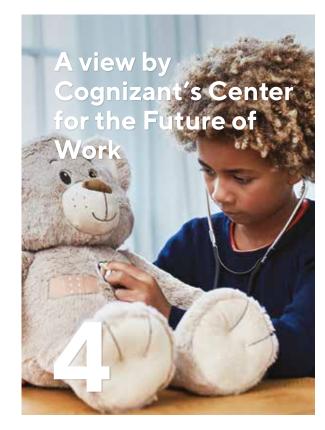
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The Future of Healthcare & Life Sciences The future of healthcare & life sciences offers a world of opportunities, but the transformation requires substantial steps and boldness. The industry needs to be open to new insights instead of being mentally closed by existing ones.

Each industry has its owns challenges, and digital disruption is everywhere. Organizations must be agile and build new momentum that respects the new reality of their industry. As organizations continuously try to remain relevant, this requires adaptation to changes not only today, but also tomorrow. Change is the only constant. Constant change requires scenario-based thinking, exploring several paths and crafting a digital strategy based on preparing for the future. For businesses to stay relevant, they need to explore the future and look at next generations.

No one can predict the future; organizations must actively explore various possible futures to anticipate what disruptions are coming. We believe that future winners in the digital economy will be those that can deliver on one key insight: put technology in the background and focus on people first. Putting customers first does not diminish technology's importance; rather, a deep customer understanding should help guide the choice of which technologies to incorporate in your business.

Cognizant can bring together digital strategy, deep industry knowledge, human sciences, experience design and technology expertise to help companies design, build and scale digital business solutions. Cognizant has both the expertise and experience with digital transformation. Together with clients we can explore tomorrow's opportunities.



Are algorithms becoming the new doctor?





Euan Davis leads Cognizant's Center for the Future of Work in EMEA. A respected speaker and thinker, Euan has guided many Fortune 500 companies into the future of work with his thought provoking research and advisory skills.

Within Cognizant's Center for the Future of Work, he helps ensure that the unit's original research and analysis jibes with emerging business-technology trends and dynamics in Europe, and collaborates with a wide range of leading thinkers to understand how the future of work will look. Previously, Euan held senior analyst, advisory and leadership positions at Forrester Research, IDC and CEB. Euan can be reached at: Euan.Davis@cognizant.com сепter for The Future of Work

A view by Cognizant's Center for the Future of Work

Meet the customer **of the future**

Vicky steps into the car and breathes a sigh of relief. When the doctor called last week and asked her to come in for some tests, she was quite worried. Although she'd been following her personalized health plan to the letter, data from her smartwatch and home scanners had given her doctor reason to be concerned. It turns out Vicky is showing the very earliest signs of liver disease, but because it was caught so early, it shouldn't be a problem. The home scanners are now set to keep an eye on Vicky's levels, and send updated dietary instructions and tailored medication refills every week. She's grateful the news wasn't worse. Her aunt's 105th birthday party is on Saturday, and she would have hated to miss the fun run her aunt organized to celebrate.

Quick take Post COVID-19 impact

The COVID-19 crisis has placed the spotlight on the healthcare and life sciences industry like nothing else before it. From vaccine testing and production to hospital care for critically ill patients, every facet of this industry is operating at warp speed.

Processes implemented during the crisis will change the dynamic of the industry post-COVID and facilitate rapid response to digital innovation and future health crises.



Sounds like medical science fiction? Not at all. By 2025, patients will be in complete control of their health and well-being. And healthcare organizations that want to stay relevant will provide the tools that give them that power.

From reactive to proactive

More than ever before, people are taking an active role in their own health. Well-informed patients are making healthier lifestyle choices and adjusting their diets. But their relationship with healthcare providers is still reactive. They feel ill or experience pain, and they call a doctor. Healthcare professionals struggle to take an accurate history of the patient and make their best estimation of the potential causes of the problem.

But some experts say that the first person to live to 150 years old has already been born. And with the ambition to live longer, more vibrant, healthier lives, the patients of the future will want to do more than solve problems when they occur. They'll want to address potential issues before they become problems, and stop genetic deficiencies in their tracks. Achieving these goals will require a proactive approach that includes using technology to take preventative action and achieve long-term insight.

