

ARTIFICIAL INTELLIGENCE IN HEALTH

AI will have a far-reaching positive impact on health-care. And international collaboration is the best way to ensure that impact is global and the solutions we develop are universally relevant.

Connecting Innovation Worldwide

Dear world



Dear reader,

It is our pleasure to present this third edition of the Netherlands Innovation Network magazine on Artificial Intelligence (AI) taking place across the 17 countries worldwide where the Netherlands Innovation Network is active.

In the Netherlands, we have launched a strategic AI action plan where we work together closely with a public-private national AI coalition of over 380 representatives from research, business and government. This special focuses on AI in Health, which the coalition has identified as an AI priority sector for the Netherlands.

Insights and overviews

In this special you will find contributions from the Ministry of Health, Welfare & Sport, and various representatives of our national AI coalition. The magazine also focuses on the current COVID-19 crisis, which digital solutions like AI can help us to address.

The Innovation Attachés have an important trend-watching role and here provide an overview of the scientific and technological developments in the countries where they are based across the world.

The Netherlands Innovation Network is there for you: for companies and knowledge institutes of every sort and size, and from every sector. So I encourage anyone with ambitions in the field of international innovation, research and collaboration to contact our attachés with whatever questions or needs you may have.

Sources of inspiration

During 2021, we will be organizing (online) innovation missions on AI, including to France (25-27 January) and Japan (3-5 February), with AI in Health as one of the main topics. More information can be found on the RVO website: www.rvo.nl

On behalf of the Netherlands Innovation Network, I hope this magazine can help you discover new possibilities and launch future collaborative success stories that we can report on in later editions.

All the best,

Focco Vijselaar
Director General Entrepreneurship and Innovation
Ministry of Economic Affairs and Climate Policy

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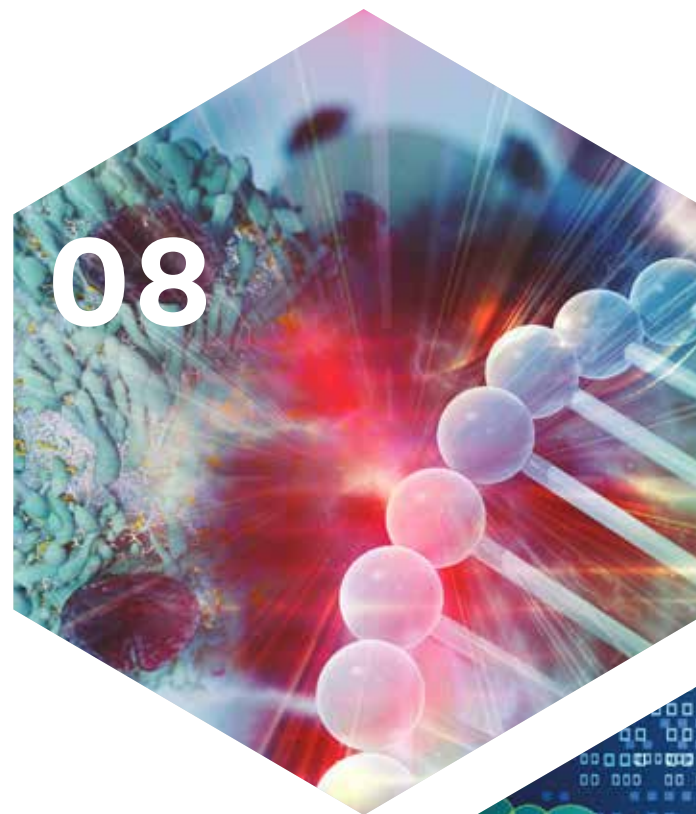
Nico van Meeteren

