PHILIPS

Digital transformation: shaping the future of healthcare

Position paper

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Executive summary

The COVID-19 pandemic has radically accelerated the adoption of digital health technology, given further impetus to long-term trends that were already underway. Digital transformation is now top of mind for healthcare leaders as they seek to build resilient and future-proof healthcare systems. Yet challenges remain.

When COVID-19 first swept across the globe, healthcare providers rapidly scaled up their virtual care capabilities. Digital triaging apps helped healthcare providers prioritize care while keeping their staff and patients safe. Telehealth and remote patient monitoring turned from a novelty into a necessity. Faced with an acute scarcity of resources, healthcare leaders also saw an urgent need to improve data sharing and care collaboration. Central hubs or command centers were set up to help steer clinical and operational decision-making in real time.

As we begin to emerge from the pandemic, there is a unique opportunity to embed such digital, data-driven practices into everyday healthcare operations, and to rethink how and where care is delivered. Patients are asking for it. Growing staff shortages demand it. And technology enables it.

At Philips, we envision the future of digital health as a connected and highly accessible network of virtual and in-person care, with real-time and predictive insights supporting care collaboration across the patient journey. In tandem, AI-enabled workflow optimization can help improve operational efficiency so that healthcare professionals get to focus on what they do best: providing patient care. And by enabling people to take better care of their health and well-being, with personalized digital health solutions, we can promote a shift from sick care to true *health* care. Taken together, that's how digital transformation can support better health outcomes, improved patient and staff experience, and lower cost of care.
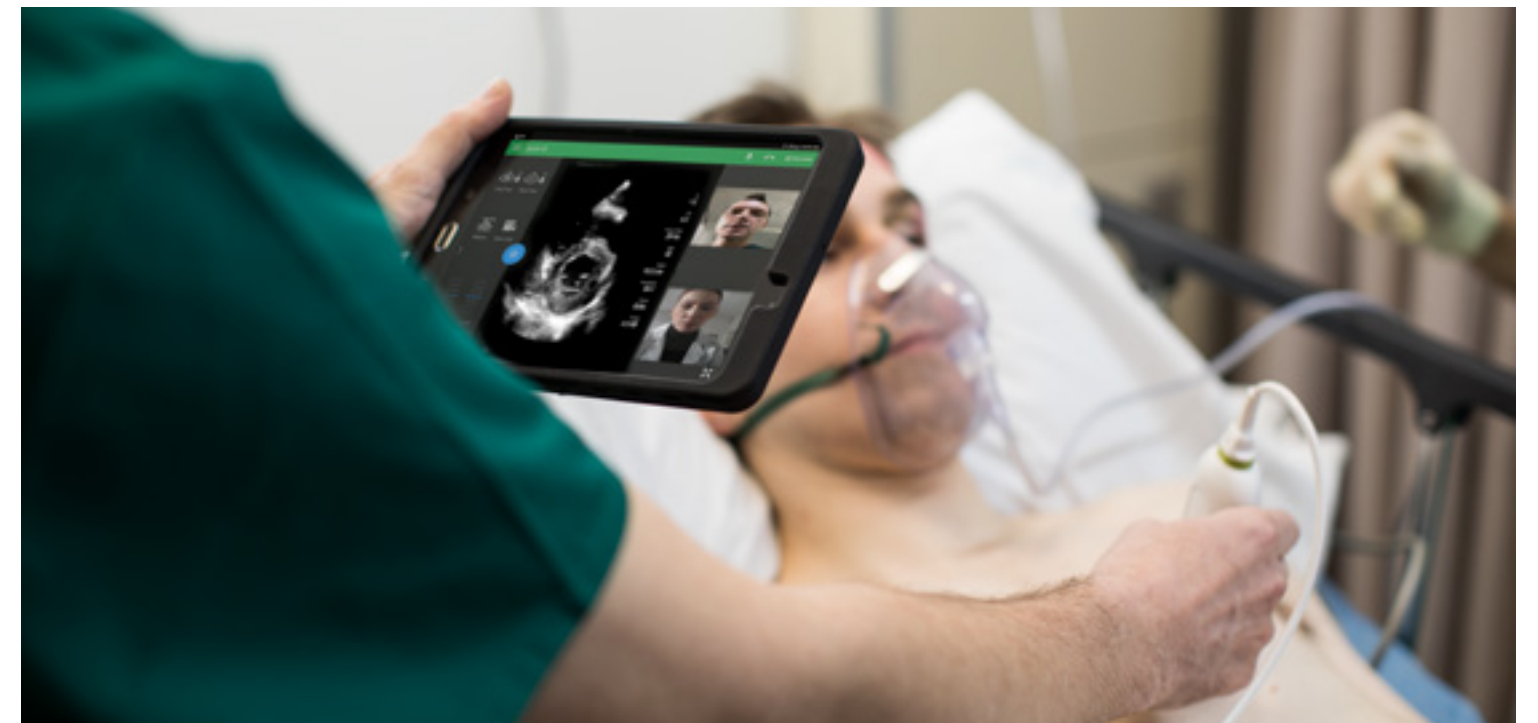
Digital transformation at scale

To turn this vision into a reality, healthcare leaders need to overcome several barriers. In our Philips Future Health Index 2021 report, healthcare leaders cited difficulties with data management (44%) and lack of interoperability and data standards (37%)

as the biggest barriers to adoption of digital health technology in their hospital or healthcare facility, followed by a lack of training on how to fully utilize digital health technology (32%).

Moving from pockets of digital innovation to sustained digital transformation requires a collaborative approach, centered around people and driven by partnerships. Digital solutions need to integrate into the workflows of healthcare professionals and people's daily health routines, to create frictionless care experiences. Virtual education and collaboration can extend the reach of specialist care and help healthcare professionals get the most

out of digital health technology. Open, cloud-based digital platforms will form the backbone for connecting patient data across settings, with open data standards promoting greater interoperability, and with AI helping to turn data into actionable insights at the point of care.

This vision can only be realized based on a robust foundation of trust, calling for responsible use of digital technology that safeguards data privacy and security, while preventing unintended side-effects that can inadvertently increase existing health inequities. To fully deliver on the promise of digital transformation, it should benefit every patient in equal measure.

Digital transformation of healthcare is not just about adopting new digital technology. It's about reimagining healthcare for the digital age – using the power of data, AI, cloud-based platforms, and new business models to improve health outcomes, lower the cost of care, and improve the human care experience for patients and staff alike.

The need for digital transformation

While COVID-19 has served as a catalyst for change, the need for digital transformation has long been recognized by healthcare leaders. Four long-term global trends are fueling this transformation.

1. Chronic diseases are on the rise

Chronic, lifestyle-related diseases are placing an increasing burden on healthcare systems worldwide. Today, more than 400 million people have diabetes[1], 500 million suffer from respiratory diseases[2], and 1.1 billion adults have hypertension[3]. These numbers are projected to soar as populations continue to age. By 2050, the world's population aged 60 years and older is expected to total 2 billion, up from 900 million in 2015[4]. To keep healthcare systems sustainable, there's an urgent need for digital health solutions that can help detect, diagnose, and treat disease earlier and more effectively – or, better yet, prevent people from developing chronic disease in the first place.

2. Patients expect more convenient and personalized care experiences

With the world increasingly at their fingertips, patient expectations of healthcare are also shifting. Patients are taking an increasingly proactive role in their health and well-being, expecting more convenient and personalized care experiences. Prior to the COVID-19 pandemic, 75% of US health consumers said they wish their care experiences were more personalized[5]. The pandemic has further caused patient expectations to shift. For example, around 40% of surveyed consumers stated that they believe they will continue to use telehealth going forward – up from 11% of consumers using telehealth prior to COVID-19[6].

Patients are calling for new ways of care delivery

1 in 3
adults worldwide has multiple chronic conditions

World Health Organization

75%
of health consumers expect more personalized healthcare experiences

Redpoint global survey 2019

40%
of health consumers believe they will continue to use telehealth, up from 11% pre-pandemic

McKinsey virtual health survey 2021

3. Healthcare providers face growing staff shortages

As demand for care continues to increase, healthcare providers are facing increasing staff shortages in many parts of the world. The World Health Organization estimates that by 2035 there will be a global deficit of 12.9 million skilled healthcare professionals[7]. Physicians and staff are already paying a heavy toll. A 2021 Medscape survey revealed that 42% of them report feeling burnout, with the COVID-19 pandemic adding to the strain for many[8]. Protecting the mental and physical well-being of healthcare professionals has become more important than ever, calling for digital solutions can help automate routine tasks and simplify workflows. At the same time, healthcare providers are seeking ways to extend the reach of specialist care to communities where experienced staff is in short supply.

4. Healthcare providers seek efficiencies to reduce waste and costs

Adding to the challenge for healthcare systems is that costs keep rising while reimbursement is under pressure. Between 2020 and 2024, global health spending is expected to rise at a 3.9% annual rate, considerably faster than the 2.8% recorded in 2015-2019[9]. Yet more money spent does not necessarily translate into better outcomes. In the US,

it has been estimated that approximately 25% of total healthcare expenditure is wasted, with administrative complexity being the main source of waste[10]. Improving operational efficiencies and reducing waste is a key priority for healthcare leaders – and they need data-driven insights to figure out where the biggest gains are to be made.

Taken together, these four trends show the urgent need for digital transformation to enable new ways of matching supply and demand. It is no understatement to say that the future of healthcare systems depends on it.

Healthcare capacity is strained and burdened with inefficiency

42%
of physicians report feeling burned out

Medscape survey 2021

25%
of total healthcare expenditure is estimated to be wasted, primarily due to administrative complexity

JAMA 2019

12.1M
the projected global deficit of skilled healthcare professionals by 2035

World Health Organization

The future of digital health

In a post-pandemic future, patients will continue to access care from different settings, encouraging healthcare providers to meet patients where they are – with personalized services that suit their needs and preferences.

There's no going back now. With patients and consumers having grown accustomed to virtual health services during the pandemic, they will continue to demand more choice and convenience in their care experiences. Banking, retail, and other industries already offer 24/7 digital access to their services since many years. Healthcare will have to follow suit to meet the expectations of today's health consumer.

Patients will take an increasingly active part in their own care, by collecting data through wearable technology and sensors, and by sharing that data with care providers. The empowered patient will be at the center of the

care team of the future, participating in shared decision-making alongside care professionals.

