessary to form an interdisciplinary consortium with representation from all stakeholders, allowing for the development of political strategies and regulatory frameworks that promote progress in the digital transformation of the health sector at the regional, national, and community levels.

Financing models: To encourage enterprises to engage in innovation and digital solutions, purchasing instruments and hybrid financing methods are required.

Overview of the Global and European Digital Health Landscape

Some of the most successful businesses in the world have originated in marketplaces where consumers spend a small percentage of their income. In comparison, healthcare is one of the most popular consumer categories, but it is still largely undigitized at practically every stage of the value chain and patient journey. In Europe, and within telehealth (Babylon, Kry), operations software (Doctolib, Docplanner), and insurance (wefox), one can already see the significant development of digital health companies and an ecosystem develop. A market that is expected to touch a trillion dollars could easily support a European multi-decacorn in the future.

Most valued digital health companies (founded after 2000)



Graph 1: Most valuable digital health companies by sub-sector globally¹⁵

Leading and Emerging European companies in digital health

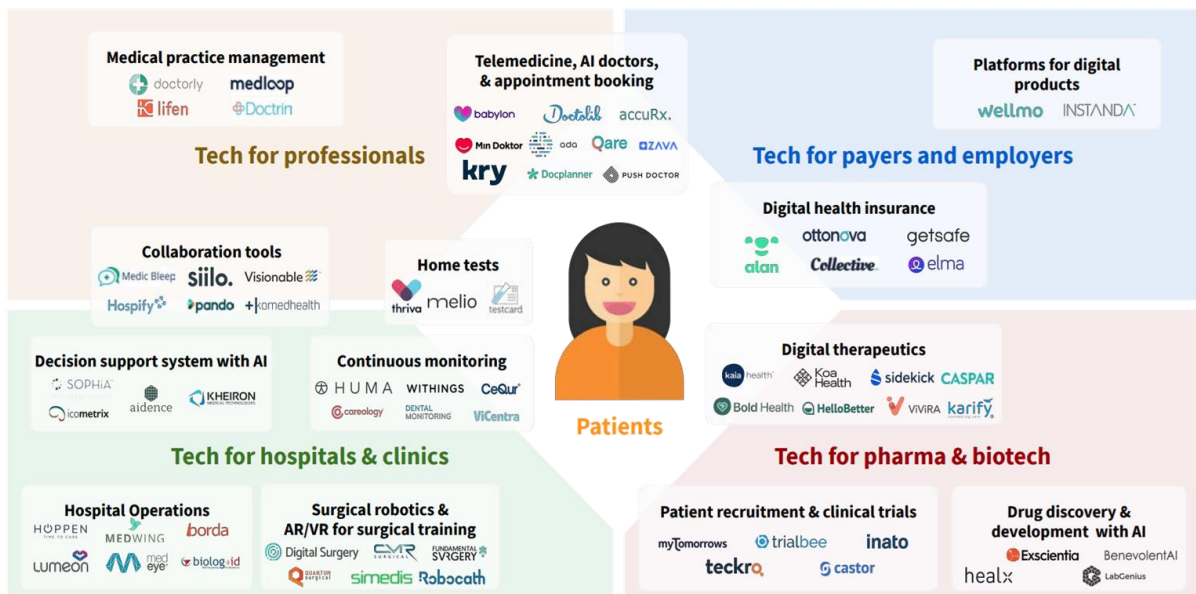
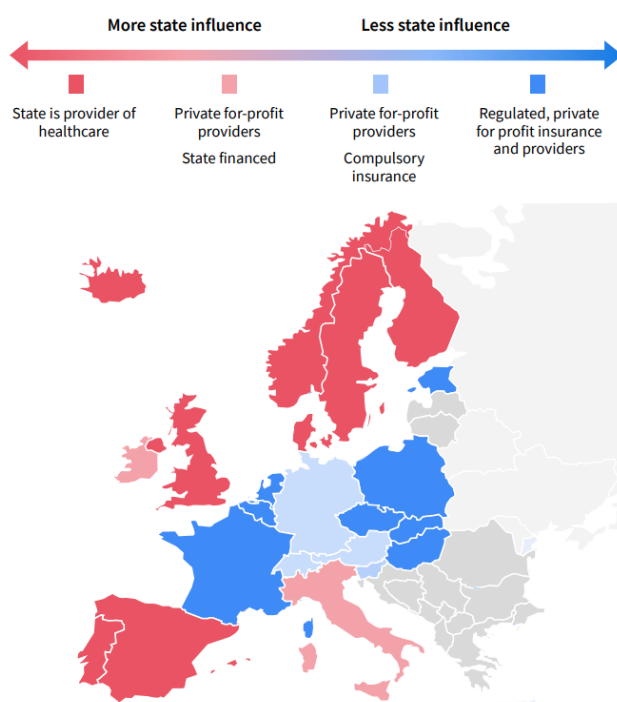


Table 1: Mapping of digital health companies in Europe¹⁵

Digital health initiatives within Europe

After the recovery of healthcare systems and the acceleration in digital transformation post the COVID-19 pandemic, the European Commission will focus on strengthening digital health governance, improving digital therapeutics and working on cross-border projects, a few of which are listed below¹⁶. Governments and regulators across Europe are putting incentives in place to improve health-based outcomes and reduce costs for patients, which present a promising opportunity for tech companies.



Picture 3: Distribution of health care services provided by states across Europe¹⁵

EU Digital COVID-19 certificate: Cross border, verifiable digital certificates that can be revoked and updated when required (borderless)

Disinfection robots: Completed the delivery of 305 disinfection robots as part of an action taken early in the COVID-19 pandemic to ease the burden on hospitals across the EU.

Investments: The European Commission allocated nearly €2 billion for investments aimed to advance on the digital transition, France invested €650 million when it led the Council of the EU.

European Innovation Partnership on Active and Healthy Ageing (EIP on AHA): An initiative that aims to foster innovation use of digital for active and healthy ageing

Privacy code of conduct on mobile health apps: Aims to promote trust among users and provide a competitive advantage for those who sign up to it.

1+ million genomes initiative: Potential to improve disease prevention, allow for more personalized treatments and support groundbreaking research.

Digital transformation policy: Adopted a Communication and a Staff Working Document on Digital transformation of health and care to boost European Union action. France plans to publish a report on a digital health barometer in 2022 to monitor, develop and attract investments.

Exchange of electronic health records: Adopted a Recommendation on a European electronic health record exchange format to unlock the flow of health data across borders. European Health Data Spaces (EHDS), part of the European Data Space, is a priority for the European commission aimed at strengthening the data exchange between member states.

eHealth experts: Created two expert groups working on eHealth: the eHealth Stakeholder Group and a temporary eHealth Task Force

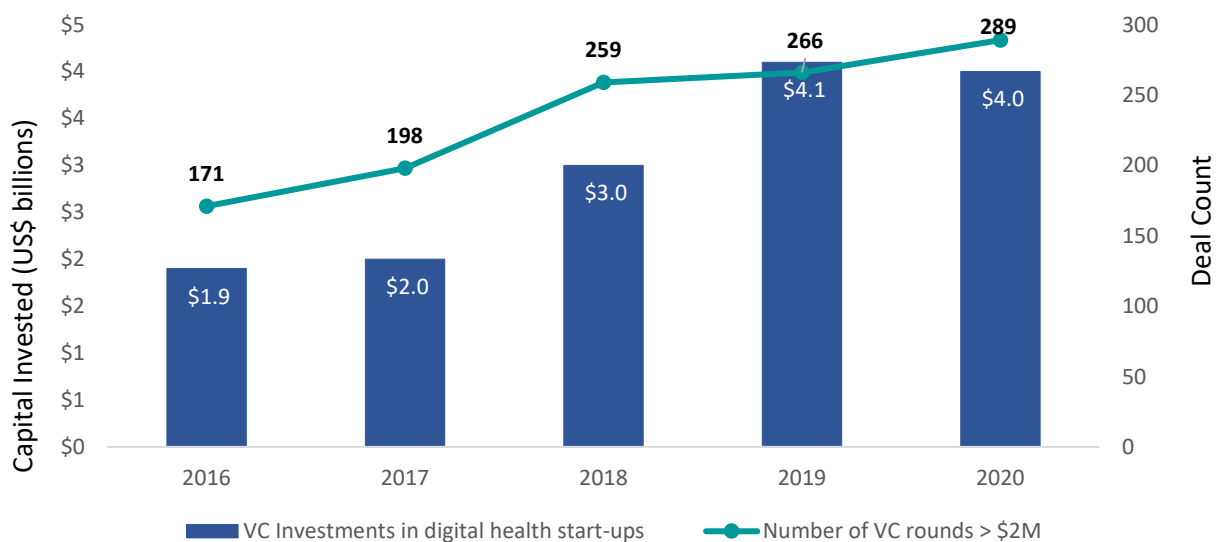
HERA: The Health Environment Research Agenda for Europe was launched to strengthen the role of science and research within health care, with a budget of over €3 billion and 24 partners from the EU.