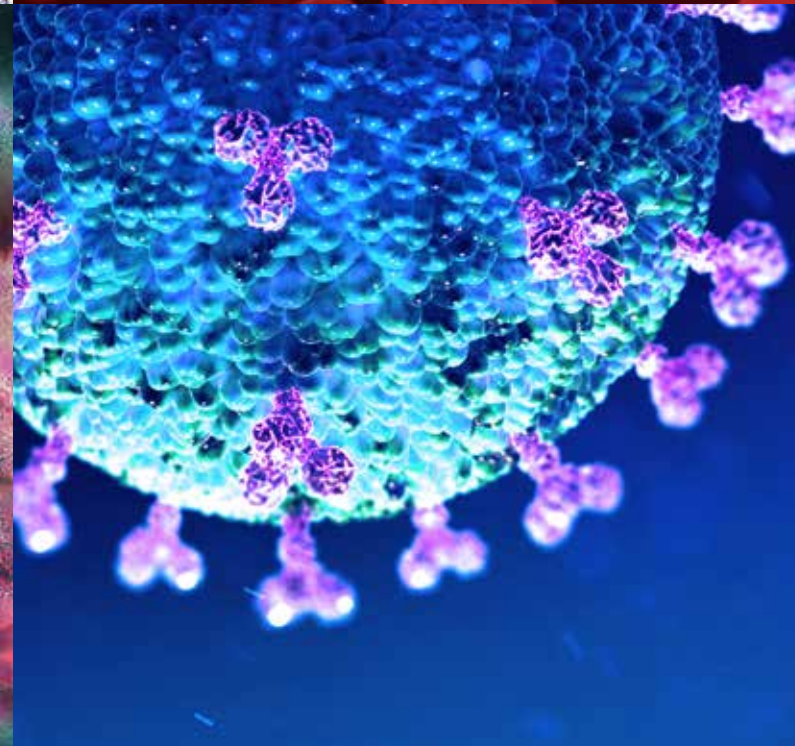
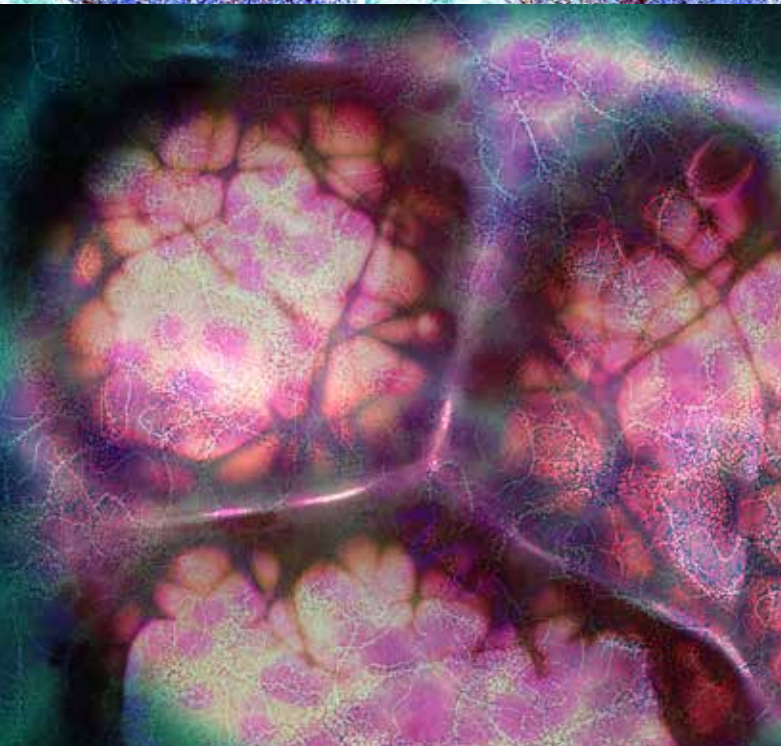