Healthcare anytime, anywhere

Telehealth and remote patient monitoring will become a mainstay of healthcare, supplementing in-person care. For patients with chronic conditions, much of the care that currently takes place in hospitals will move into lower-cost settings such as the home. New access points such as retail health clinics will bring care closer to local communities.
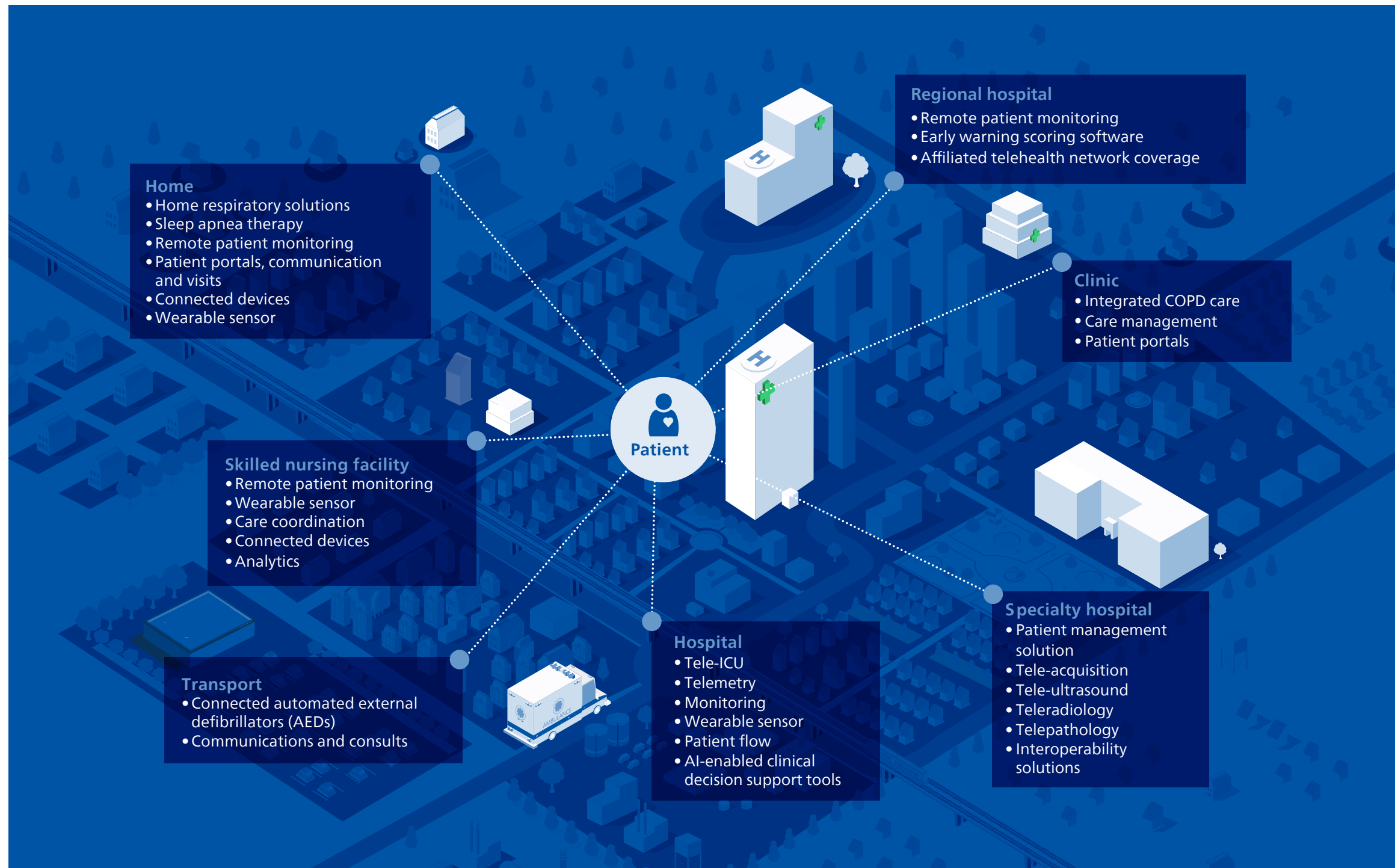
Virtual collaboration between healthcare providers will also help extend the reach of specialist care to remote and rural regions, where specialist staff is in short supply. Through real-time audiovisual streaming, experienced clinicians can look over the shoulder of their less experienced peers to provide remote guidance and support. The power of this approach is that it can make specialized care more accessible and affordable, while improving consistency in the quality of care.

As an additional benefit, digitally enabled remote interactions can reduce travel-related emissions, thereby supporting environmental sustainability as well.

Personalized	Connected	Integrated
• Patient engagement tailored to individual needs and preferences • From general to personalized care pathways • The patient at the center of the care team	• Access to care anytime, anywhere • Remote patient monitoring connects the hospital to the home • Patients can easily manage and share their own health data	• Seamless integration of in-person and virtual care • Integration of patient data for precision care • A holistic view of health and well-being, with increased focus on prevention

An intelligent network of care: connecting care across settings

Home
- Home respiratory solutions
- Sleep apnea therapy
- Remote patient monitoring
- Patient portals, communication and visits
- Connected devices
- Wearable sensor

Regional hospital
- Remote patient monitoring
- Early warning scoring software
- Affiliated telehealth network coverage

Clinic
- Integrated COPD care
- Care management
- Patient portals

Skilled nursing facility
- Remote patient monitoring
- Wearable sensor
- Care coordination
- Connected devices
- Analytics

Patient

Transport
- Connected automated external defibrillators (AEDs)
- Communications and consults

Hospital
- Tele-ICU
- Telemetry
- Monitoring
- Wearable sensor
- Patient flow
- AI-enabled clinical decision support tools

Specialty hospital
- Patient management solution
- Tele-acquisition
- Tele-ultrasound
- Teleradiology
- Telepathology
- Interoperability solutions

"When I think of the future of healthcare, I think of 'your care, your way'. We'll see a proliferation of access points, from texting to video, to retail and ambulatory care centers, in addition to hospital care and post-acute care. Behind each of these access points there are going to be digital technologies that remove friction from care experiences – allowing patients to receive high-quality care anytime, anywhere."

Shez Partovi
Chief Innovation & Strategy Officer
Philips

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Integrated data for precision care

In this distributed network of care, the integration of data across settings – both within and outside the hospital – will become even more important than it is today. By intelligently integrating data from multiple sources, healthcare providers will gain a deeper and more complete understanding of a patient's health and condition(s). This will enable more precise and personalized care, with treatment tailored to the needs and characteristics of the individual patient.

For example, in cardiac care, healthcare providers need to have the right insights available at their fingertips, across the patient journey – all the way from emergency care to diagnosis, treatment, and care in the home. Integration is key here. Smart diagnostic solutions, supported by a secure informatics backbone, can bring together patient data in one comprehensive view, spanning the full patient's history. Similarly, in the treatment of heart patients, bringing together different types of patient data can help interventional cardiologists decide, guide, treat, and confirm successful outcomes.

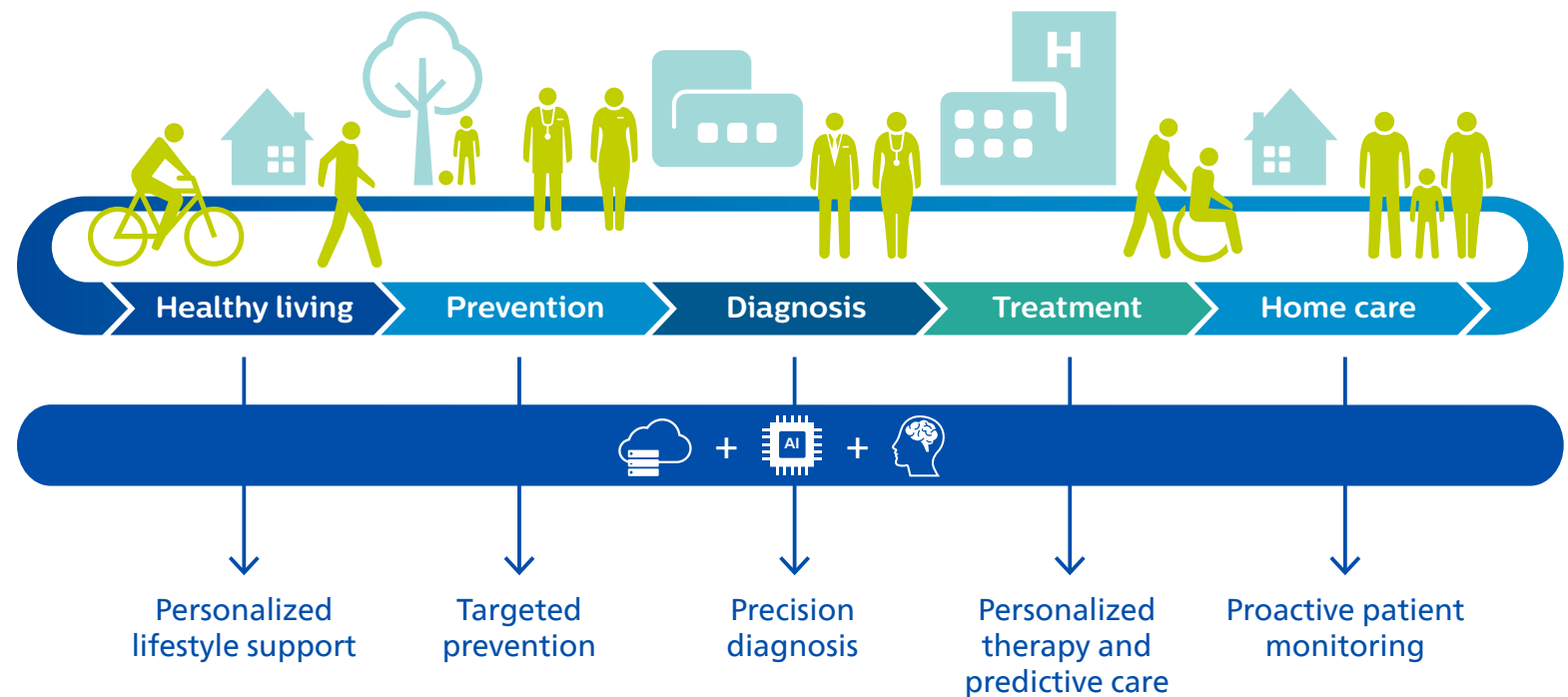Once patients have been discharged from the hospital or an ambulatory facility, clinical care teams can keep a caring eye on patients at home through remote cardiac monitoring solutions and patient-reported outcomes collected via online questionnaires.

As we continue to connect data across devices, departments and episodes of care, the ultimate vision is to have a full digital twin of a patient: a model that integrates all relevant information about the patient, and that is updated over time to offer a 360-degree view of the patient at the point of care. Creating a digital model of a patient's heart has already shown promise in diagnosis and treatment of heart conditions[11].

From sick care to *health* care

As the focus shifts from managing episodes of care to a more holistic and longitudinal approach across the care continuum, prevention will also become a stronger focus for healthcare systems.

Digital health technology can promote more healthy lifestyles, with AI-enabled apps offering tailored recommendations based on a person's behaviors and health goals. Ultimately, digital transformation will enable sick care to evolve into true *health* care, setting it on a more sustainable course for the future.