DiGA: Germany, in 2019, having already taken the initiative in introducing apps on prescribing medicines (Digital Health Applications), France too joined this movement in 2021 and has initiated a “fast track” process on its adoption.

Different countries in Europe have seen varying trajectories within digital health. Germany adopted the digital healthcare act in 2019 and was the first country to cover prescription apps. It also gave an incentive of €500 for start-up video consultations. Sweden has been integrating EHRs solutions and e-prescriptions since 2019 and reimbursing teleconsultations since 2016. The UK launched an NHSX innovation accelerator and pledged US\$ 300 million into AI for health investments. France launched online diagnosis and treatment since 2018 and has allowed EU doctors to teleconsult patients in France.

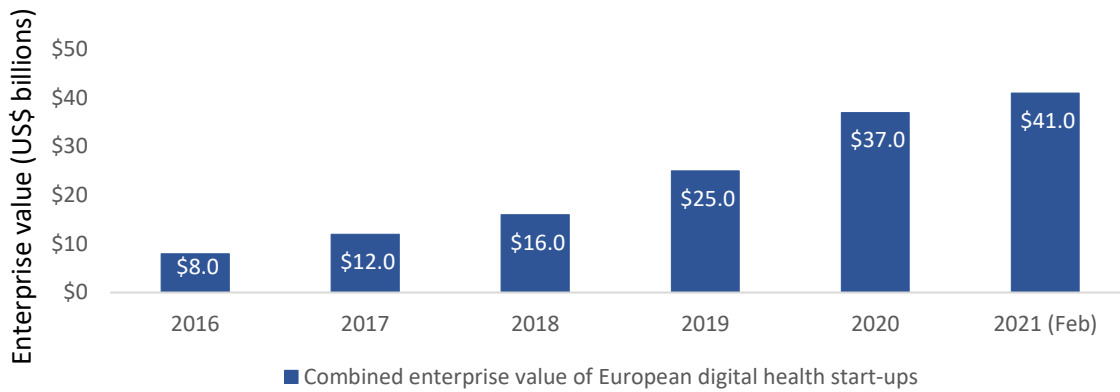
Fund raising trends across European digital health start-ups

Despite the fact that digital health investments have been progressively increasing since 2016, the global epidemic prompted an extraordinary increase in venture capital activity. As the health-care business was under increasing pressure to innovate and accept alternative treatment solutions, money flooded into digital health companies. Following an early rise in telehealth, venture capitalists have expanded their focus to include remote monitoring, AI solutions, and digital treatments.



Graph 2: VC activity in European digital health start-ups¹⁵

Europe’s healthtech companies were worth a combined US\$ 41 billion in 2021 (February), up from US\$ 8 billion in 2015. Drug discovery, telehealth and online pharmacy startups have so far accrued the most value in European healthtech.



Graph 3: Combined enterprise value of European digital health companies over the years¹⁵

European digital health start-ups and companies across the patient journey

Digital tools are being developed by startups to improve and change the pain spots in the patient's journey, providing tailored and engaging self-care solutions.

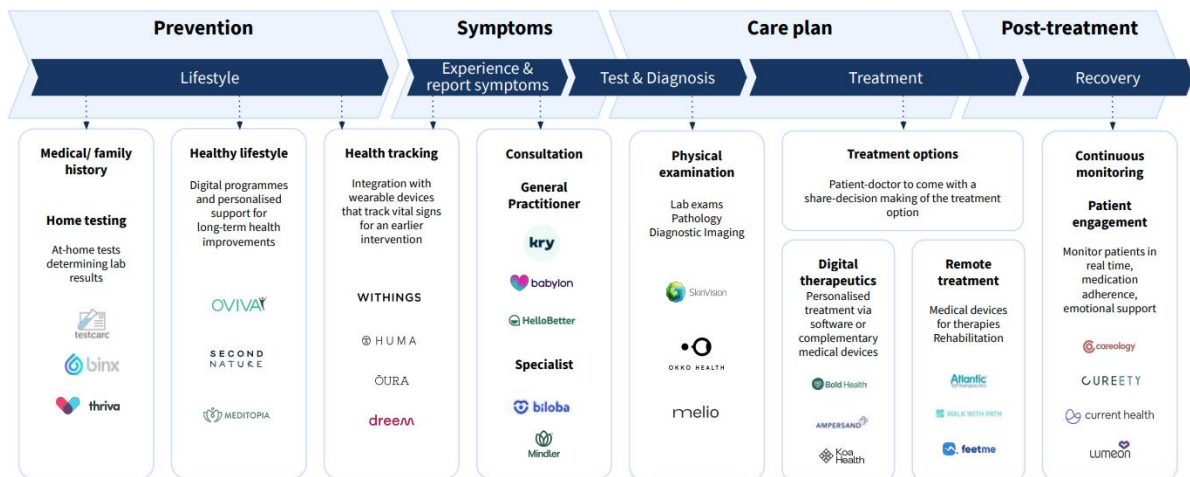


Table 2: Curated start-ups across different aspects of the patient's journey¹⁵

Similarly, software-enabled solutions are altering and streamlining the digital stack of healthcare providers.

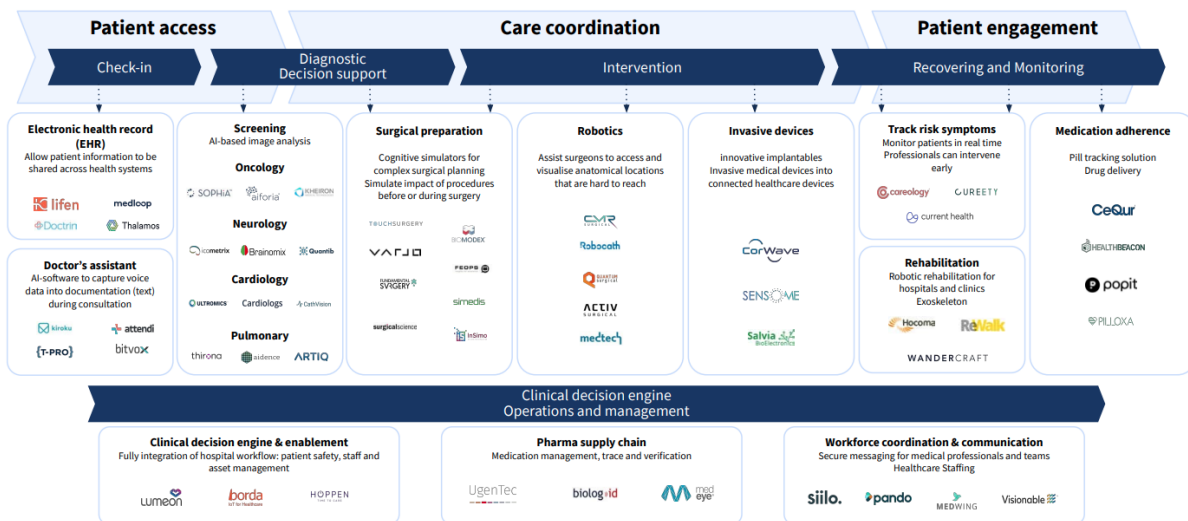


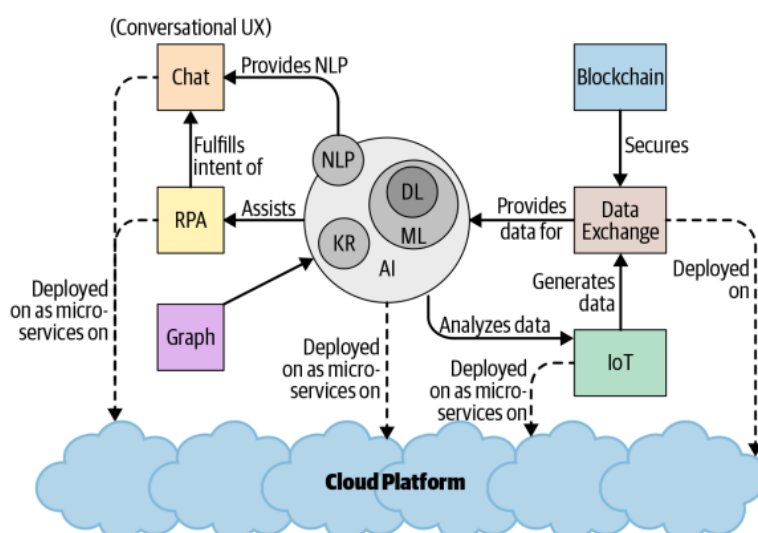
Table 3: Software solutions across the patient engagement ecosystem¹⁵