The road to wellness

In the years to come, there will be a fundamental shift in the role of healthcare providers. Wearable devices and home sensors will allow real-time monitoring of vital signs, medicinal uptake, sleep, dietary changes and more. And with the wealth of data collected, healthcare professionals can monitor patients and ensure that issues are identified long before they have a noticeable impact on health and well-being.

The tech-savvy and health-conscious patients of tomorrow will welcome these new devices into their lives. After all, what better way to avoid the difficulties of long-term illness than to continuously monitor the body and receive alerts at the earliest signs of trouble? Patients will also form a new relationship with their physicians. Instead of dreading the bad news that often comes from a doctor's visit, patients will welcome the insights that will enable them to take early action on potential health issues.

Next-level patient care

Technologies like telemedicine and augmented/virtual reality (AR/VR) will transform the patient experience and reduce the fear and anxiety of medical visits. Patients will be constantly aware of their health status, and will be in more regular contact with the professionals who can guide them. Blockchain will keep patient records secure and transparent, and the Internet of Things (IoT) will provide all the devices and gadgets that make monitoring automatic and hassle-free.

Machine-learning technologies will allow patients to track their entire health history, recognize patterns and get alerts when something goes off track.

Other advanced technologies will transform human health as we know it.

Think, here, of "smart toilets" that measure nutrient and medicine uptake or wearable devices that track vital signs. Other technologies will augment human capabilities; Seismic's "Powered Clothing", for example, integrates robotics with its textiles to give users a discreet level of extra strength and stability when standing for long periods of time or climbing stairs. And we'll increasingly see virtual caregivers like Addison Care, which offers comprehensive health monitoring, daily reminders, monitoring and advice, and the ability to answer basic health questions and connect users to a physician 24 hours a day if the need arises.

Technology that transforms

Other advanced technologies will transform human health as we know it, from personalized medicines that are programmed for each patient's specific needs, metabolism and lifestyle, to babies born free of any preventable diseases. These developments will become realities not decades into the future but today.

Prellis Biologics is already addressing the need for viable human organs, using technology that produces biocompatible organs on a 3D printer. Biolumo is combating antibiotic resistance with technology that accurately diagnoses and distributes the right antibiotic to cure specific bacterial infections in both farm animals and humans. Bioserenity employs smart clothing, IoT and AI to diagnose, monitor and test solutions for those suffering from epilepsy.

The future of healthcare is human

The patient of 2025 will be better informed, more healthconscious and more self-motivated than any time in the past. And with the possibility of living well past 100, patients will reach out to the technologies that take the fear and uncertainty out of healthcare, and replace it with monitoring, education and support.

By embracing IoT, AI and machine learning, healthcare companies can become active participants in patients' long-term well being, instead of the bearers of bad news when illness remains undetected for too long. Chronic illnesses like obesity, diabetes and high blood pressure will cease to be life-long struggles as real-time insights enable patients and doctors to work together to resolve issues. Rather than waiting until symptoms are impossible to ignore, patients will heed the earliest warning signs and make better health decisions. Waiting rooms will shift from places of dread to bastions of hope.

the future healthcat is human

On the way to 150

The idea that, within the next generation or two, people will live healthfully and happily well past their 100th birthday is not just a dream, but a direct possibility. The capabilities of IoT, AI, wearables and sensors to transform human health are closer than we think. And the security of blockchain will ensure that patient records are more secure than ever before.

The result? A lifetime of healthy choices, preventative action and tailored treatments that ensure Vicky will not only enjoy her aunt's 105th birthday, but will be fully prepared to reach that milestone herself, with a vibrant, healthy body that's ready to run all the fun runs she wants.

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Tony Bosma (1973) is a futurist and trendwatcher. He is the founder of futuring and consultancy organization Extend Limits (www.extendlimits.nl). Extend Limits does not predict the future but helps organizations anticipate it. Do not ask yourself why things are happening. Ask yourself why hasn't it happened yet? This is the mindset companies need to adopt in this era of change.