Healthy living	Prevention	Diagnosis	Treatment	Home care
Personalized lifestyle support	Targeted prevention	Precision diagnosis	Personalized therapy and predictive care	Proactive patient monitoring

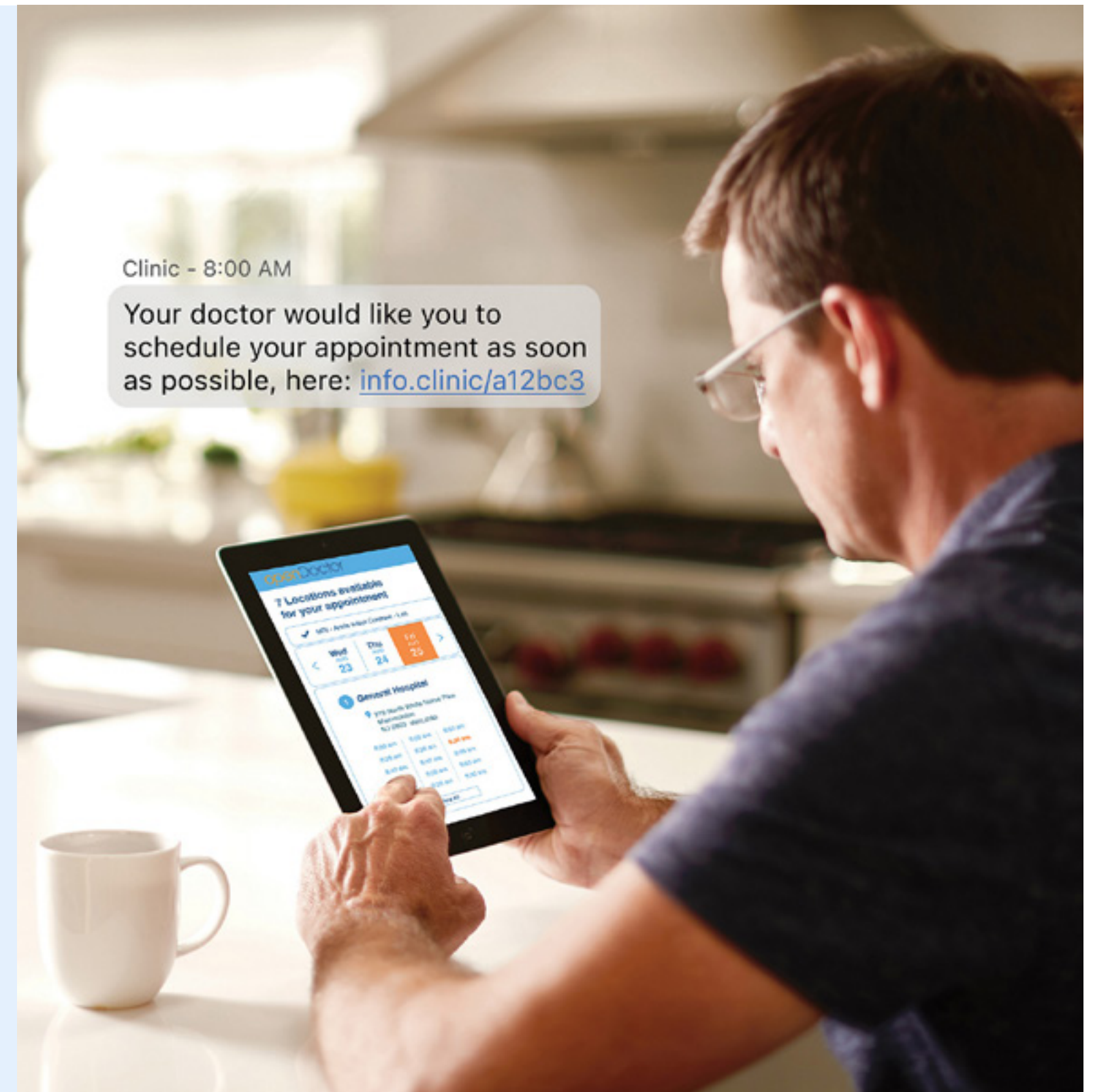# Welcoming patients to the hospital through digital front doors

Digital patient engagement can help involve patients in their own care, increasing the chance that they show up and prepare for their hospital appointments.

Missed patient appointments are a constant challenge for radiology departments, with no-show rates as high as 7% for some modalities[12]. Patient no-shows disrupt workflow, leave staff and equipment underutilized, and may cost an imaging center financial losses of up to $1 million[13]. Patients themselves may suffer the consequences too, as delays in diagnosis and treatment can lead to irrevocable harm. It's a problem that has taken on increased urgency in the wake of COVID-19, with hospitals looking for ways to ease patients' anxiety and safely bring them back in.

To remind patients of their upcoming appointments and make them feel at ease, leading radiology centers are using digital patient engagement platforms to send personalized text messages that include links to relevant safety protocols and educational content. Studies have shown that such automated reminders can lead to a 42% reduction in patient no-shows[14] and a 67% reduction in poor patient preparation[15].

Radiology centers have also virtualized their check-in processes, allowing patients to check in with a text message once they arrive at the hospital. Staff receive an automatic notification via the EHR system and can send a text message back once they are ready to see the patient. This sort of 'virtual waiting room' could very well become the new norm – allowing patients to enjoy a leisurely stroll or wait in the comfort of their car right until the start of their appointment.

Clinic - 8:00 AM

Your doctor would like you to schedule your appointment as soon as possible, here: info.clinic/a12bc3

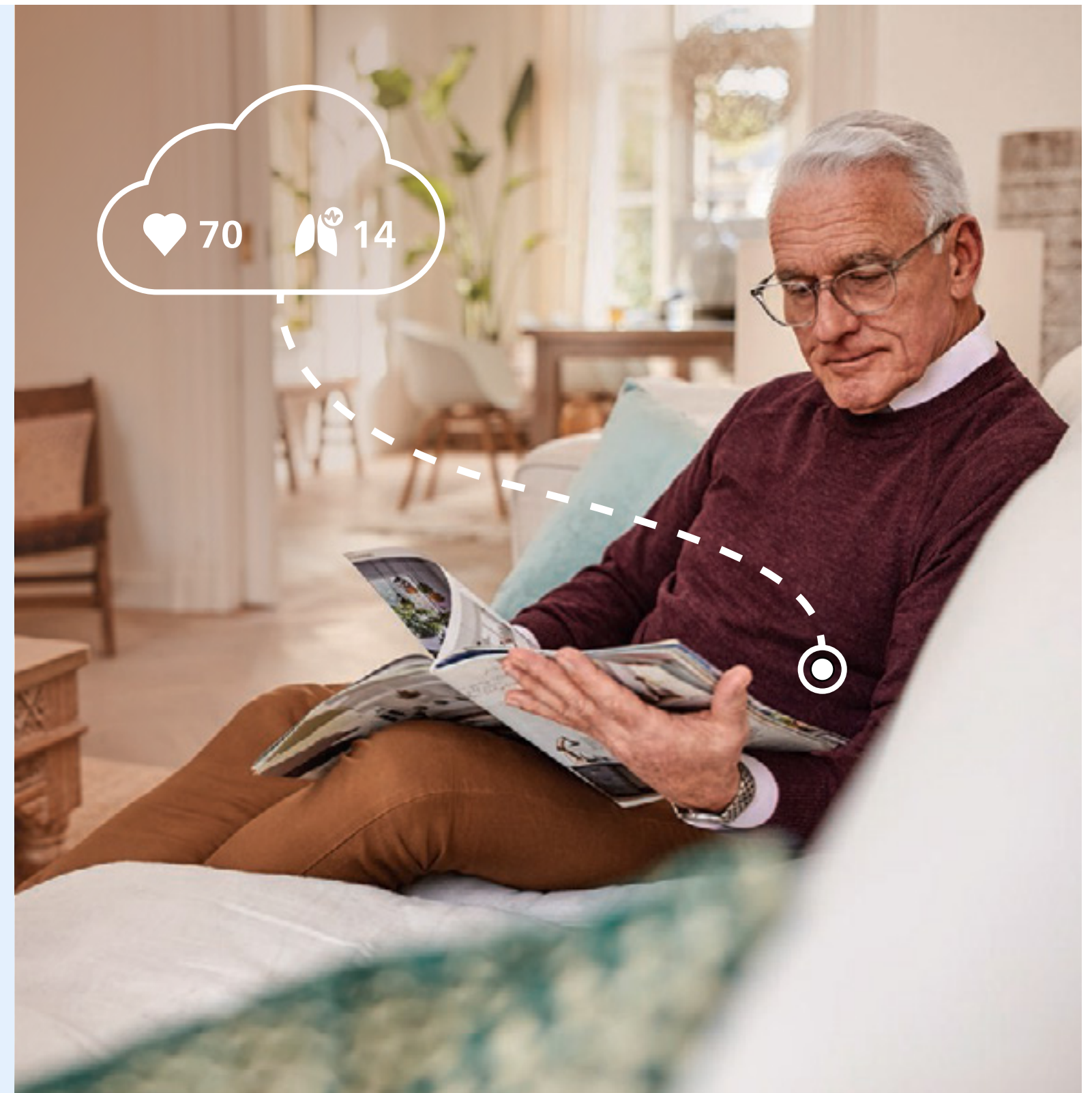## Keeping a caring eye on patients from the hospital to the home

Wearable biosensors can transmit data about a patient's vital signs and other psychological measures, enabling care providers to monitor the patient's health from the hospital to the home.

Following the COVID-19 outbreak and the shortages of personal protective equipment that initially accompanied it, hospitals have benefited greatly from using wearable biosensors to closely monitor patients on dedicated COVID-19 wards without exposing staff to unnecessary risks. Yet their potential application extends well beyond that – from lower-acuity settings in the hospital all the way into people's homes.

Patients are typically disconnected from healthcare oversight after hospital discharge, contributing to potentially avoidable hospital readmissions that cause patient distress and cost more than $17 billion in the US alone[16].

Wearable biosensors can help physicians monitor a patient's condition to support the transition from hospital to home. In addition, people can provide regular feedback on their health and quality of life by filling out online questionnaires or talking to a chat bot – without having to leave the house. It's an approach that has already shown to be useful in monitoring COVID-19 patients following hospital discharge.

Bringing various health measures and patient-reported outcomes together allows healthcare providers to detect early signs of deterioration and invite patients for follow-up treatment when needed. The potential benefits are clear to see: increased comfort for the patient, reduced cost of care, and an opportunity to act on patient deterioration earlier in order to prevent avoidable hospital readmissions.