Emerging technologies and their use-cases in digital health

For many years, technology and medicine have gone hand in hand. Pharmaceutical and medical innovations have saved millions of lives and improved the lives of many more. It's impossible to predict what medical discoveries will be made as time passes and technology improves. The Covid-19 pandemic propelled healthcare into the future in 2020 and 2021, and as a result, several promising medical technologies were put to the test on a large scale. The question in 2022 will be how those technologies can be combined in a post-pandemic society.

We can find new technologies being used to battle illness, generate new vaccines and treatments, and help people live healthier lives anywhere we turn in the healthcare industry. Many software businesses have spent the previous two years focusing on using their skills to solve challenges caused by the global pandemic. At the same time, many healthcare companies that would not be called tech companies in the past have shifted their attention to technology and its potential to revolutionize how their products and services are delivered.

The Pandemic has clearly pushed the healthcare industry's digitization. According to the HIMSS Future of Healthcare Report, during the next five years, 80% of healthcare providers¹⁷ aim to expand their investment in technology and digital solutions. Listed below are emerging technologies that will be leveraged by the digital health industry going forward.



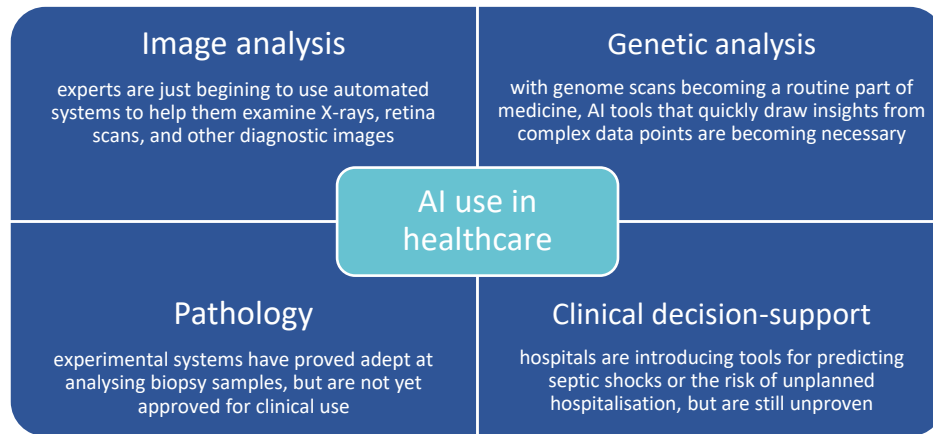
Picture 4: The many collaborative technologies at play within digital health¹⁸

1. Artificial Intelligence (AI) and Robotic Process Automation (RPA)

In 2021, the market for artificial intelligence in healthcare was estimated to be worth US\$10.4 billion. From 2021 to 2030, it is predicted to rise at a 37.1% annual rate¹⁹. The high-level use case for AI in healthcare, as in other industries, is to assist in making sense of the massive amounts of unstructured data accessible for capture and analysis. In healthcare, this can take the shape of medical image data such as X-rays, CT and MRI scans, as well as data on the spread of communicable diseases such as COVID-19, vaccination distribution, genomic data from living cells, and even handwritten doctor's notes.

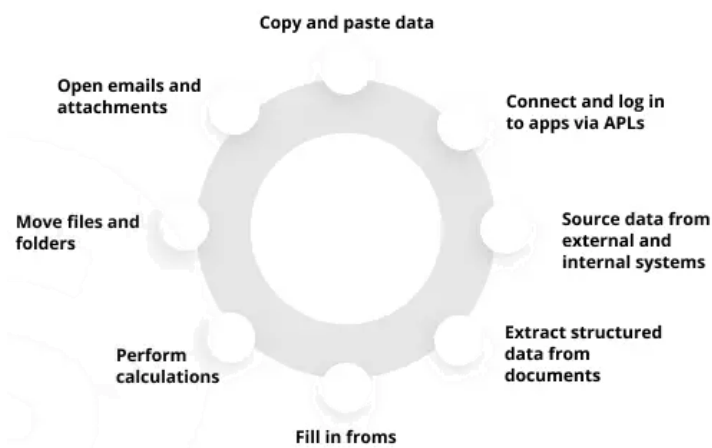
Current AI advancements in the medical area frequently entail the augmentation and upskilling of human professionals. Computer vision - cameras that can recognize what they are seeing and convey the information – is used by surgeons working with AR, as discussed in the preceding section. Another

important application is automating first patient contact and triage to free up clinicians' time for more important tasks. Telehealth companies like Babylon Health employ AI chatbots that are driven by natural language processing to collect information about symptoms and route them to the appropriate healthcare practitioners.



Picture 5: Leading AI uses cases in Health care²⁰

Bots driven by RPA are a huge step forward in the development of healthcare information technology. With the know-how, health providers can enjoy accurate automation, cost reduction, staff optimization, and even make dramatic improvements. On the patient side, AI algorithms can more accurately assess patients' symptoms and direct them to the appropriate clinician than traditional search engines. In essence, RPA's technological breakthrough has brought robots to the healthcare field that mimic human behavior. They have a wide range of capabilities, including screenwriting detection, data input, and pre-defined action execution. RPA is now widely used in healthcare for data administration, appointment scheduling, claims management, optimal care delivery, and hospital management.



Picture 6: Typical tasks that can be automated using RPAs²¹

2. Remote Patient Monitoring (RPM) and Remote Healthcare

Physicians can now monitor a patient without having to be physically there, thanks to RPM. RPM has various advantages, including improved patient outcomes, faster reaction times, and long-term cost savings. In fact, RPM and telehealth go hand in hand in minimizing the need for patient travel and lowering everyone's risk. Various forms of RPM were permitted for reimbursement as a result of legislative changes to Medicare in response to the COVID-19 outbreak, effectively enhancing the popularity of this new therapy. Approximately 23.4 million patients²² used some type of remote patient monitoring in 2020. Blood pressure, weight, heart rate, and blood sugar were the most prevalent types of monitoring, all of which could be done without having to visit an office or a lab. This practice has become so common that an 88% of healthcare professionals²³ surveyed by Spyglass Consulting Group said they had invested in or were considering adding RPM to their practice.



Picture 7: Pictorial representation of RPM²⁴

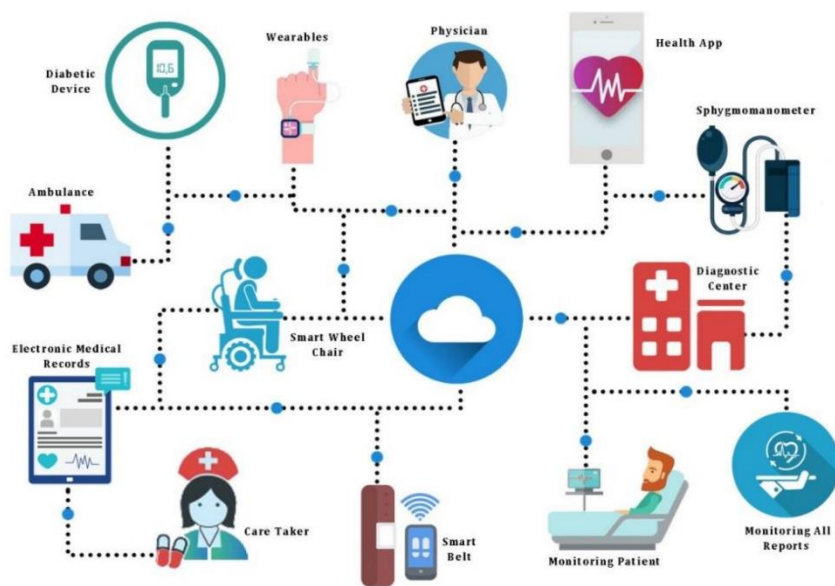
3. Cloud Migration, Interoperability and Connectivity

Cloud migration addresses a number of significant service delivery issues, such as record management, remote treatment, and reaching low-income patients. Providers all around the world are adopting the cloud to efficiently handle emails and electronic medical records (EMRs) while also providing real-time data to healthcare professionals. Moving traditional call center operations to the cloud from on-premises technology can improve customer interaction and speed issue resolution. Traditional health care systems frequently impede an organization's capacity to provide efficient and cost-effective care while also retaining patients. By moving operations to the cloud, companies can establish a safe and compliant omnichannel contact center platform with conversational AI and automation, as well as an interconnected ecosystem to provide a better customer experience.