Tony Bosma is an authority in future thinking and trendwatching and was nominated in The Netherlands several times for trendwatcher of the year. He is an internationally renowned keynote speaker. He is known for his confronting, inspiring, visually attractive and surprising sessions about a wide variety of topics. He also works for a variety of companies and governments, helping them anticipate the future and, more important, challenge and question today's world and mindset.

In collaboration with Cognizant, Tony Bosma did extensive research into near future trends across industries. Together with Cognizant, he made abstracts of the most dominant developments – not far fetched futuristic worldviews – but realistic developments which are seen right now. These are not only plausible future developments but also the challenges of technological developments.

An external perspective by futurist & trendwatcher Tony Bosma

Healthcare & Life Sciences **reinvented**

We are at a tipping point with our approach to healthcare and well-being. As we unravel the mysteries of the human body and mind, we look for ways to predict diseases, program cures into the human body, extend life and even defeat death. New technologies are making it possible to influence every aspect of life and health in the near future. We see unprecedented opportunity in the world of personalized medicine, DNA sequencing, synthetic biology, nanotechnology, wearables, robotics and genomics.

But while healthcare must, and will, change in unimaginable ways, innovations driven by technology are only as valuable as their impact on an individual life. More than ever, we need to embrace change while also remaining aware of the new challenges it will bring. To understand the future of healthcare and to really achieve improvement within the field, we must learn to be open to other insights instead of being mentally closed by our existing ones. The future of healthcare is not about making healthcare more efficient; it is to reinvent it, extend the borders and challenge the status quo.



We often read about the new "golden age" in healthcare as unprecedented technological opportunities become the hallmark of care. But the success of new healthcare principles and technologies also requires a change in perspective toward our living environments and our economic and social models that put an unprecedented strain on our mental and physical well-being. To improve health, we must focus on providing opportunity for everyone to realize happiness and peace of mind and reach their full potential. While this type of change is the most difficult to make, it will also be the most impactful on human health in the near future.

The past 50 years has introduced many changes in healthcare, including a longer average human lifespan and, just as importantly, improved well-being in those later years. The merging of medical science and technology makes the future of healthcare look bright; however, it's up to us to harness the promises of both. Which trends will have the most impact on the near future of healthcare? Well-known developments like telemedicine, virtual reality, augmented reality, Internet of Things,

blockchain, digital twins and wearables will change the face of healthcare in the coming decade. But there is more to come.

Connected healthcare

Societal expectations toward the performance of healthcare are growing every hour. Patients want information when they need it, demand transparency and loathe fragmented healthcare systems. They want to be in control of their own health, data and everything surrounding it. Rather than being forced to adjust to the healthcare system, they expect the system to be organized around them.

The healthcare consumer is increasingly an aware, educated and engaged individual who wants to take an active role in realizing his or her own health and well-being. This is giving rise to accessible self-care and innovative health services that offer professional expertise on-the-go and even at a distance. Connection is key, using tools that continuously engage individuals at the right moment with the right medical and personalized data and services.

Ageing is a triumph of development: people are living longer because of better nutrition, sanitation, healthcare, education and economic well-being. United Nations

Are algorithms becoming the new doctor?

While advanced technologies make all this possible, connected healthcare also starts with achieving digital health literacy, including the ability to think critically about healthcare information sources, services, products and apps – a challenge given the onslaught of information available today. Doctors can play a role in helping patients connect, with the rise of smart and autonomous algorithms, as well as other new technologies that help personalize information and services in healthcare.

Algorithmic healthcare

With increasingly intelligent algorithms, smart machines are becoming able to make decisions about clinical treatments, medicines and diagnoses. Are algorithms becoming the new doctor? Developments in artificial intelligence like deep learning and machine learning are also helping the medical world move from descriptive to predictive and even prescriptive care. Not only can algorithms diagnose diseases like cancer and cardiovascular illnesses, but they can also predict a mental breakdown or depression by analyzing our voice. Beyond a diagnosis, algorithms can also make predictions like length of hospital stay, chances of getting out of a coma or a patient's odds of dying. While most of these predictions still come from analyzing patterns in existing data, we'll eventually enter a world where algorithms will answer patients directly on what they should do before getting ill.