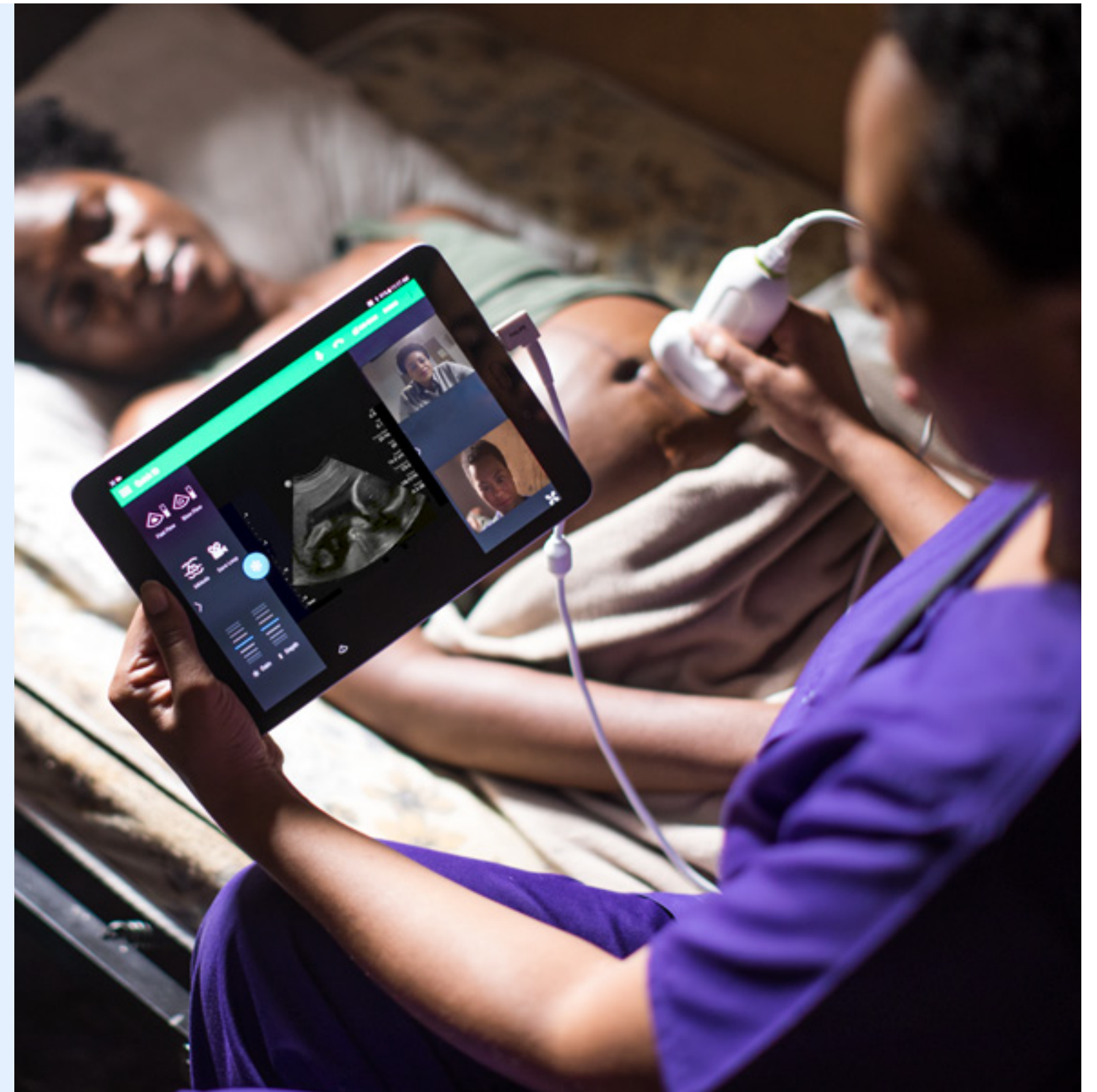# Improving access to care around the world through virtual collaboration

Live video-based collaboration between healthcare providers can extend the reach of care to where it's needed the most.

Even in developed countries, healthcare resources today are often unevenly distributed across urban and rural divides. For example, in maternal care, it is estimated that the shortage of highly skilled obstetricians, gynecologists, and maternal-fetal medicine specialists in the US will increase more than threefold between 2020 and 2050, with shortages becoming increasingly acute in rural areas[17]. Already today, more than 1 in 10 rural women in the US have to drive 100 miles or more to get access to obstetric services[18].

Tele-ultrasound can make expert knowledge more widely available throughout a health network. Although ultrasound technology is getting easier to operate, it still requires a relatively high level of manual skills, especially in more complex clinical cases. Using a live collaboration platform integrated into an ultrasound system, an experienced sonographer at an urban hospital can support a colleague at a remote site in performing the exam. A specialized doctor can use the same tele-ultrasound platform to provide instant reassurance to the patient and explain the exam findings from a distance.

Similarly, in developing countries such as Kenya, real-time video collaboration can connect experienced specialists in urban hospitals to trained midwives in local communities who are equipped with portable ultrasound devices. This allows the midwives to build the skills and confidence that are needed to perform routine basic obstetric screening themselves. As a result, they can more easily identify high-risk women for timely treatment at an appropriate healthcare center, giving those women a better chance of bringing a healthy child into the world.

The digital, data-driven healthcare enterprise

As healthcare becomes increasingly distributed, healthcare leaders need to ensure that every patient gets the right care in the right setting at the right time. That's where data-driven, centralized care coordination comes in.

During the COVID-19 pandemic, centralized care coordination models have taken hold to share data in real time, visualize untapped capacity, and facilitate patient transfers. These ways of working will now be embedded into the everyday management of patient flow. This will enable healthcare leaders to maximize throughput and productivity, while reducing waste and preventing delays that frustrate patients and staff alike.

Real-time, predictive insights

Using the power of prediction, AI can extract relevant patterns from real-time and historical data to forecast demand and help decide when a patient should be transferred from one setting to the next. Physicians will remain in charge of such decisions, supported by a central hub that oversees the bigger picture to proactively manage patient transfers. By continuously learning from new data, healthcare systems will become more adaptive and resilient in the face of change and crisis.

Continuous operational optimization

Similarly, the digital healthcare enterprise of the future will use data-driven insights to continuously improve operational performance. For example:

- Remote monitoring of medical equipment makes it possible to identify maintenance needs early, thereby avoidable preventing disruptions to patient care.

- Real-time location systems can accurately capture the movement of mobile medical equipment, staff, and patients, enabling workflow optimization.
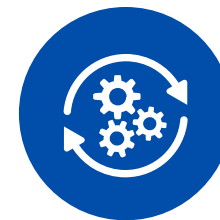
Ultimately, hospital departments will have full digital twins or virtual representations that can be used to model and simulate operational improvements before they are implemented.

Centralized care coordination

Real-time and predictive insights at scale

Continuous operational optimization

Forecasting and managing patient flow

Data-driven, centralized collaboration enables healthcare leaders to forecast patient demand, make better informed decisions about patient transitions, and spot bottlenecks before they occur.

For hospital leaders tasked with managing unexpected surges in patient demand, the ability to anticipate and adapt to rapidly changing circumstances has become more essential than ever. Managing patient flow requires an enterprise-wide view across different parts of the hospital or hospital network. However, that's often precisely what's missing today. With clinical and operational data dispersed across disparate systems, care teams lack wider situational awareness beyond their unit or department.

By bringing clinical and operational insights together in a command center or central hub, healthcare providers can manage the patient journey across the entire care continuum. Predictive analytics can help turn data into actionable intelligence that helps to answer questions such as:

• Which patient should get a bed in the intensive care unit (ICU) first?

• Which patient is ready to be transferred from the ICU to a step-down unit?

• Which patient is ready to be discharged for home monitoring?

Armed with such insights, it becomes possible to manage patient flow proactively from one care setting to the next. By expediting patient transfers throughout their care journey, healthcare providers can prevent congestion in certain areas of the hospital and overutilization of critical resources in others. For patients, this means they don't have to stay in the hospital any longer than necessary. This, in turn, gives other patients a better chance of getting access to the critical care they need.

Extending critical care capabilities across locations

Remote care for patients in intensive care units, known as tele-ICUs, can extend critical care resources to the bedside independent of a health facility's location.
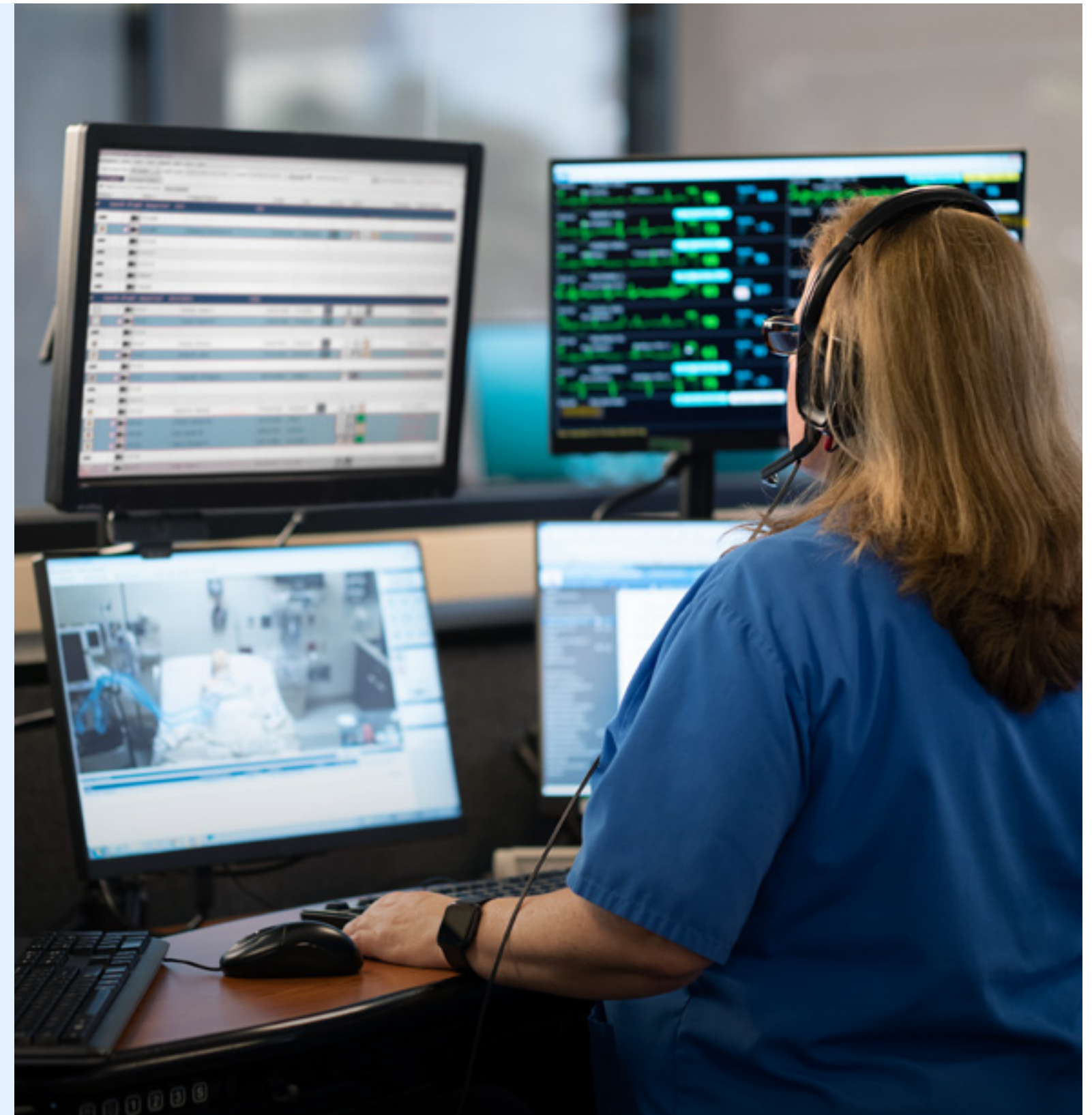
During the pandemic, tele-ICUs have played a pivotal role in providing critical care support as ICUs were flooded with patients. Led by an intensivist care team in a central monitoring facility, tele-ICUs allow for patients to be monitored remotely and transitioned to the most appropriate care setting. Intensivists and nurses in the central hub are supported by high-definition cameras, telemetry, and advanced data visualization to assist their bedside colleagues, wherever they are located. Predictive analytics alerts care teams to early signs of patient deterioration, allowing them to intervene quickly when needed.

Prior to the pandemic, tele-ICUs already demonstrated their value in addressing intensivist staff shortages. For example,

through a cross-continental tele-ICU collaboration, critical care teams in Australia can keep a caring eye on patients in a US hospital to reduce the burden of traditional night shift work. With COVID-19 primed to leave a lasting mark on healthcare delivery, the next few years will likely see a further expansion of tele-ICU programs around the world.