Medical device interoperability and connection are widely acknowledged as critical components in assisting hospitals in achieving improved patient data flow, synchronization, and faster and more accurate identification of high-risk patients, as well as improving overall outcomes. According to Google Cloud's research²⁵, roughly 59% of doctors feel improved interoperability will help them identify high-risk patients more quickly, and 95% agree that improved interoperability will improve patient outcomes. The US Department of Health and Human Services (HHS) has finalized rules that give people more control over how their health information is shared²⁶, resulting in a more consumer-centric approach to healthcare. Patients can now more readily access and share their electronic health records. Interoperability between providers and digital health developers is projected to increase, and the industry is expected to grow significantly in the next years.

4. Internet of Medical Things (IoMT)

Precedence Research estimates that the worldwide internet of medical things (IoMT) market would reach US\$ 172.4 billion by 2030²⁷. Wearables and trackers are becoming increasingly popular in healthcare information technology. Their main value is that they provide doctors with real-time and thorough information about patients' health conditions. The Internet of Things allows for a dramatic shift in patient awareness. People can use trackers to gather real-time data on their daily activities and make modifications along the way. If the device has gamification capabilities, it can even motivate patients to live a healthier lifestyle by rewarding them. As a result, technology has had a huge impact, combining a reasonable requirement for healthy behaviors with pure enjoyment. Doctors, for their part, can receive notifications and participate more actively in their patients' treatment than ever before. Sleep patterns, eating habits, average activity level, and other factors are among the rich data set generated by this innovative technology in healthcare. Healthcare practitioners can use this data to create more realistic coaching programs and assess treatment success more precisely.



Picture 8: Overview of different IoMT sensors²⁸

5. Predictive analytics and big data to Improve Decision-making

According to Frost & Sullivan, the use of predictive analytics in healthcare data analytics might save the business at least US\$ 150 million by 2025²⁹. The ability to analyze and assess patient data in real time and over great distances has made this possible. Given its remarkable cost-effectiveness, this technology trend is set to take off in the next years. The COVID-19 pandemic brought data analytics to the forefront for medical professionals and academics, as well as the enormous task of making real-time decisions in constantly changing situations. Healthcare practitioners can become lost in dozens of spreadsheets and meetings if data is processed manually. That is why, in the digital future, technology capable of processing Big Data instead of humans and giving real-time analytics for decision-makers will eventually be included.

Another advantage of analytics is the ability to make predictions. In this scenario, advances in predictive analytics and business intelligence make it possible to use data-driven insights from previous patient contacts with healthcare companies to make necessary modifications. It is beneficial to both parties. Patients receive precise treatment regimens and prompt assistance. As a result, healthcare providers benefit from increased personnel efficiency and supply chain control. Moreover, preventative medicine seeks to forecast where and when sickness will arise and put remedies in place before it occurs, rather than reacting to illness by offering treatments after the fact. Predicting outbreaks of communicable diseases, hospital readmission rates, and where lifestyle factors like nutrition, exercise, and environment are likely to lead to health difficulties in particular demographics or geographical locations are all examples of this. Predictive analytics enables the creation of systems that can discover trends across large datasets far more effectively than traditional analytics procedures, resulting in more accurate predictions and, in turn, better patient outcomes.

Notable investments, acquisitions and home-grown products	R&D layer	Intelligence layer	Infrastructure layer	Engagement layer
Google	verily Life sciences	Project Baseline Data clinical research	DeepMind Neural research	efficient Insurance
amazon			Google Cloud Google Cloud for healthcare and life sciences	amwell Digital care
Apple			aws AWS, Amazon Comprehend Medical, Amazon HealthLake	halo Digital care
facebook			Open source software	amazon alexa Digital care
Microsoft				beddit Sleep sensors
Tencent 腾讯	Microsoft Research Microsoft Immunomics, Project InnerEye, Project Talia	voiceitt Speech recognition	Azure Azure for the healthcare industry	Devoted Digital care
Roche	XtalPI AI-based drug discovery	innovaccr Health data	Tencent Cloud Covid-19 Cloud Resources Support Program	Preventive Health Digital care
Bristol Myers Squibb	flatiron Cancer research data platform	viewics Decision-making		ANDOR Telehealth
	Exscientia AI-based drug discovery	Sensyne Health Real-world evidence		RapidSOS Emergency response
	MYOKARDIA Cardiovascular diseases			Digital health Digital Therapeutics

Table 4: Acquisitions by tech giants to build out their emerging tech stack and product portfolio¹⁵

Digital Health trends that will shape the future of healthcare

In a post-pandemic future, patients will continue to obtain care from multiple places, urging healthcare practitioners to meet them there with individualized services. Patients and customers who became acclimated to virtual health services during the pandemic will expect more variety and convenience. Banking, retail, and other businesses already offer 24/7 digital access. Healthcare must adapt to match today's customer expectations.

COVID-19's imprint is still felt around the world, even though the year 2021 has passed. Healthcare is perhaps the industry that has been irrevocably affected by the global pandemic's effects. The healthcare business has changed in unique ways to continue to give the same great level of service, thanks to substantial developments in technology and processes required to meet the increased demand for healthcare access and expanding digitalization of protected health information. As we move forward, it's vital to keep an eye on the trends that will shape healthcare technology in 2022 and beyond. While legacy software and infrastructure are vital to the operation of modern hospitals and care centers, it's also critical to evaluate how old systems can merge with newer technology or be replaced with more reliable systems in the future. Performance, productivity, efficiency, and security should all be prioritized without losing reliability or accessibility.

1. Telehealth and the evolution of remote care

Since the pandemic began in 2020, telehealth has come a long way. During the pandemic's early months, remote healthcare consultations rose from 0.1% to 43.5%³⁰, and is expected to remain at such levels. By 2022, health care experts will be holding frequent video conference discussions with patients over the Internet to discuss concerns and offer suggestions. The necessary infrastructure has substantially improved. By 2026, the telehealth market is estimated to reach US\$ 310 billion⁶³. We are witnessing highly creative and globally relevant medical robotics technologies that will allow doctors to treat patients and even execute high-precision surgery without needing to be there. Technically, patients can now receive high-precision surgery with surgeons situated in distant cities, countries, and even continents. Even though this technology raises many legal problems and challenges, it will become widespread because it allows treatment nearly anytime and anyplace, even in urgent instances or remote regions without a specialist. The medical robotics market is expected to cross US\$ 16 billion by 2025, with surgical and rehabilitation robotics seeing the biggest growth³¹.