The rise of algorithms makes it possible for healthcare professionals to focus more on patient care. Rather than replacing them, it will improve patient care by making it more personalized, proactive and efficient. Doctors are likely to embrace smart algorithms because these medical professionals tend to favor using new technologies to improve their healthcare services.

Merge of technology with the human body

Remember Facebook's idea of telepathic typing, which involved typing with your mind instead of your fingers? The battle for our brains has begun, with tech organizations trying to connect the human brain to the virtual world. In this way, the human body is becoming the most important platform for the tech industry in the 21st century, from exoskeletons to smart sensors in clothes, our homes and even our bodies.

Technology is increasingly seen as a way to augment and even remake ourselves toward higher ideals. This idea isn't completely new – from wooden legs to glasses and hearing aids, humans



have tried to improve their biological bodies. Today, however, the approaches are growing more sophisticated. We want to fight the existing limitations of aging with new and improved technologies. This desire will stimulate the acceptance of the merging of technology with the human body.

Human life unraveled and reprogrammed?

Developments in the biosciences, combined with big data analysis, have led to a revolution in healthcare. It became possible to intervene in the human genetic code and even rewrite the disease genes embedded in it. What took evolution billions of years can now be undone in minutes. We can even synthesize life by creating unlimited variations of gene sequences.

Will we develop into super humans as we learn to control biological design and correct genetic deficiencies? There is cause for both hope and fear, and it's important to remember we've got a long way to go. In 2016, the first artificial cell designed in a lab revealed genes essential to life. It was the world's first minimal genome capable of supporting life but also showed that we humans still do not know the functions of many essential genes.

Although the path toward playing God is long and uncertain, we see the rise of DNA services in the field of healthcare. Unraveling human life and creating healthcare services for it will become a field of enormous growth in healthcare. This will be the future of health and will fundamentally challenge our way of thinking about being human.

Will we develop into super humans as we learn to control biological design and correct genetic deficiencies?

If we're already playing God, we're not doing a particularly good job of it. Simply streamlining what's already in nature doesn't seem very God-like and, if anything, is a very humbling exercise.

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A. Elfick, bioengineer at the University of Edinburgh, UK (2016)

Imagine, one day...

By letting go of our mental barriers, we can think freely about a possible future of healthcare. Imagine it's 2050, and hospitals no longer have patients. From the moment you are an embryo, you are analyzed. What is your DNA, and what will you look like? This can be changed at your parents' will. Which diseases are you prone to? The risk of acquiring them can be eliminated through gene editing. Spare body parts and organs can be printed if needed. Everyone knows what is best for them, as an individual, to eat and drink, which activities to participate in, what their talents are and how to prevent mental diseases. Pills containing miniature needles will painlessly inject drugs into places where treatment needs to be delivered. Healthcare is fully personalized and accessible to everyone. Everything you do is monitored and analyzed. Medical records are stored seamlessly, and personal health data has become a "currency" to pay for treatment and for companies to enhance personalized healthcare. Healthcare is fully organized to prevent disease. When you become ill, it is considered a failure in the healthcare system. Dying is a choice, and everyone is able to live on in the virtual world.

Is this an awe-inspiring or fear-inducing future scenario? What does the future of healthcare mean for basic human aspects like death, life, nature, freedom, privacy and ethics? Is technology transforming us into gods who are able to edit and change nature? Technological progress in healthcare is what we all want, but these new capabilities are catapulting us into an era when science fiction becomes a reality. Humans who will reach the age of 180 and beyond will become reality. What is the meaning of life if we cheat death? Just imagine!

Healthcare & Life Sciences reinvented **New challenges** and questions

The biggest challenge is how we as a society respond to all the new possibilities in healthcare – possibilities that will change the essence of being human. When we can predict and even influence nature and human development, we will be changing human life. How will we deal with the revelation of the new unknown?

The future of health will be influenced and driven by new innovations in technology, but the future of healthcare will equally be shaped by the human response to each new form of progress.