Having a centralized remote patient monitoring center provides the ability to standardize care and reduce transfers while maximizing bed utilization. In previously published studies, tele-ICU programs have been shown to reduce ICU mortality by 20%[19], generate care savings of nearly $1,500 per patient across a 60-day post-ICU episode[20], and reduce ICU length of stay by 30%[21].

Note: Results are specific to the institutions where they were obtained and may not reflect the results achievable at other institutions.

Virtual imaging operations in the cloud

Central command centers can help standardize radiology operations across sites by having specialized technologists offer virtual support to less experienced colleagues.

Highly experienced technologists who know the ins and outs of advanced modalities such as MR and CT are often in short supply within large imaging practices that have multiple scanning locations. Until recently, these expert users would have to travel from their central location to remote sites to help out their less experienced colleagues. But now they can provide assistance at multiple locations in real-time while the patient is on the scanner table – without having to leave their central location.

Through a new form of tele-presence in image acquisition, expert technologists can provide guidance, support, and training from one central location: the Radiology Operations Command Center. Secur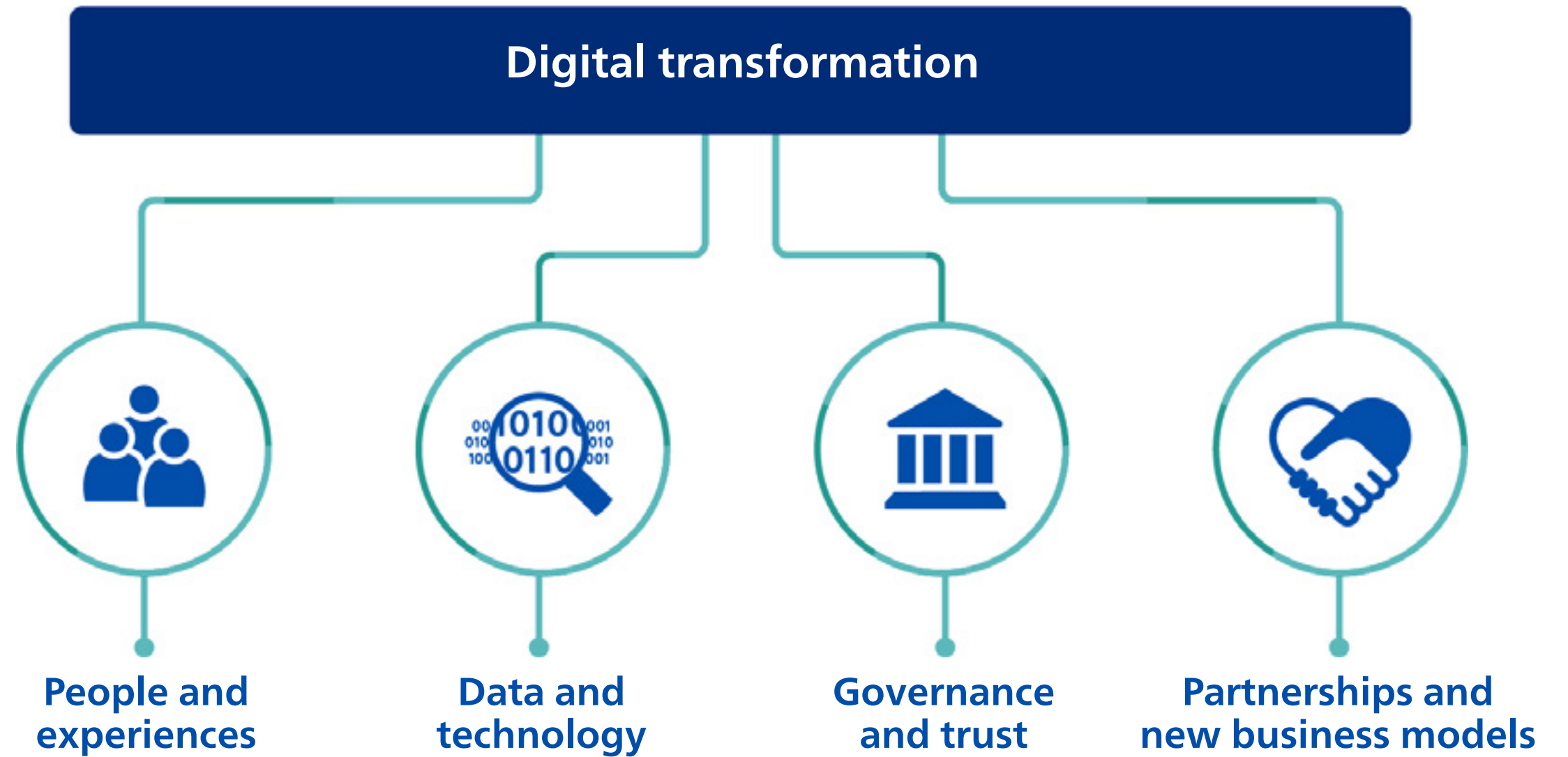e virtual scanner access enables these expert users to assist or train their colleagues across locations, thereby driving consistency in image quality and standardization. This reduces the need for unnecessary recalls and repeats, which can be a heavy burden on patients and on staff.

This cloud-based hub-and-spoke model can be easily scaled across several or even hundreds of sites. It makes imaging operations less vulnerable to local staff turnover and unforeseen disruptions. Having a central command center also allows imaging providers to offer complex procedures at more locations, closer to where patients live and at more flexible hours, to improve access to care. For patients, that means less hassle and more convenience, while having the peace of mind that a super-expert is looking over the technologist's shoulder – even if it's from hundreds or thousands of miles away.

Driving digital transformation at scale: four enabling areas

What is needed to bring this vision of digital transformation to full fruition? We see four enabling areas, each of which is outlined in more detail in the next few pages.

Digital transformation

People and experiences

Data and technology

Governance and trust

Partnerships and new business models

People and experiences

Ultimately, the value of digital health technology is only as strong as the human care experience it supports. That's why, at its heart, digital transformation is about people.

With digital technology, we can take the friction out of care experiences. That means healthcare professionals get to focus on what they do best, without getting bogged down in complexity and inefficiencies. And it means consumers and patients get to take an active role in their health and wellbeing, with easy to use and intuitive tools that support them in their daily health routines.

But as we know from the early days of electronic health records, digital technology can also become a source of frustration if it adds complexity or detracts from the patient-provider relationship. As one doctor lamented in the Scientific American: "we physicians entered the profession to connect with and help patients – not to stare at a screen."[22]

Similarly, patients may be reluctant to adopt digital health technology if it creates more hassle than convenience. Or their interest in using the technology may wane over time if it doesn't add enough value, as we have seen with first-generation wearables for fitness and health tracking[23].

Human-centered design for frictionless experiences

The most beneficial and impactful digital innovations are need-driven rather than technology-driven. They improve the human care experience without getting in the way of it. Or as one hospital CIO put it: "Digital medicine is just medicine in the same way that really good technology is not about technology. It blends into the fabric of our everyday lives."[24]

To achieve this, human-centered design is critical. Digital innovation should start with uncovering unmet needs. Solutions must fit into people's workflows and routines, offering the same kind of seamless experience that they have come to expect from other industries.

At Philips, we use tools such as experience flows to understand the practical and emotional context in which digital technology is used. Co-creation sessions with healthcare professionals and patients can generate the sort of insights that inspire solutions which solve real needs and pain points.

Digital in action

Designing for human-AI collaboration

What does it mean to take a people-centric approach to digital transformation? One example is how we are designing for human-AI collaboration in radiology.

Recognizing that radiologists and AI have complimentary strengths, we are working with clinical and academic partners to develop human-centered AI that augments the capabilities of radiologists.

First, we conducted 360-degree on-site workflow analyses and co-creation sessions with medical experts at two leading Dutch hospitals to understand the current pain points of radiologists, and ways in which AI could alleviate them.

Based on further research, we then went on to identify three experience drivers that foster effective human-AI collaboration: (1) added value, (2) workflow integration, and (3) appropriate trust in the AI's recommendations.

Read more

Education across borders

A few years ago, Peru instituted a law that every emergency department (ED) should have an ultrasound machine. But with that law, no education came.

To address this gap, the Philips Foundation provided ED physicians in US hospitals with a video platform to train their peers in Peru in the use of point-of-care ultrasound (POCUS) – through live virtual collaboration. Through regular education sessions, sometimes as short as 5 minutes, ED physicians in Peru developed the skill and confidence to perform and interpret ultrasound exams.

Trained physicians in Peru have since become local champions who leverage their learnings beyond their own practice by educating colleagues. During the pandemic, these local champions have also taken a leading role in using POCUS to support diagnosis and treatment guidance for COVID-19 patients.

Virtual education and collaboration

As new digital technologies enter healthcare, new skills will be required. Our Future Health Index 2021 report revealed that 32% of healthcare leaders consider lack of training to fully utilize digital health technology a barrier to its adoption in their hospital or healthcare facility.

One way to address this skill gap is through real-time video collaboration, which enables remote education and on-demand support. For example, in minimally invasive image-guided therapy, virtual collaboration allows interventional physicians to look over their peer's shoulder via webcams mounted on the ceiling of the interventional room. First experiences with this type of cloud-based collaboration have been highly encouraging. For example, one study showed how an expert physician in Canada successfully supervised the first US use of a new type of implant to treat aneurysms in the brain, through bidirectional audiovisual streaming[25]. In the future, one can imagine wider use of such tools for the rapid dissemination of knowledge and continuous learning.

Co-creating with all stakeholders

As the scope of digital solutions expands – often impacting multiple stakeholders across departments – change management also becomes increasingly critical to their successful implementation. For example, as healthcare providers seek to better orchestrate patient transitions from one care setting to the next (see page 13), senior leadership will need to agree with clinical care teams on enterprise-wide KPIs that reflect patient flow across departments. In addition, implications for frontline staff need to be well thought through. Only by involving all stakeholders from the start will such large-scale transformation live up to its full potential.

Key takeaways

- Digital health solutions should address people's unmet needs, with intuitive solutions that fit into their workflows and daily routines, removing friction from care experiences rather than adding to it.

- Virtual training and education can help upskill staff and extend the expertise of care teams.

- Co-creation with all stakeholders is needed to develop new models of digital care delivery and embed them into everyday processes.

Data and technology

Data is the lifeblood of digital transformation. At Philips, we are helping healthcare providers unlock data from different systems and devices to make it available at the point of care in an integrated and meaningful way – providing actionable insights at scale, when and where they are needed.

In our Philips Future Health Index 2021 report, healthcare leaders cited difficulties with data management (44%) and lack of interoperability and data standards (37%) as the biggest barriers to adoption of digital health technology in their hospital or healthcare facility.

While most healthcare providers have largely digitized their patient records, data is typically stored in disparate systems that do not speak to each other. The result is a patchwork of point solutions.

As healthcare becomes more distributed, with a mix of in-person and virtual engagement, having an end-to-end data strategy that spans the entire patient journey will become even more important.

Cloud-based digital platforms

What's needed for digital transformation at scale are digital platforms that enable the fast and secure exchange and integration of data across settings. During the COVID-19 pandemic, healthcare providers have experienced firsthand how cloud-based services provide flexibility, scalability, and speed – both in adopting new innovations and in adjusting resources to meet demand. In the next year, 66% of healthcare executives expect to move their technology infrastructures to the cloud – a number that is set to rise to 96% three years from now[26].