- **Consumerization of healthcare:** The retail model of digital patient care will be the future. Companies such as Amazon could change health care access, delivery, and reimbursement. Some patients may prefer a digital app-based diagnosis or prescription, but preferences may vary depending on socioeconomic level, age, and other factors. Middle-class Millennials in urban areas have different care delivery and insurance coverage needs than low-income single parents. Companies are adapting to this new dynamism and will continue doing so.
- **Delivering to an underserved population:** Many individuals struggle to access health care. Digital health solutions offer many benefits, but new apps or telehealth advances won't solve all access issues. Patients have different histories and demographics, live in rural and urban areas, and have different family and work relationships. Technology can sometimes bridge care gaps, but it's not a one-size-fits-all answer. Telehealth can benefit some patients. For example, a low-income patient may postpone seeing a doctor because they can't afford to miss work, but telehealth could allow them to see a doctor during their lunch break. There is an app³² that helps rural women obtain birth control tablets. This software makes birth control

more accessible to women who otherwise would have to drive hours to see a doctor and get a prescription. However, it may disadvantage women by replacing a personal physician visit with an app that cannot connect seemingly unrelated symptoms that may suggest a health risk. Doctors should give individualized, flexible solutions that don't compromise patient care and digital techniques can fulfill these changing needs

- **Regulations:** One of the most essential difficulties with telehealth is HIPAA / GDPR compliance. Although certain limits were eased during the pandemic's peak in 2020, it's critical for healthcare providers to think about the apps they're utilizing to interact with their patients. Certification of secure access will soon become mandatory for future consultations.
- **Video Conferencing standards:** In many cases, a more dedicated solution is necessary that can conform to legal privacy standards. WebRTC, an open-source API-based system that connects web browsers and mobile applications and enables for the transmission of audio, video, and data, is one of the most significant technologies that meets this requirement, and many providers and apps will implement it going forward.
- **Cloud hosting and storage:** While most cloud storage systems are relatively safe, they are not always consistent with federal rules regarding protected health information. HIPAA-compliant cloud hosting solutions are essential for any healthcare organization that uses electronic health records to preserve performance and efficiency (EVR), and going forward, certified storage records would become a necessity, based on the jurisdiction one is in.

During the pandemic, people learnt to work and play remotely, proving that this distant, distributed paradigm may work well for non-in-person gatherings. In 2021, virtual care adoption was 38 times higher³³ than pre-COVID-19. Over the following years, telehealth apps and a health data infrastructure will gain popularity.

2. Adapting AI to more aspects of digital health

The market for AI is expected expand tenfold in the next five to eight years³⁴. Undeniably, digitization will outpace regulation, even if numerous legislators have already acknowledged the necessity to regulate AI separately (for example, the EU proposal for harmonized rules for AI³⁵). As a result, we will likely see many new and extremely inventive AI and machine learning solutions in healthcare, for which there may not be enough and thorough regulation. Increasing financial pressure on healthcare systems internationally, demographic changes in many nations, healthcare staffing shortages, and COVID-19 related disruptive tendencies will promote AI and Machine Learning (ML) in healthcare

- **Ongoing role in COVID-19 and beyond:** Society has been profoundly affected by the global pandemic, yet cutting-edge technology has allowed us to keep ahead of the curve. For example, a Toronto, Canada-based firm using AI and Machine Learning (ML) predicted that COVID-19 will spread globally. The BlueDot tool may detect harmful breakouts in near real time by examining 100,000 media sources in over 65 languages on a daily basis³⁶. Machine learning advancements in vaccine development have also made significant progress. COVID-19 vaccines have been generated in significantly less time³⁷ than ever before thanks to the use of machine learning to aid in the identification of protein fragments. AI has also aided in the analysis of crowd temperature data. As a result, thermal screening becomes a far more viable tool for detecting individuals who may be symptomatic. Advances in AI-powered facial recognition have made it possible to recognize people even while they are wearing a mask³⁸. It can also tell if the user is wearing a mask in areas where they are required to. These trends will continue to be levered, as more systems make use of AI in battling future outbreaks of COVID-19 and any other types of pandemics.

- **Use in drug development:** Outside of treating and responding to the pandemic, artificial intelligence offers a wide range of uses. AI is extremely useful for increasing information processing and decision-making efficiency. Machine learning is particularly useful in the healthcare business for the development of novel drugs and the efficiency of diagnosis processes. AI is assisting in the analysis of CT scans³⁹ to detect pneumonia in those being treated for the effects of COVID-19. Project InnerEye⁴⁰ is a radiotherapy AI tool created by Microsoft. This drastically reduces the time it takes to complete the 3D contouring of the patient, reducing it to minutes rather than hours. Another Microsoft AI system, Project Hanover⁴¹, is designed to catalog biomedical research papers from PubMed. This shortens the time it takes to diagnose cancer and makes picking which medications to employ for each patient easier.
- **Applications to mental health:** AI advancements aren't limited to physical health. Researchers from MIT and Harvard University used machine learning⁴² to track patterns and mental health in the COVID-19 pandemic. They were able to evaluate hundreds of online Reddit messages using an AI model and discovered that issues of suicidality and loneliness had virtually increased over time. This has the potential to revolutionize our understanding of population mental health.
- **More use of Natural Language Processing (NLP):** Chatbots have the potential to increase telehealth efficiency. UCLA researchers⁴³ created a Virtual Interventional Radiologist (VIR) using chatbot technology and AI algorithms. This was created to assist patients in self-diagnosing as well as clinicians in diagnosing those patients. Natural language processing-powered chatbots aren't yet ready to provide primary diagnosis, but they can help with the process. They're also well-equipped to assist patients in gathering information before effective treatment can begin.

A trend that has already kicked off is the adoption of robotic systems, aimed at reducing the cost of recruiting medical staff, supporting medical facilities that are already suffering from a nurse and clinician shortage owing to the COVID-19 pandemic, and optimizing workflows for hospitals, doctors and patients alike. These AI-driven and robotic technologies are supplementing conventional processes rather than replacing them, and hence merging the past and future.

3. Adoption of IoT (IoMT) and Wearables becoming the norm for health and wellness

Wearable biosensors can communicate a patient's vital signs and psychological indicators, allowing care providers to monitor their health at home. After getting discharged from the hospital, patients are usually cut off from healthcare management, contributing to needless readmissions that cause patient pain and cost the US over US\$ 17 billion⁴⁴. Wearable biosensors can assist doctors monitor patients' health during the hospital-to-home transition. Online questionnaires and chat bots allow users to provide regular input on their health and quality of life without leaving home. This method has already proven beneficial in monitoring COVID-19 patients after hospital discharge.

As wearables and IoT technologies gain popularity, their potential in healthcare has increased. In 2021, there were 11.3 billion IoT devices. The global medical devices IoT market is expected to grow from US\$ 26.5 billion in 2021 to US\$ 94.2 billion in 2026⁴⁵. IoMT (IoT devices used with healthcare applications) devices have been proven useful in providing high-quality care in rural places without full-time hospitals or from home, which is crucial for people with limited mobility or in isolated communities. Portable devices can do routine tests and provide results to doctors remotely, all from the patient's home. IoT healthcare might save the American healthcare system US\$ 300 billion⁴⁶ by

boosting access to diagnostic, therapeutic, and preventative care, according to a Goldman Sachs analysis.

- **Wearables:** Wearable technology is a major healthcare innovation and the capacity to remotely check a patient's status or one's own is invaluable. According to a Deloitte survey, 39% of consumers globally own a smartwatch⁴⁷, reaching 320 million consumer health and wellness devices by 2024.

Country	Q3 2019	Q3 2020	Q3 2021
US	10.3%	11.6%	15.0%
France	5.6%	7.6%	10.2%
Germany	8.4%	8.7%	11.3%
Great Britain	9.0%	11.3%	14.1%
Italy	9.0%	10.8%	14.3%
Australia	11.1%	13.7%	16.9%
Japan	3.0%	3.3%	4.2%

Table 5: Trend in smart watch consumers (% of population) across geographies⁴⁸

As consumer smartwatches become increasingly common, their potential for usage in healthcare should be acknowledged. Heart rate is one of the most fundamental health-monitoring features a smartwatch can offer. But a smartwatch can measure more than just that. Pedometers and blood oxygen monitors are included. Without specialized sensors, low oxygen saturation is hard to detect. Having this sensor on a smartwatch can save lives. Smartwatches may now measure users' blood pressure. Photoplethysmography (PPG) uses light to assess changes in blood volume and composition. This data can help doctors diagnose and counsel patients. Not all wearables have potential in the healthcare industry. Smart hearing aids and bio patches have similar effects. Bio patches can measure vitals without a smartwatch. AI improves hearing aid noise isolation.

- **Smart Pills:** Smart pill are physical pills that transform electronic devices from “the internet of things” into “the internet of bodies”. Smart pills are edible electronics that can give healthcare providers with crucial patient data. 2017 saw the first FDA-approved smart drug⁴⁹.
- **Smart Implants:** Smart implants are diagnostic and therapeutic bio-implants. Advanced implant technologies are likely to impact the healthcare market in the future, promising more efficiency in regenerative medicine and better patient outcomes. Some gadgets may even be able to treat previously incurable disabilities.