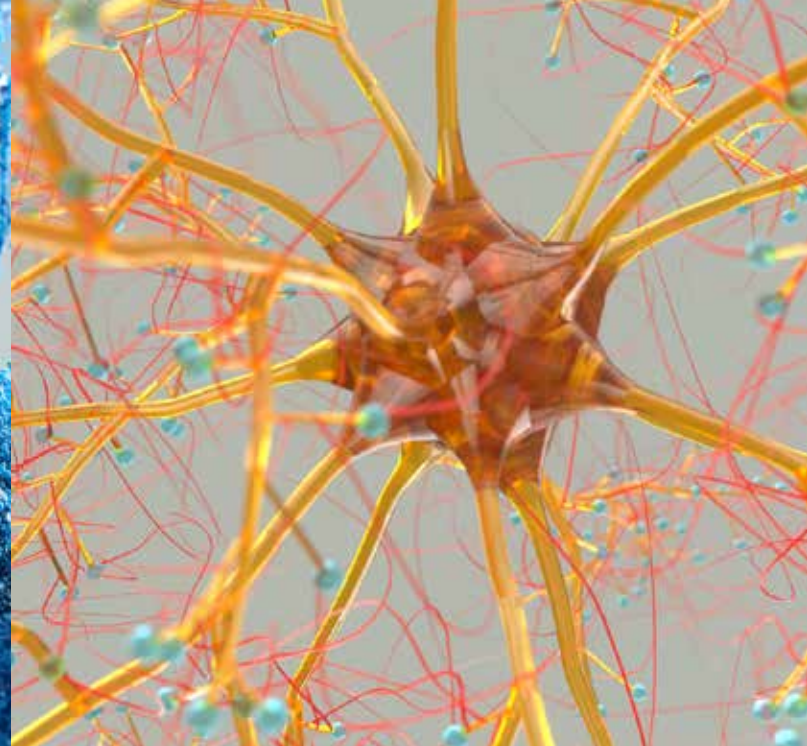
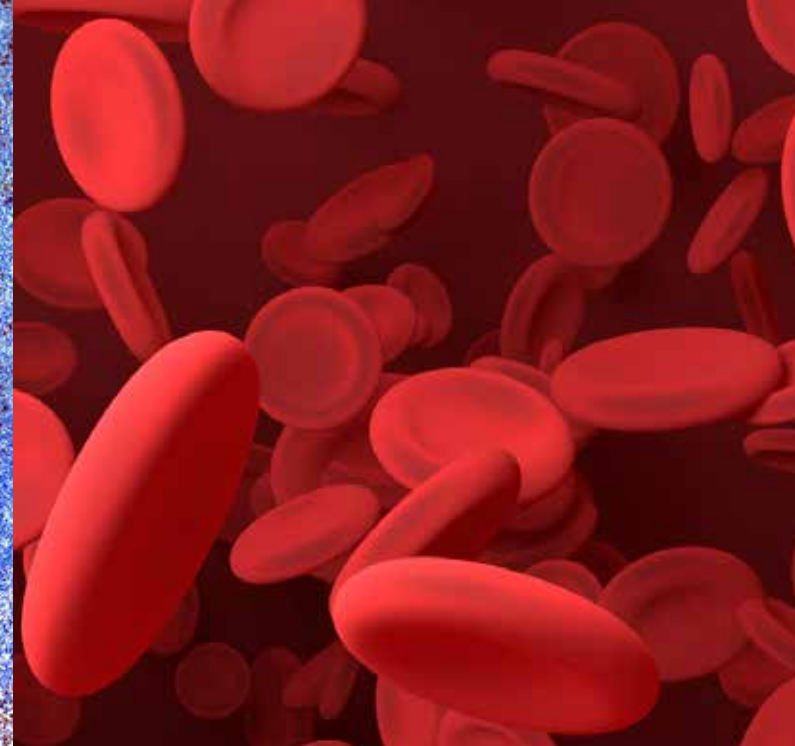
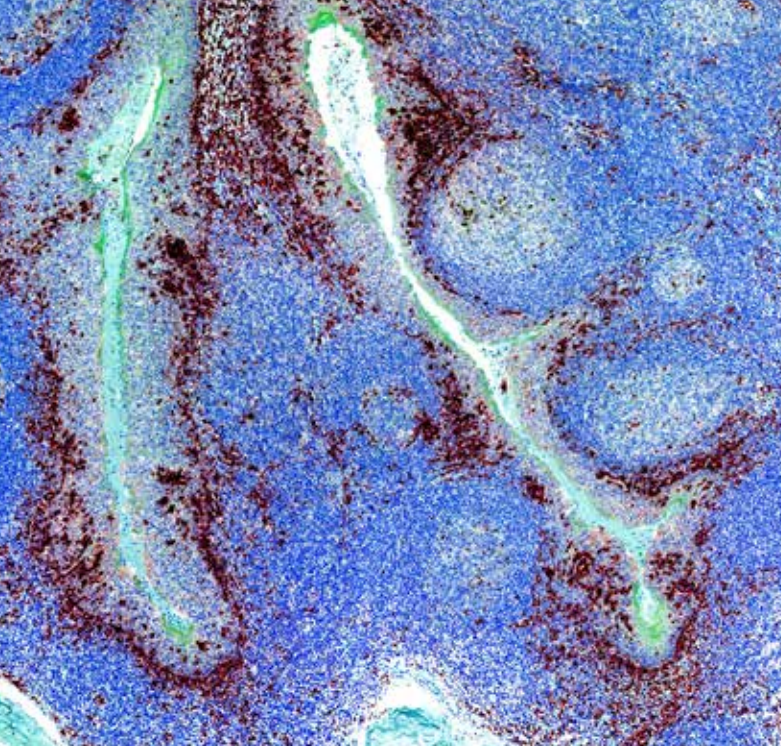