At Philips, we're enabling this transition with Philips HealthSuite: an open, secure, cloud-based platform that collects, compiles, and analyzes clinical and other data from a wide range of devices and sources. Through this platform, we offer a growing portfolio of cloud-based healthcare informatics solutions that support coordination of care across settings.

The need for open data standards

To leverage digital platforms to their full potential, interoperability and data sharing between different hospitals and health systems is key. Data should be available in formats that can be shared effortlessly, transparently, and securely.

Healthcare executives say they will move their IT infrastructure to the cloud
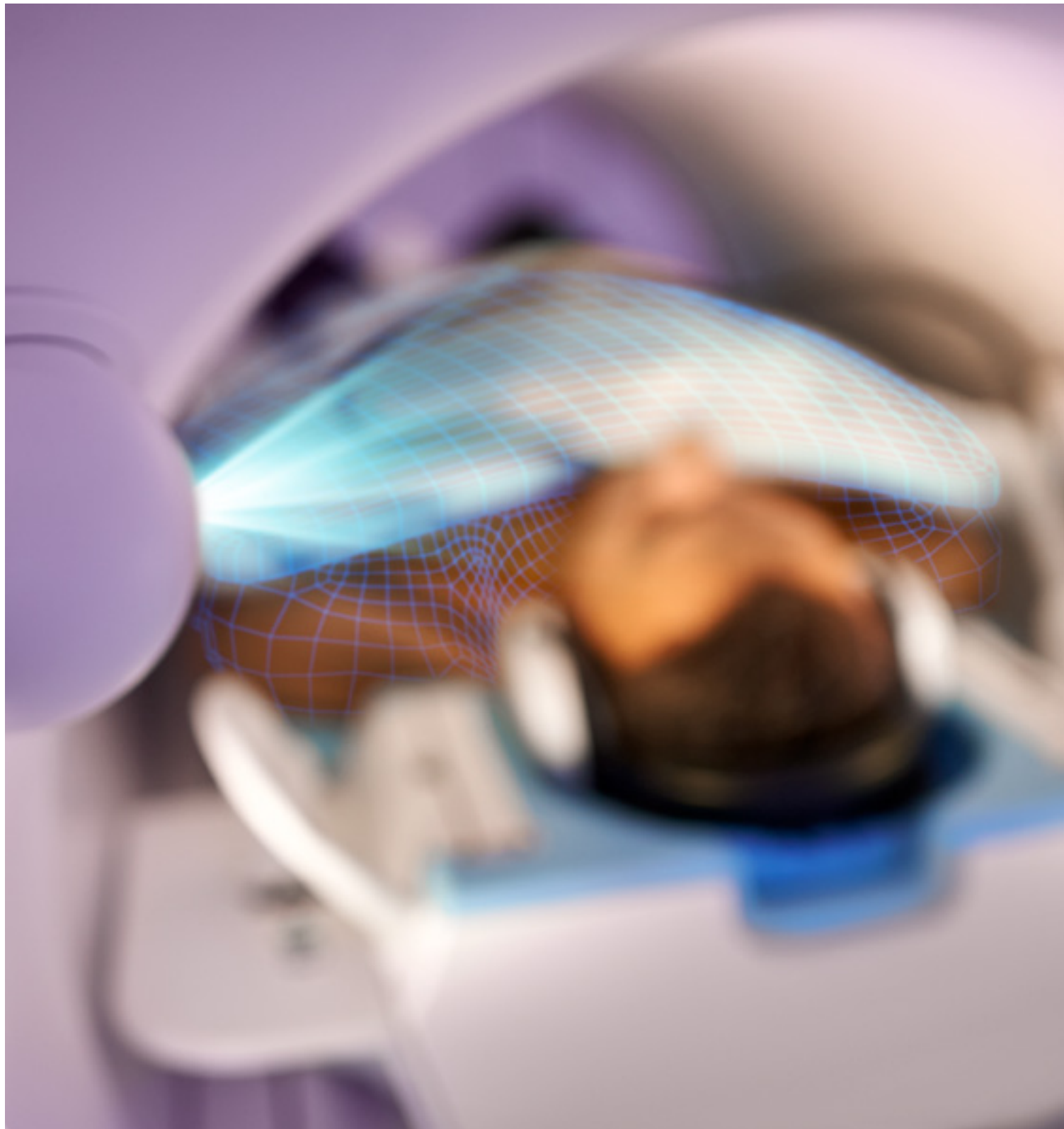
66%
within one year

96%
within three years

Accenture Digital Health Technology Vision 2021

Open data standards such as FHIR (Fast Healthcare Interoperability Resources) will play an essential role here.

Efforts to promote data sharing in healthcare are already underway in many parts of the world and should be encouraged. One interesting example is the GAIA-X initiative, which is meant to create a secure and scalable infrastructure for data sharing across Europe. Potential use cases could include chronic heart failure patient management, which relies on the combination of electronic health record data with device measurements and feedback from the patient at home. GAIA-X can provide the secure infrastructure to enable such data exchange at a national and even European scale[27].

AI supporting the human experience

While having access to data from different sources is critical, data is only as valuable as the insight it provides. Information overload is a pressing problem for healthcare professionals, who are facing a growing deluge of data both from in-hospital and patient-generated data sources. By 2025, the amount of healthcare data is expected to grow by 36% per year[28]. Wearable and embedded sensors will further fuel this growth as the Internet of Things (IoT) in healthcare takes hold, generating continuous streams of data from multiple locations including the home.
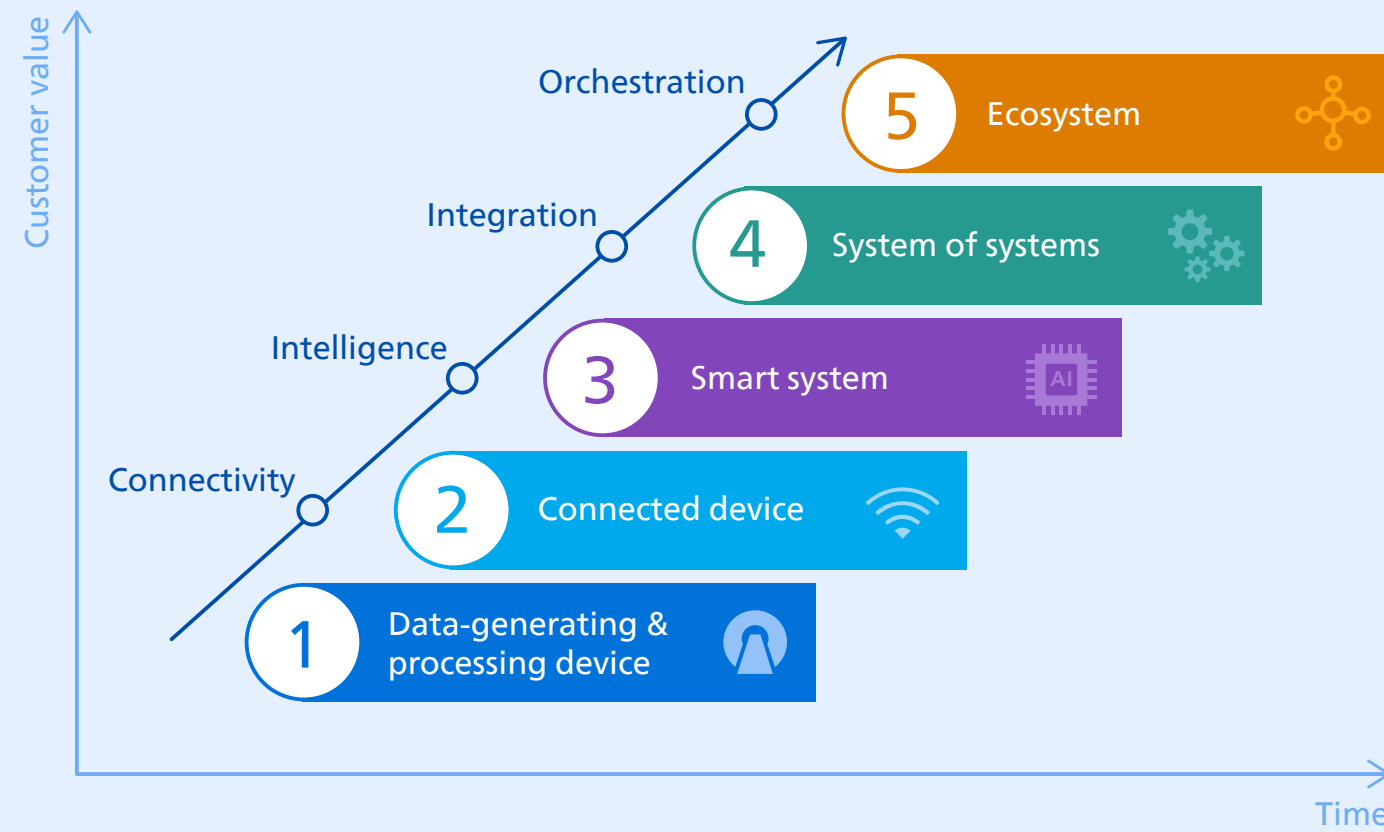
To keep pace with this explosion of data, artificial intelligence (AI) will play an increasingly important role. With its ability to extract insights from large amounts of data, AI can augment the capabilities of healthcare professionals to help them detect, diagnosis, treat, and monitor disease. AI can also help save valuable time and optimize workflows by automating mundane tasks – allowing physicians and staff to focus on value-added work.

The first use cases of AI in healthcare are already having a real impact today. For example, in magnetic resonance (MR) imaging, camera-enabled patient sensing technology lets the technologist monitor a patient's breathing without having to set up an old-fashioned respiratory belt. AI can analyze over a hundred body locations in parallel to extract signs of breathing – allowing the setups of routine MR exams to occur in less than a minute, even for less experienced operators. With the help of smart algorithms, we can also drastically accelerate image acquisition, shortening MR exams by up to 50%[29].

Similarly, AI will help prioritize and expedite image reading by radiologists to support a precision diagnosis and timely treatment. In complex clinical domains such as oncology, AI will also be pivotal in facilitating integrated decision-making – by analyzing imaging studies as well as

The pathway of digital transformation
From stand-alone devices to ecosystems of digital propositions

"Cloud-based digital platforms, IoT, and AI will ultimately enable an ecosystem of connected medical and personal care devices from multiple vendors, which can collect, analyze and exchange data to help consumers, patients, care providers, and payors make timely and better informed decisions."

Henk van Houten
Chief Technology Officer, Philips

other patient data including pathology reports, molecular tests, and genetic profiles. But AI will not be a panacea in and of itself. It's the combination with robust scientific knowledge and deep clinical insight that will give AI its biggest and most beneficial impact on patient care .

Collaborative ecosystems

In this future of smart and connected healthcare, different systems and devices will become increasingly integrated to provide seamless experiences to patients and healthcare professionals. But no single company will be able to "do it all". Healthcare is too complex for that. Instead, the future of digital healthcare will be built in collaborative ecosystems, with solutions from multiple vendors working in concert on open and interoperable platforms.