With an IoMT ecosystem, traditional structures will crumble, and new innovative consumer health applications will emerge — not only for those who already have an illness, but also for those who want to avoid getting one. This tendency may indirectly help healthcare systems move from a disease-based to a prevention-based approach, resulting in significant treatment cost savings.

4. The importance of health data towards transparency and an increase in data incidents

Health data is important for the pharmaceutical, medical device, and life sciences businesses, as well as AI developers and health insurers. Health data are required for both patient therapy and the development and approval of new healthcare items. Recently, the US Department of Health and Human Services adopted two landmark guidelines that gave people secure, expanded access to their healthcare data⁵⁰, allowing them to make better decisions. As the collection and processing of health data (a sensitive category of data) involves significant risks, challenges, and costs (for example, in clinical trial settings), new industries have developed to collect and market health data (such as, for

example, medical data traders, or companies specializing in research on synthetic health data). Synthetic health data (representative data artificially scaled on the basis of existing data sets) will become more important – not only for privacy reasons, but also in areas where collecting health data is technically or ethically challenging, such as with rare diseases, high-risk products, or vulnerable patient groups such as pregnant women or children. Blockchain has the potential to give patients greater control of their data, and healthcare organizations and digital health companies are ramping up research in developing ways to harness the power of blockchain in healthcare.

Despite the rapid global digitization of healthcare and the importance of health data for healthcare development, many healthcare providers are still unprepared in terms of data and cybersecurity. It's feared that data and cybersecurity in healthcare won't evolve as quickly as digitalization, which brings cyberattack and data incident concerns. Accellion's FTA secure file-transfer service leaked Kroger pharmaceutical data in 2021⁵¹. They are not the only ones. According to HealthITSecurity.com, last year's data breaches harmed approximately 40 million people⁵². In the near future, healthcare data mishaps and cyberattacks will likely rise. External hackers allegedly acquired data about BioNTech's COVID-19 vaccine, which was in the approval phase at the time⁵³. Making sure medical data is HIPAA compliant is the first step to avoiding costly data breaches. As companies serve patients globally, many of them will consider the EU's General Data Protection Regulation (GDPR), since it is considered to adhere to the highest standards of privacy.

Some healthcare providers can utilize Facetime and Skype to connect with patients, despite government limitations. Although the Office for Civil Rights (OCR) of the U.S. Department of Health and Human Services (HHS) has announced looser enforcement standards during the ongoing public health emergency, it's vital not to rely on this discretion. As the outbreak subsides, enforcement will return to normal. Getting ahead of the curve will help prevent future fines. Compliant video conferencing software available, however a bespoke solution is occasionally needed. Notably, existing data infrastructure may not be adequately integrated with alternative solutions. To use an existing system to exchange ePHI with patients via third-party software, a healthcare practitioner must first secure a business partner exception from the vendor, which can be laborious and difficult. The third-party program may not adequately protect patient data. Remote medical calls can pose a security risk, and a focus on their security will be emphasized going forward. Data and cybersecurity awareness and protection will thus become increasingly critical in the healthcare sector. Cloud solutions may not be the ideal method for transporting and storing sensitive healthcare data in the future.

5. Extended reality in healthcare

Extended reality, which includes augmented, virtual, and mixed reality, has a lot of potential in healthcare. AR and VR can help in many ways in the healthcare profession, from surgery to telehealth. Analogue healthcare procedures are increasingly being replaced by virtual platform solutions, which are today being seen in jurisdictions with less stringent regulations but are slowly expected to be adopted in the US and Europe. These include fully integrated platform solutions that bring together all market participants in a virtual environment and allow patients to have a consolidated customer journey through all treatment levels and key contacts, from physicians, hospitals, or other therapists to pharmacies and health insurers.

- **Augmented Reality (AR) and Mixed Reality (MR):** AR and MR are useful in healthcare, and as seen over the years, surgeons often employ mixed reality headsets like Microsoft HoloLens 2⁵⁴. The headgear can offer surgeons with real-time information while allowing them to utilize both hands. This information can be used to enhance procedures, collaborate remotely, and help train surgeons. The headset's head-mounted camera allows other doctors to observe and

advise. The device's 'holographic' nature helps enhance training. Similar uses are possible with emerging AR headsets. Future expansion will require more specialized software solutions. AR isn't just for headsets and operations. The technology can also help nurses find the correct vein and draw blood⁵⁵ and perform other assistive tasks - AED4EU⁵⁶ gives real-time directions to the nearest publicly accessible automatic defibrillator unit.

- **Digital Twin simulation and Metaverse:** Training is one of the most useful VR uses in healthcare right now. To strengthen doctors' expertise and prepare for procedures, create virtual training scenarios. In some cases, VR can be utilized to treat. The Virtual Reality Medical Center uses VR therapy to treat PTSD and acrophobia. Maplewood Senior Living in Connecticut features a VR treatment program for seniors to release memories and promote emotional health⁵⁷. Meta's cartoon-style sessions may be useful for VR therapy, but its effectiveness in substitute of standard teleconferencing is unknown. Spatial audio could improve telehealth systems by giving a more immersive digital experience.
- **Live virtual collaboration:** Live video-based collaboration between healthcare providers can prolong care. Even in industrialized countries, urban and rural healthcare resources are often unequal. In maternal care, the deficit of obstetricians, gynecologists, and maternal-fetal medicine specialists is expected to triple between 2020 and 2050, with rural shortages growing more severe⁵⁸. More than one in ten rural women in the US must drive 100 miles or more to get obstetric treatment⁵⁹. Tele-ultrasound can expand a health network's specialist expertise. While ultrasound technology is becoming more user-friendly, it still requires manual abilities, especially in more complex clinical scenarios. An experienced sonographer in an urban hospital can assist a colleague in a rural location using a live collaboration platform built into an ultrasound machine. A specialist can use tele-ultrasound to reassure a patient and explain exam findings.

The benefits of using extended reality in a more connected world will see widespread adoption as more parts of the healthcare ecosystem shift online.

6. Digital, data driven healthcare enterprise and patient engagement

Healthcare administrators must guarantee that every patient receives the right care in the right setting at the right time as healthcare becomes more spread. This is where centralized, data-driven care coordination comes in. During the COVID-19 pandemic, centralized care coordination models gained traction as a way to communicate real-time data, show underutilized capacity, and enable patient transfers. These methods of operation will now be incorporated into the daily management of patient flow. This will allow healthcare executives to increase throughput and production while decreasing waste and avoiding delays that upset both patients and employees.

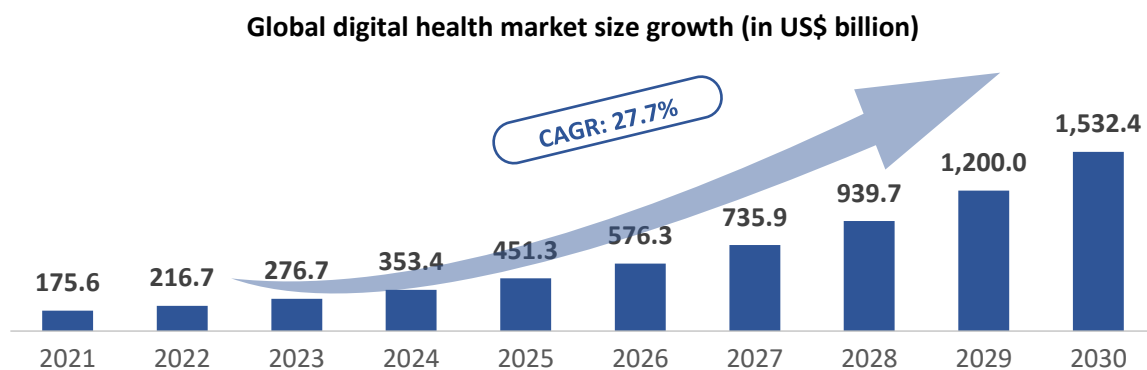
- **Digital patient management:** Digital patient engagement can help individuals become more involved in their own care and more likely to attend hospital consultations. Some radiological modalities have a 7% no-show rates. No-shows impede workflow, underutilize people and equipment, and can cost an imaging center US\$ 1 million.⁶⁰ Delays in diagnosis and treatment can hurt patients irreversibly. Hospitals are also seeking for ways to relieve patients' worry and safely bring them back after COVID-19. Radiology centers, with many others to soon follow, have virtualized check-in, allowing patients to check in by text messaging. Staff are notified via text message when a patient is ready to be seen. This type of 'virtual waiting room' could become the new norm, allowing patients to take a leisurely stroll or wait in their car until their appointment begins.