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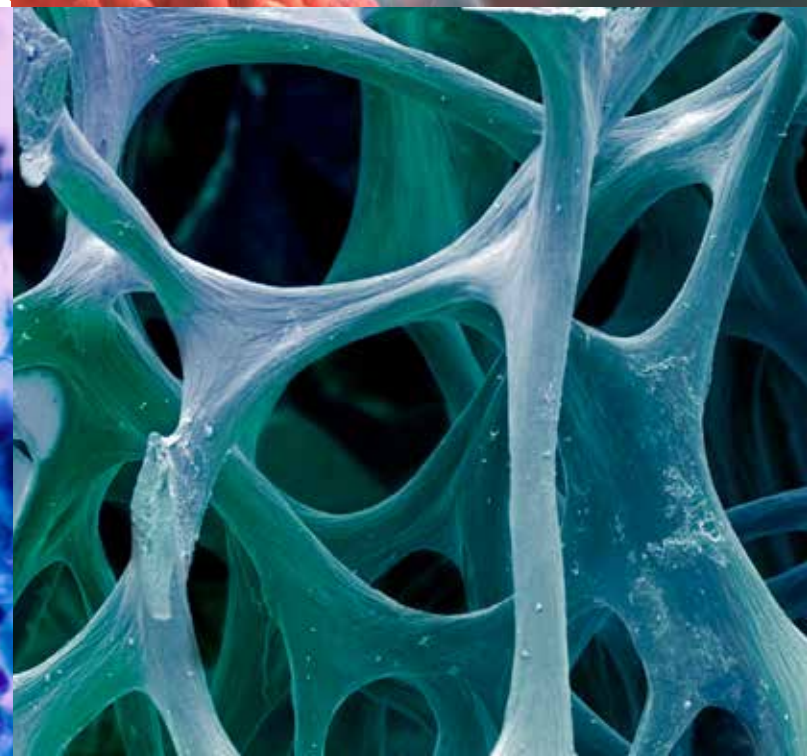