The big question of this era is: ethics or innovative health technology, which comes first? There are now four cryogenic facilities on this planet, where the richest people in the world can have their bodies cryogenically preserved until medical science is able to revive and resurrect them. Algorithms that cannot be understood by patients and their doctors are having an enormous impact on decision making.

These are just two examples of technological progress and innovation within healthcare that are already raising ethical questions. Because technology doesn't police itself, it requires human intervention in the form of attention, discussion and new regulations.

Can we allow normal citizens to interpret their medical information?

Regulators are becoming more aware of the ethics and questions involved with the field of future healthcare. This future is data-intensive, but who owns the data? Our lives are being logged in meticulous detail, which results in an enormous amount of personal health data. This data gets into the hands of only a few powerful companies.

Although new regulations like the GDPR give citizens more control over their data, there's still a large imbalance and massive power inequality between the companies that collect and use data and those whose data is being used. To what extent can this go on in our fight against getting ill? Patients will need to decide in the near future to what extent they want to be predicted, edited and monitored.

With the ever-rising availability of medical data and selfdiagnosis, patients will receive medical information on their own. With this, they can ultimately make treatment decisions by themselves, all without consulting a medical expert. Misinterpretation and misinformation are becoming serious threats to public health when the doctor is no longer needed. Algorithms aren't sophisticated enough to prevent or deal with this. Can we allow normal citizens to interpret their medical information? Since it's already impossible to prevent, what will the future bring?

Other important questions include the race toward longevity, creating enhanced humans and, of course, security. Longevity will have an enormous impact on our social systems. Will we be

able to support the growing number of people 150 years old and beyond? Is it desirable for humans to be able to replace healthy body parts with technological improvements? Will humans who aren't technologically improved be considered disabled? Will we be able to hack our own bodies and design our babies? With the merging of technology with the human body, the importance of security grows. Where does science and technology need to stop or be stopped? Or should there be no brakes put on scientific progress in healthcare?

The list of ethical issues will grow by the hour in today's fastchanging world of technology and science. Public awareness and ethical debate will need to begin, and we all need to be prepared for what's to come. The biggest risk is failing to keep up with all the technological advancements. The biggest challenge is to create real human progress for everyone and to make a clear distinction in what we technologically and scientifically can evolve and what we want to evolve. What do we need to live as humanly and healthfully as possible, in a way that is meaningful, economically secure and even fullfilling. What is our definition of enhanced and better living?





Where does science and technology need to stop or be stopped?





The future is already here

Many healthcare startups are working to reinvent the industry through technology. We're seeing the industry shift from a reactive system, in which people seek medical help when they get sick, toward a fully predictive healthcare network. We're moving from being diagnosed by doctors to being diagnosed by algorithms in cooperation with doctors. Rather than being physically present in waiting rooms, we're moving toward virtual analyses. With the worldwide aging population, chronic disease will still be on the rise despite advancements in defeating more diseases through gene editing genes. This will result in a change in focus from cure to care – on well-being. Medical devices will become nanoscaled, and healthcare itself will become democratized and accessible. Patients will gain insights more quickly than their doctors. This transition in healthcare will take many years to realize. The biggest challenge will be to use technology to humanize healthcare rather than treating patients like machines that need to be monitored and checked.

From:	То:
Reactive	Prescriptive
Hospital (waiting room)	'Home-spital' (living room)
Treatment	Lifestyle
Wearables	Inside-ables
Diagnosed by doctor	Diagnosed by algorithm
Heal/recovery	Quality of life
Healthcare silo	Clinical 360-degree intelligence
Symptom-driven	Data-driven
Specialists	Networked



The following cases are inspirational and show how healthcare is changing. Startups and new innovative ideas can grow but also fail fast – that is innovation at the frontiers of an industry. (No business relationship exists between the cases below and Cognizant.)