- **Forecasting and managing patient flow:** Data-driven, centralized communication helps healthcare leaders estimate patient demand, make better transition decisions, and discover bottlenecks. Hospital directors who must manage unanticipated patient demand must be able to foresee and respond to changing situations. Managing patient flow demands a hospital-wide or network-wide view. But that's often lacking nowadays. Dispersed clinical and operational data means care teams lack situational knowledge outside their unit or department. By combining clinical and operational knowledge in a command center or central hub, doctors may oversee the whole patient journey. Predictive analytics can turn data into actionable intelligence. With such knowledge, patients can be moved more efficiently from one care environment to another. By accelerating patient transfers, healthcare professionals can reduce congestion and overuse of resources. This implies people can avoid unnecessary hospital stays. This improves access to critical care for other patients.
- **Extending critical care across locations:** Tele-ICUs bring critical care resources to the bedside regardless of a hospital's location. Tele-ICUs provided critical care help during the pandemic as ICUs were swamped. Tele-ICUs allow patients to be observed remotely and moved to the most appropriate care setting. High-definition cameras, telemetry, and enhanced data visualization let intensivists and nurses in the central hub aid bedside colleagues. Predictive analytics informs care professionals to early patient deterioration so they can intervene immediately. A centralized remote patient monitoring center can standardize care, reduce transfers, and increase bed usage. Tele-ICU programs have been demonstrated to cut ICU mortality by 20%, save about US\$ 1,500 per patient over a 60-day post-ICU event, and reduce ICU duration of stay by 30%⁶¹.
- **Virtual imaging in the cloud:** Specialized technologists at central command centers can assist standardize radiological procedures across sites. Large imaging practices with several scanning locations often lack highly skilled technologists familiar with modern modalities like MR and CT. Expert users had to travel to faraway areas to help less experienced colleagues until recently. Secure virtual scanner access allows experts to help or train colleagues across locations, driving image quality and standardization. This avoids unwanted recalls and duplicates, which stress patients and staff. This cloud-based hub-and-spoke approach can scale to hundreds of sites. It reduces the risk of local worker turnover and disruptions. Having a central command center also allows imaging providers to deliver more complex procedures closer to patients' homes and at more convenient times. With a super-expert watching over the technologist's shoulder from hundreds or thousands of miles away, patients have less difficulty and more convenience.

Digital health market expected reach US\$ 1.5 trillion by 2030

A report by Grand View Research expects the global digital health market to reach US\$ 1.5 trillion by 2030, growing at a 27.7% CAGR from US\$ 216.7 billion in 2022⁶², during the forecast period. Rising smartphone penetration, improved internet connectivity, advanced healthcare IT infrastructure, rising healthcare expenditure, rising prevalence of chronic diseases, rising demand for remote patient monitoring services, and rising accessibility of virtual care are driving market expansion.

The global digital health market stood at US\$ 175.6 billion in 2021 and driven by COVID-19 pandemic, is expected to grow to US\$ 216.7 billion in 2022. The market is projected to grow from US\$ 216.7 billion in 2022 to US\$ 1.5 trillion in 2030 at a CAGR of 27.7% during the forecast period. This market was already witnessing growth prior to the onset of COVID-19, and it witnessed a growth rate of 19.1% from 2019 to 2020.



Graph 4: The global digital health market is expected to grow at a CAGR of 27.7% till 2030⁶²**Error!**
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The ongoing COVID-19 pandemic exposed the shortcomings of existing overcrowded healthcare systems and highlighted the promise of digital health solutions, resulting in a rapid increase in use of these technologies. mHealth, telehealth, patient management, enhanced diagnostics, digital integration of health systems, and evolving cybersecurity procedures all contributed to the market's rapid expansion. To extend their company footprint and product portfolios, market participants devised novel product development strategies and focused on their collaboration and partnership strategies in response to the growing trend of digitization of healthcare systems.

Clinical decision support, telehealth, mHealth, fitness applications & platforms, healthcare IT systems, and wearables & activity trackers are among the applications where digital health solutions are seeing a rapid increase in acceptance, which is driving market growth. Furthermore, the current COVID-19 epidemic has benefited the business by highlighting numerous potentials. For example, to avoid in-person consultations, healthcare professionals and patients quickly adopted telehealth technologies. mHealth, telecare, patient management, enhanced diagnostics, digital integration of health systems, and evolving cybersecurity procedures all contributed to the market's rapid expansion. To extend their company footprint and product portfolios, market participants devised novel product development strategies and focused on their collaboration and partnership strategies in response to the growing trend of digitization of healthcare systems.

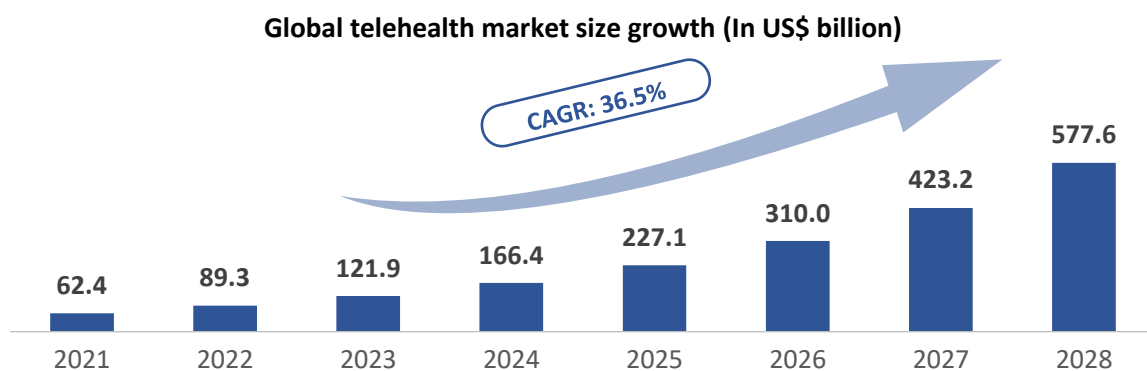
The market's rapid growth prompted firms to rethink their product innovation plans, investment strategies, mergers and acquisitions, and collaborations in order to meet rising demand and increase

their geographic reach. The market is rising because to the growing trend of individualized medication and value-based treatment. Furthermore, the rise of specialist digital health solutions businesses and ventures is driving growth and earning attention from government authorities and private investors.

Telehealth holds a commanding share within digital health and will keep the lead

The telehealth category dominated the market in 2021, accounting for 35.5% of total revenue. The global telehealth market was worth US\$ 62.4 billion in 2021, and it is expected to increase at a 36.5% CAGR from 2022 to 2028⁶³. Over the next few years, the market is likely to flourish due to improving internet connectivity, rising smartphone penetration, advanced technology readiness, a growing shortage of healthcare providers, rising medical costs, widespread availability of telehealth applications, and increasing patient and physician adoption of these technologies.

Telehealth applications are constantly evolving, and technology advancements are accelerating the segment's growth. Furthermore, the increased need for virtual healthcare consultations as a result of the COVID-19 pandemic, as well as the integration of modern IoT technologies and developing connectivity, are all contributing to the segment's strong growth rate. According to the Centers for Disease Control and Prevention (CDC), telehealth visits in the United States increased by 154 percent in March 2020 compared to March 2019⁶⁴.



Graph 5: The global telehealth market is expected to grow at a CAGR of 36.5% till 2028⁶³

Telehealth was widely employed during the COVID-19 pandemic because it helps to reduce contact with healthcare facilities, personnel, and patients, lowering COVID-19 risk. During the epidemic in China, online mental health surveys and communication systems like Weibo, TikTok, and WeChat, among others, aided health authorities and mental health experts in providing mental health treatments safely and online. SOC Telemed, a telehealth technology and services firm based in the United States, reported an increase in demand for on-demand acute care via telehealth in March 2020.

In comparison to the previous year, companies in the market have experienced exponential development during the COVID-19 epidemic. Teladoc Health, Inc., for example, grew 109 percent year over year from Quarter 3 of 2019 to Quarter 3 of 2020. Another major competitor in the sector, American Well Corp., claimed that in 2020, its clients, who include health systems and health plan providers, will deploy tens of thousands of their own care providers onto their platforms. By December 2020, the Amwell Platform was used by almost 68,000 active providers to provide primary care, chronic care management, and specialist visits.