For example, in radiology, this can take the form of curated software marketplaces. With the rise of AI, there's a plethora of apps coming from start-ups and universities. But hospitals may find it hard to put these apps to use if they lack a common underlying platform that is integrated with their workflow at the point of care.

A curated software marketplace allows radiologists to download validated apps from a large number of third-party developers via one common platform – without having to worry about point-to-

point integrations. It will then be the role of healthcare solution providers like Philips to ensure that such apps run seamlessly on the consoles and mobile devices used by hospital staff. By combining the strengths of technologies from different vendors, in a way that is easy to access and implement for healthcare providers, we can further accelerate innovation and deliver on the full promise of digital transformation.

Key takeaways

- To connect patient data across a patient's care pathway, open, secure, and interoperable cloud-based digital platforms are essential, as well as open data standards such as FHIR.

- Artificial intelligence will help make sense of the growing avalanche of data by supporting rather than supplanting the capabilities of healthcare professionals.

- No vendor can solve all of healthcare's challenges alone – instead, the future of digital healthcare will be built in collaborative ecosystems.

Governance and trust

Because health data is among the most sensitive personal information, trust in digital healthcare is paramount – calling for robust standards and policies that govern the usage of data and data-intensive technologies like AI.

Data privacy and security feature prominently among the factors that determine trust in digital health systems. Prior to the pandemic, when asked what would keep consumers from using digital devices for healthcare, 41% ranked "concerns about my privacy or data security" as the number one barrier[31]. While the pandemic has lowered the barrier for many due to necessity, long-term concerns about privacy and security are likely to remain.

Likewise, for healthcare CIOs tasked with keeping patient data safe across a growing plethora of channels and devices, data security is as big a concern as ever[32]. Health data is the number one target for cybercriminals and is 10 times more valuable than credit card data alone[33]. As hospital networks, clinical databases, medical devices, and personal health monitoring systems become more integrated, the potential for cybersecurity vulnerabilities will only grow.
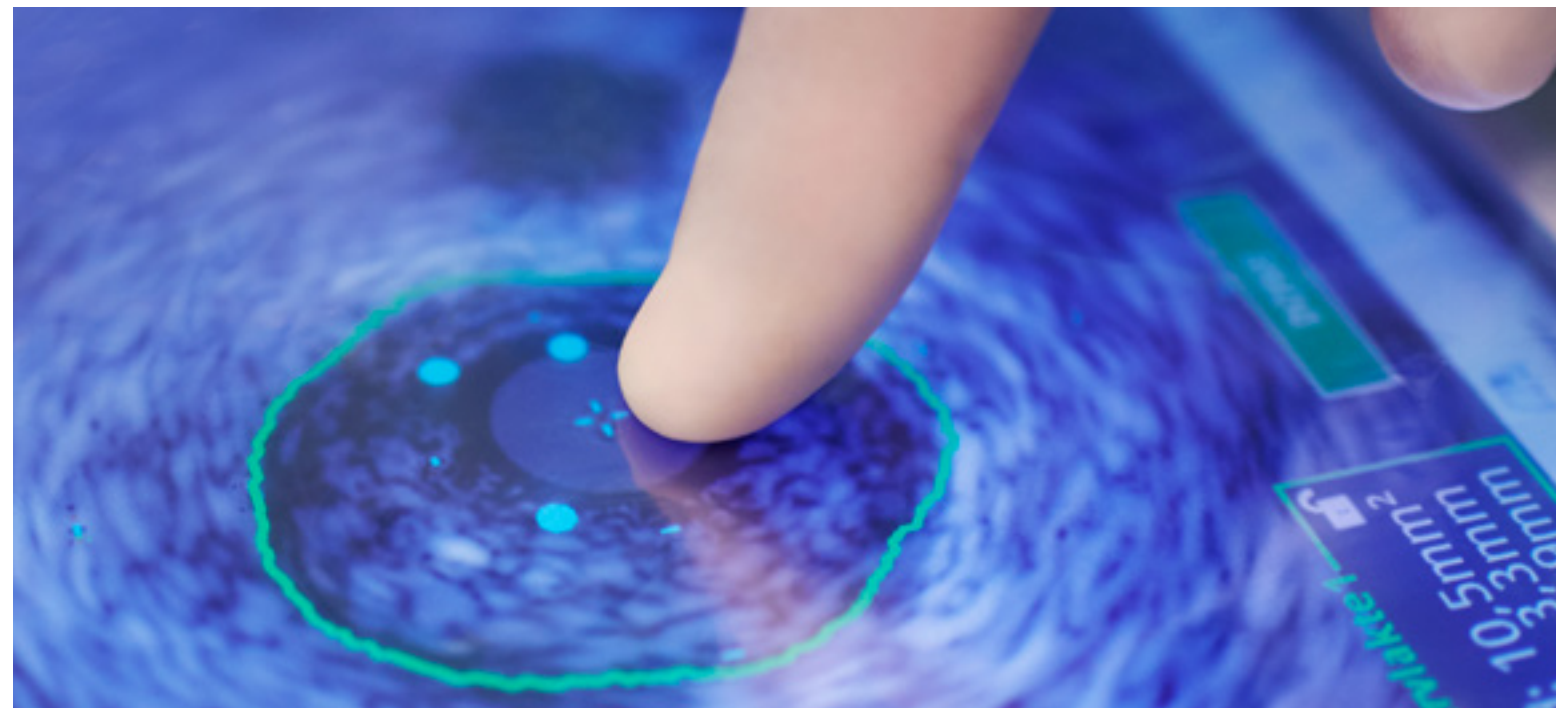
Keeping data safe and secure

At Philips, we are committed to proactively addressing security and privacy concerns, and ensuring that data is used in a way that is beneficial to customers, patients, and society as a whole. We have captured these commitments in our Philips Data Principles.

Cybersecurity, in our view, requires a systematic approach that takes into account where and how devices are used. We take an end-to-end 'Security Designed in' mindset that puts security considerations front and center all the way from product design and development to testing and deployment – backed by robust policies and procedures for monitoring, effective updates, and where necessary, incident response management.

Similarly, Philips is committed to responsible data stewardship through 'privacy by design'. This approach aims to embed privacy and data protection controls throughout the entire data lifecycle, from the early design stage to deployment, collection, use and ultimate data disposition and disposal. By being transparent about how we deal with personal data, we can help to build trust.

Philips Data Principles

Security
We ensure the security of all data entrusted to us. We operate under global security policies that guide our activities to protect against vulnerabilities and manage any incidents.

Privacy
We handle all personal data with integrity, in compliance with all applicable privacy regulations of the countries in which we operate.

Beneficial
We aim to create innovative solutions that benefit our customers, patients, and society as a whole. We use your personal data in line with your reasonable expectations.

Philips AI Principles

Well-being

We design our solutions to benefit the health and well-being of individuals and to contribute to the sustainable development of society.

Oversight

We design AI-enabled solutions to augment and empower people, with appropriate human supervision.

Robustness

We develop AI-enabled solutions that are intended to do no harm, with appropriate protection against deliberate or inadvertent misuse.

Fairness

We develop and validate solutions using data that is representative of the target group for the intended use, and we aim to avoid bias or discrimination.

Transparency

We disclose functions and features of our offerings that are AI-enabled, the validation process, and the responsibility for ultimate decision-taking.

Ethical and responsible use of AI

As AI is beginning to make its mark on healthcare, questions around its safe and responsible use have also moved to the forefront of discussion. How do we safeguard that AI algorithms are used for the intended purposes? And how do we ensure that AI does not inadvertently discriminate against specific cultures, minorities, or other groups, thereby perpetuating inequalities in access and quality of care?

Such questions are far too important to be answered in hindsight. They compel us to think through proactively – as an industry and as individual actors – how we can best advance AI in healthcare to instill appropriate trust and address unmet needs, while avoiding unintended consequences.

At Philips, this led us to develop a set of guiding principles for the design and responsible use of AI in healthcare and personal health applications – all based on the notion that AI-enabled solutions should complement and benefit customers, patients, and society as a whole.

"To reap the full benefits of AI and data science, we have to enable secure exchange of and access to properly curated data while safeguarding patient privacy. And to make sure that AI is fair and bias-free, it is important that the algorithms we develop reflect the full diversity of the world we live in. That's why we developed the Philips Data and AI Principles – to ensure that everyone gets to benefit from digital health innovation in equal measure."

Dr Tina Manoharan
Global Lead of Data Science & AI Center of Excellence
Philips

To promote the responsible application of AI, we must put safeguards in place to prevent unintended or deliberate misuse. One way of preventing inadvertent misuse is to monitor the performance of AI-enabled solutions in clinical practice – and to compare the actual outcomes to those obtained in training and validation. Any significant discrepancies would call for further inspection.

Another priority is to make sure that AI is fair and free of bias. With careful design, AI has the promise to create a healthier and fairer future for all. But as multiple studies have shown, there's also a risk that we end up encoding current and past inequalities based on biased datasets[34,35].

We should be mindful that AI is only as objective as the data we feed into it. To prevent bias, development and validation of AI must be based on data that accurately represent the diversity of people in the target group. When AI is applied to a different target group, it should be revalidated – and possibly retrained – first. By harnessing the potential of AI in a way that is inclusive by design, we can create a fairer and healthier future for all.

Key takeaways

- Public trust in the safe and secure use of their health data will be critical to the further adoption of digital health technology.

- To ensure that data-intensive technologies such as AI benefit patients, healthcare professionals, and society as a whole, careful consideration and design is needed to prevent unintended consequences such as bias that may reinforce existing health inequalities.

- At Philips, we are committed to the ethical and responsible use of data and AI, as outlined in the Philips Data Principles and the Philips AI Principles.

Partnerships and new business models

The rapid pace of digital innovation during the COVID-19 pandemic has demonstrated the power of collaboration. Sustaining that momentum will rely on long-term partnerships and new business models for the digital age, supporting a shift towards value-based care.

As healthcare leaders embark on their digital transformation, they recognize the need to forge long-term strategic partnerships with health IT companies that can help develop and implement a roadmap to digital maturity. According to our Future Health Index 2021 report, 41% of them believe their hospital or healthcare facility needs to prioritize strategic partnerships to successfully implement digital health technologies.

A roadmap to digital maturity

Taking a long-term, structured approach is essential for sustained transformation. For example, in diagnostic imaging, the HIMSS Analytics Digital Imaging Adoption Model (DIAM) provides guidance for imaging and IT leaders to identify and adopt the right digital strategy and

improve health outcomes for patients. To guide organizations along the way, HIMSS Analytics Certified organizations, like Philips, have been professionally trained on the HIMSS Analytics Maturity Model(s).