Electronic caregiver

Electronic Caregiver is a health monitoring and support system that operates in the homes of elderly people. The company has developed a smart algorithm, Addison, that continuously monitors people, and asks basic questions about their health and well-being. Addison can remind users to follow through on nutrition plans, take their medication, check their vitals, connect them 24/7 with a medical professional and provide assistance during emergencies. www.electroniccaregiver.com

Prellis Biologics

Prellis focuses on addressing the unmet medical need for viable organs and tissues by developing lab-grown human organs and tissues. The organization has developed a solution to print any 3-D structure from a computer-aided design file. Engineers and cell biologists at Prellis have demonstrated several applications of ultra-fast biocompatible 3-D printing like stem cells and neurons. **www.prellisbio.com**

Biolumo

Resistance to antibiotics is an ever-growing issue, even appearing on government agendas. To address this problem, Biolumo's technology makes a precise medical diagnosis and prescribes antibiotics/medicines adjusted to the patient's needs. As a result, treatment of a bacterial infection becomes faster and more efficient, without the dangers that accompany inappropriate antibiotic dosage.

www.biolumo.eu

Bioserenity

Bioserenity uses technological solutions to diagnose, monitor and conduct clinical trials for people with epilepsy. The company uses smart textiles, remote diagnostics, AI and the Internet of Things (IoT) to conduct long-term recordings and diagnostics to reduce the patient's burden.

www.bioserenity.com/en

Technology changes **all the time;** human nature, **hardly ever**

Evgeny Morozov

Openwater

Openwater is focused on making diagnostic imaging tools, such as MRI, PET and CT scanners, more portable and widely available. Its goal is to enable continuous monitoring of the human body with high-resolution images. Longer term, the company is working to make it possible to read and write thoughts by connecting minds directly to each other and to digital networks.

www.openwater.cc

Seismic

Seismic creates powered clothing that integrates smart robotics in a discrete way. The clothes help people move better by working in collaboration with the wearer's body. Seismic's technology mimics the biomechanics of the human body and gives users – typically the elderly – discrete strength when doing daily routine movements like standing or walking.

www.myseismic.com

Insilico Medicine

Insilico focuses on developing alternatives to animal testing for research and development programs in the

pharmaceutical industry. Through AI and deep-learning techniques, the company can analyze how a compound will affect cells and what drugs can be used to treat the cells, in addition to possible side effects.

www.insilico.com

The future is human

Humans excel at being creative, in seeing, identifying and investing in opportunities, and solving problems. Our human emotions – anger, sadness, love – will drive the future of healthcare. The biggest benefit technology can offer us and our organizations is to help us emphasize our most basic and strongest human skills, which will never be digitized.

Let's be curious about the future, not fearful. Let us, as a society, create and discover new rules and norms. The future is not about making the present more efficient but about reshaping it – something only humans can and will do.

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- 1. Put customers in control of their own data, and enable them to utilize it their way.
- 2. Put digital ethics and data responsibility at the heart of your business.
- Use technology to empower patients and practioners in healthcare, not to make them obsolete.
- Do not overestimate the impact of technology, and do not underestimate the power of human contact in healthcare.
- 5. Transform healthcare silos toward platforms, and from people serving the healthcare structure toward networks serving patients.
- 6. Prepare for a smart digital world of prediction and prevention.
- Digitization isn't a goal in healthcare; it is a supportive solution.
- 8. Use technology to empower patients and give them control over their lives and healthcare solutions.

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ABOUT COGNIZANT

Cognizant (Nasdaq-100: CTSH) is one of the world's leading professional services companies, transforming clients' business, operating and technology models for the digital era. Our unique industry-based, consultative approach helps clients envision, build and run more innovative and efficient businesses. Headquartered in the U.S., Cognizant is ranked 193 on the Fortune 500 and is consistently listed among the most admired companies in the world.

Driven by a passion to help our clients build stronger, more agile and more innovative businesses, we enable global enterprises to address a dual mandate: to make their current operations as efficient and cost-effective as possible and to invest in innovation to unleash new potential across their organizations. What makes Cognizant unique is our ability to help clients meet both challenges. We help them enhance productivity by ensuring that vital business functions work faster, cheaper and better. And, our ability to conceptualize, architect and implement new and expanded capabilities allows clients to transform legacy models to take their business to the next level.

Learn how Cognizant helps clients lead with digital at **www.cognizant.com**

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