Geographical distribution and growth: North America largest market, Asia fastest growth

Globalization, changing lifestyles, an aging population, rising chronic disease incidence rates, and rising demand for value-based care are all driving market expansion in North America and the rest of the world.



North America led the market in 2021, accounting for 45.9% of total sales. Growing healthcare IT spending to improve infrastructure, technological literacy, readiness to adopt advanced technological solutions, favorable government initiatives, the emergence of startups, lucrative funding options, growing smartphone penetration, and advancements in internet connectivity are all factors contributing to the growth.



The European digital health market was the second largest globally, driven by the UK digital health market thanks to early adoption and innovation within artificial medical intelligence. Germany is the second largest digital healthcare market, followed by France⁶⁵. European nations aim to encourage digital care innovation, particularly telehealth to battle situations such as COVID-19 and overhaul the traditional system of prescription medicines to combat an increasing number of chronic diseases.



On the other hand, Asia Pacific is expected to grow at the quickest rate in the next years as a result of advances in IT infrastructure and the introduction of entrepreneurial initiatives, both of which are contributing considerably to the market's development. The Asia Pacific market is growing due to rising smartphone penetration, increased use of activity trackers and wearables, and increased demand for healthcare analytics.

Changes in data privacy and cyber security protocols are assisting the market's development and expansion. The market is growing due to increased government expenditure and assistance in areas such as remote patient monitoring to ensure inexpensive and accessible healthcare services for people in developing countries.

Appendix

Most active Investors (US / Europe) in digital health

Alternative Care	Provider Operations	Clinical Trial Enablement	Wellness & Education	Healthcare Navigation	Overall
11 TIGERGLOBAL	9 TIGERGLOBAL	5 CASDIN CAPITAL LIFE SCIENCE INVESTMENTS	3 VILLAGE GLOBAL	3 OAK HC/FT	26 TIGERGLOBAL
7 OPTUM	8 GENERAL CATALYST	5 McKesson Ventures	3 BBG	3 andreessen horowitz	17 GENERAL CATALYST
6 LU+	7 UNITYPOINT HEALTH VENTURES	3 OBVIOUS	3 IMP	2 Acrew	15 OPTUM
6 GENERAL CATALYST	7 DEERFIELD	3 andreessen horowitz	2 TEMASEK HOLDINGS	2 GUARDIAN	15 ALUMNI VENTURES GROUP
6 .406 Ventures	6 OPTUM	3 SoftBank	2 10X CAPITAL	2 catalyst ventures	12 G/
6 CITY LIGHT	6 G/	3 T.RowePrice	2 DANONE MANIFESTO VENTURES	2 TIGERGLOBAL	12 DEERFIELD
6 polarispartners	6 INSIGHT PARTNERS	3 Northpond Ventures	2 TARGET GLOBAL	2 GREATPOINT make no little plans	12 DEFINE VENTURES
6 ALUMNI VENTURES GROUP	6 Gaingels	3 FORESITE CAPITAL	2 K50 VENTURES	2 khosla ventures	12 andreessen horowitz
5 MORNINGSIDE	6 DEFINE VENTURES	2 JAZZ	2 MICHIGAN ANGELS	2 B Capital Group	11 LU+

Table 6: Investments made by funds in digital health between 2020-2021⁶⁶

Recent Industry Developments

- Major transactions in 2022 include: Blockchain health firm Avaneer Health closed a \$50 million funding round. The firm launched in June 2021 with significant investments from its founders: Aetna, Anthem, Cleveland Clinic, Health Care Service Corp., IBM, The PNC Financial Services and Norfolk, Va.-based Sentara Healthcare.
- Digital mental health platform Headspace Health acquired artificial intelligence-powered company Sayana. Sayana's app uses an AI assistant to encourage users to track their moods and make connections with what might cause them.
- DexCare, an operating system that manages health system capacity and demand across all lines of care, closed a \$50 million series B funding round. The organizations investing in Renton, Wash.-based DexCare include Oakland, Calif.-based Kaiser Permanente and Boston-based Mass General Brigham.
- Bethesda, Md.-based Aledade acquired Iris Healthcare. Aledade will roll Iris into a new health services unit that aims to help practices lower patient costs and improve health outcomes.
- Transcarent, a digital health platform for self-insured employers founded by former Livongo CEO Glen Tullman, closed a \$200 million series C funding round.
- Medically Home, a "hospital-at-home" company, received \$110 million in a new funding round from investors including Baxter International, Cardinal Health, Global Medical Response, Rochester, Minn.-based Mayo Clinic and Kaiser Permanente.
- Google has acquired Israel-based cybersecurity startup Siemplify, which provides security orchestration, automation and response services, to improve its cloud security.
- Major transactions in 2021 include: Cityblock Health, which provides holistic primary care to lower-income communities, raised \$400 million in its latest funding round this past September 2021 for a \$5.7 billion valuation. The company plans to use the cash to fund growth.
- Hinge Health closed on a \$400 million Series E fundraising round to give the company a \$6.2 billion valuation. Touting itself as the premier digital musculoskeletal clinic, Hinge Health partners with providers and plans to treat musculoskeletal conditions such as back pain.
- XtalPi raised \$400 million in a series D Round, receiving a valuation of \$2 billion. The company uses AI models that employ machine learning, deep learning, and natural language processing to discover molecular compounds that can address a specific aspect of a targeted condition or disease. The company then combines the most promising of these into potential drug compounds for its pharmaceutical partners to develop.
- InBrace raised \$102 million in a Series D round for an undisclosed valuation. Using AI, the company personalizes teeth straightening with its Smartwire technology. Smartwire's main selling point is fast, healthy tooth movement while being completely hidden behind the teeth. The funding is earmarked for 'expanding its sales force, launching new marketing initiatives, and driving further support and integration with new and existing orthodontic providers across the country.'
- Maven brought in \$110 million in a Series D round, valuing the company at over \$1 billion. The virtual care offering focuses upon offering women and families critical support across fertility, pregnancy, adoption, parenting, and pediatrics. The company plans to use the capital to expand into new demographics and further product development.
- Symplr, a digital healthcare operations platform and provider, acquired HealthcareSource, SpinFusion, and Halo Health all in Q3 2021.

- Health software company Commure completed three acquisitions in 2021, including Patient Keeper, Merlin, and Karuna.
- Invitae, a public genetic testing company, is perhaps the most prolific example of an active acquirer in the digital health space, with a total of 14 acquisitions since 2016. Of those 14 acquisitions, three were completed in 2021, and all expand Invitae's digital health footprint. Invitae acquired One Codex in February 2021 for an undisclosed amount, to bring a new user interface and analytical features to Invitae's platform. In April 2021, Invitae acquired Genosity for \$200 million to horizontally expand its offering into oncology. Finally, it acquired Ciitizen, a patient health portal provider, in September 2021 for \$300 million.
- Unite Us raised a \$150 million Series C round in March 2021 and, less than five months later, acquired both Carrot Health and NowPow.
- Olive raised \$400 million in an unlettered July 2021 series round for a valuation of \$4 billion. Right before the fundraising, Olive acquired Empiric Health to expand into surgical data analytics.
- Genome Medical raised a \$60 million Series C round in August 2021 and then subsequently acquired GeneMatters in the same month to support growth into virtual genetic counseling.
- In January 2021, medical device behemoth Boston Scientific announced the acquisition of Preventice Solutions for \$925 million to gain a larger footprint in the mobile cardiac space. Preventice Solutions provides ambulatory cardiac monitors, cardiac event monitors, and mobile cardiac telemetry.
- In April 2021, Microsoft acquired Nuance Communications for \$19.7 billion in order to 'combine solutions and expertise to deliver new cloud and AI capabilities across healthcare'. Microsoft has been pursuing a strategy to provide more industry-specific cloud offerings, and the boom in healthcare helped to make Nuance Communications an attractive target.
- Healthtech Patient21 bags \$142m from Target Global and emerges from stealth
- Dermatology startup Formel Skin raises €30m in Germany's largest healthtech Series A
- DocPlanner enters Germany by acquiring Jameda
- Ada Health raises \$90m, plans further US expansion
- Fertility-as-a-service startup Béa Fertility raises \$1m
- Sidekick Health raises \$20m to combat deaths by lifestyle diseases
- Death tech startup Exizent raises £3.6m
- Withings raises \$60m for healthcare pivot

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