DIAM offers a framework to support an organization's existing strategic plan by identifying the strengths and weaknesses of its tools and processes and determining the overall approach to help them get where they want to be. It identifies seven development stages, from limited electronic image management to sophisticated, enterprise-wide digital imaging solutions.
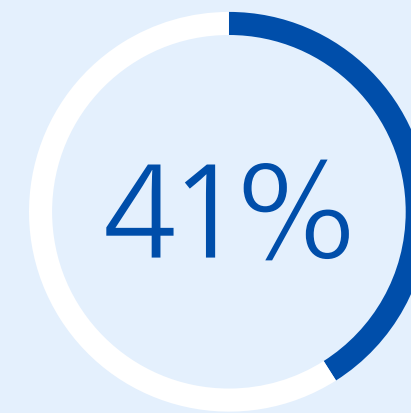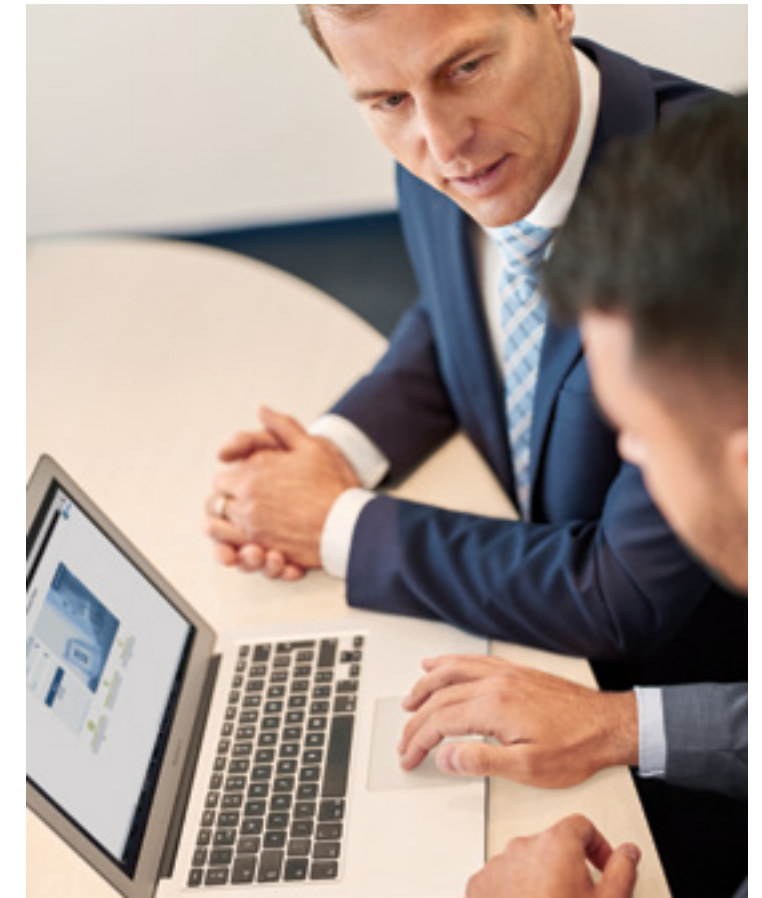
Healthcare organizations using maturity models such as DIAM have insight on where their organization is today and establish a clear baseline of their enterprise's performance. From there, organizations can set goals and objective benchmarks that ladder up to their larger digital transformation objectives. In doing so, organizations will be able to make links between their investments and ROI and better identify progress towards their KPIs.

Maturity models such as DIAM also provide a common language that healthcare leaders can use with vendors to clarify their needs and expectations regarding digital technologies and informatics solutions.

Ecosystem partnerships

As we have seen before, these technologies and solutions will typically not come from one vendor alone. Digital transformation will rely on platform and ecosystem partnerships that bring together the strengths of different established technology vendors, start-ups, healthcare providers, and payers, to foster joint innovation – with the patient or health consumer firmly at the center.

Open digital platforms and application programming interfaces (APIs) will form the foundation of shared digital infrastructures that make it easier to aggregate patient information across settings and turn it into meaningful insights at the point of care.

41%

of healthcare leaders believe their hospital or healthcare facility needs to prioritize strategic partnerships to successfully implement digital health technologies

Philips Future Health Index 2021

A shift towards value-based care

In conjunction with these developments, we expect the shift from fee-for-service to value-based care to continue, driving a shared focus on improving outcomes. In value-based care models, providers are reimbursed based on quality (or value) metrics as opposed to the quantity (or volume) of services delivered – promoting a more preventative approach to healthcare.

In the aftermath of COVID-19, the transition to value-based care may first slow down. All types of value-based care arrangements, including bundled payments, capitation models or pay-for-performance, require some form of capital commitment to take on the inherit risks of these payment models. As healthcare leaders continue to struggle with the financial impact of COVID-19 on their bottom line, it is uncertain whether they will continue their pursuit of new payment models in the short term.

But in the long term, the outlook for value-based care remains bright. In many ways, the pandemic has shown that value-based delivery networks are actually the best chance we have of keeping healthcare costs sustainable by managing population health in a more proactive and preventative way.

Patients with poorly managed chronic conditions – including COPD, diabetes, and obesity – have shown to be must vulnerable to the coronavirus. Too many patients with chronic conditions, particularly those from disadvantaged backgrounds, have been left vulnerable. The need to manage their conditions has never been clearer. This will require concerted efforts among providers, patients, technology vendors, and payors – supported by value-based reimbursement strategies that promote the continued use of telehealth, remote patient monitoring, and other digital technologies beyond the pandemic.

Innovative partnerships with health insurers can also promote a stronger focus on prevention to promote health and well-being and reduce downstream healthcare costs. For example, in the US, Philips has established a partnership with a major health insurer to advance oral health and improve healthcare outcomes in a connected ecosystem that encompasses oral hygiene at home and care at the dentist[36].

"Collaboration is crucial in further accelerating the digital transformation of healthcare. At Philips, we embrace the power of platforms and ecosystems to help foster partnerships among healthcare providers, patients, technology vendors, and payors – based on the principles of value-based care."

Jan Kimpen
Chief Medical Officer
Philips

Business models for the digital age

With the increased focus on strategic partnerships and a shift from fee-for-service to value-based care, the relationship between healthcare providers and technology vendors like Philips will increasingly be defined by new business models.

Historically, healthcare providers made one-time investments in medical equipment, buying a new and improved MR or CT scanner every so many years. Subscription- and usage-business models such as managed technology services allow for more flexibility and lower total cost of ownership, turning one-time capital expenses (CapEx) into predictable operational expenses (OpEx).
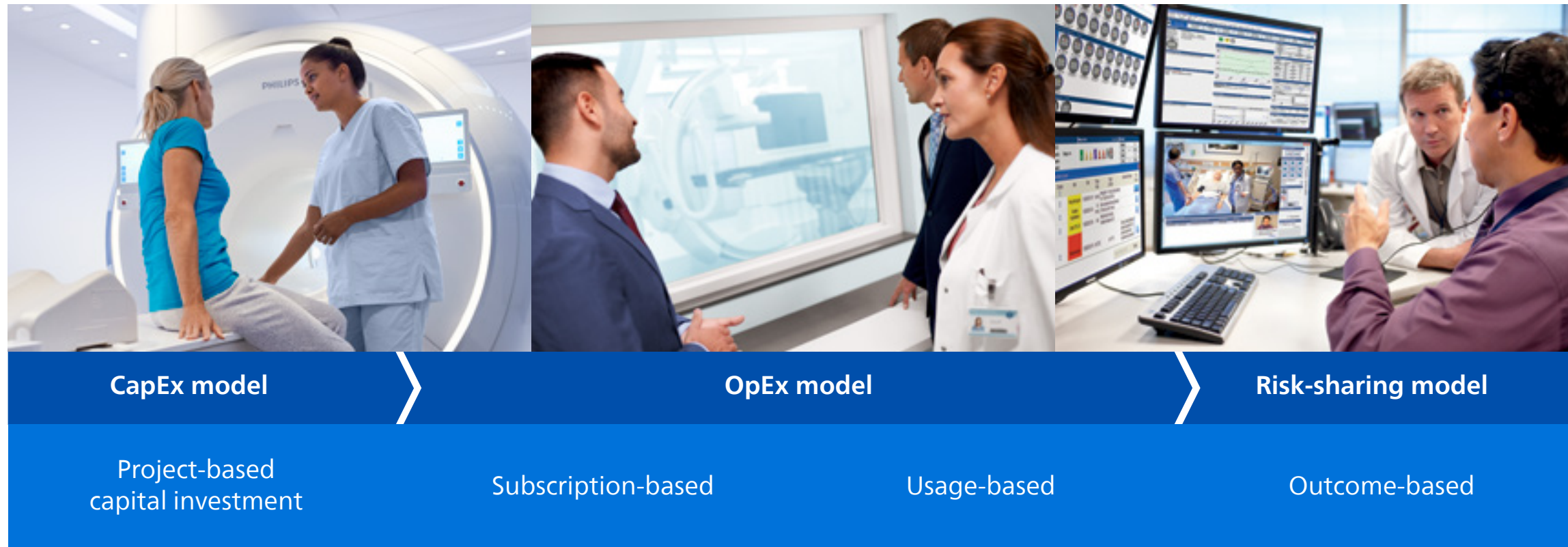
Digital transformation and cloud adoption will accelerate this trend, with a growing number of healthcare leaders considering the Software-as-a-Service (SaaS) model for their healthcare IT solutions. SaaS models generally require a lower initial investment and create a transparent total cost of ownership with the vendor, who can manage the complete life cycle and support services, identify optimization opportunities, and enable continuous adoption of new innovation.

Cloud-based platforms built on SaaS can be centrally hosted on the servers of the service provider, alleviating the need for on-premises software solutions, and offering organizations the financial flexibility to "pay as they go" with subscription-based models.

Ultimately, a joint focus on improving outcomes will lead to the wider adoption of risk-sharing models, in which healthcare providers and technology vendors commit to shared KPIs and incentives.

Key takeaways

- Digital maturity models can help create a strategic roadmap for digital transformation and assess progress towards clearly defined goals as part of long-term strategic partnerships.

- Digital transformation is part and parcel of the transition from fee-for-service to value-based care, with different ecosystem partners sharing a focus on improving outcomes at lower cost.

- Digital transformation will go hand in hand with new business models such as Software as a Software (SaaS), which allow healthcare providers to benefit from continuous innovation on a subscription basis instead of requiring large upfront investments.

CapEx model	OpEx model		Risk-sharing model
Project-based capital investment	Subscription-based	Usage-based	Outcome-based

Conclusion: key priorities

As healthcare systems are still reeling from the pandemic, digital transformation offers a unique and urgent opportunity to reimagine how and where healthcare is delivered – with patients and care professionals both set to benefit from more frictionless experiences.

To deliver on this promise, a collaborative approach is needed, focused on the following priorities:

- **Starting from the unmet needs of patients and healthcare professionals** to co-create solutions that integrate into their workflows and daily routines, supported by virtual training and education to promote continuous learning.

- **Adopting a secure, cloud-based platform approach** to connect data from different settings, systems and devices, both inside and outside the hospital, to deliver the right insights when and where they are needed.

- **Using the power of AI to support and enhance the human care experience** – whether it's through augmenting the expertise of healthcare professionals and aiding their decision-making, or by improving operational efficiencies that allow them to focus on patient care.

- **Building and maintaining trust in digital health technology** through robust data privacy and security policies, while promoting controlled data sharing and digital innovation through federated data infrastructures.

- **Safeguarding the fair and responsible use of data-intensive technologies like AI** to ensure that they benefit every patient and society as a whole – without inadvertently amplifying existing health disparities.

- **Accelerating the shift towards new business models such as Software as a Service (SaaS)** to allow healthcare providers to benefit from continuous innovation on a subscription basis, in an easily scalable way.

- **Promoting value-based reimbursement strategies** that support the continued use of telehealth, remote patient monitoring, and other digital technologies beyond the pandemic – for better health outcomes at lower costs, with an improved patient and staff experience.

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