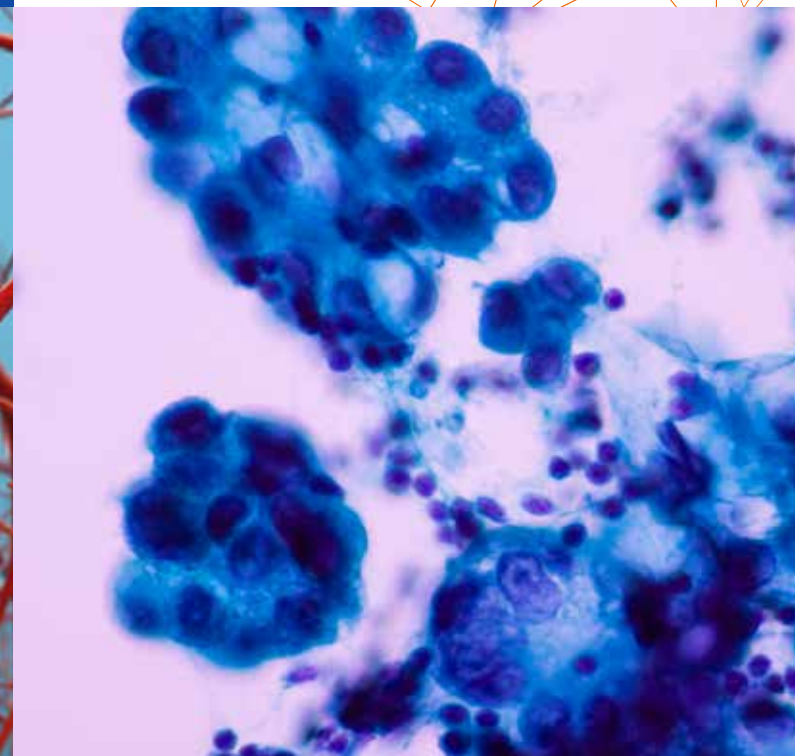
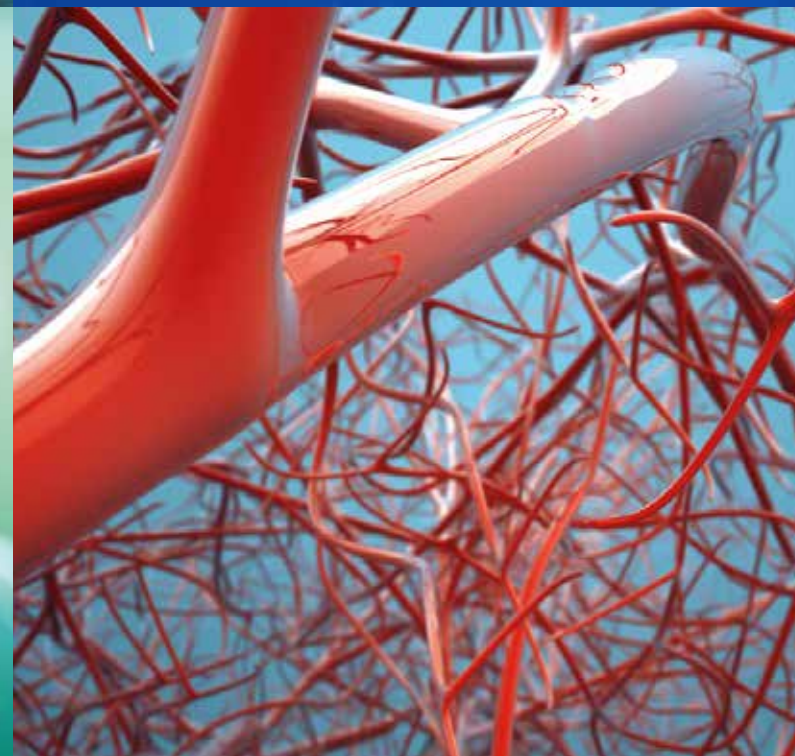
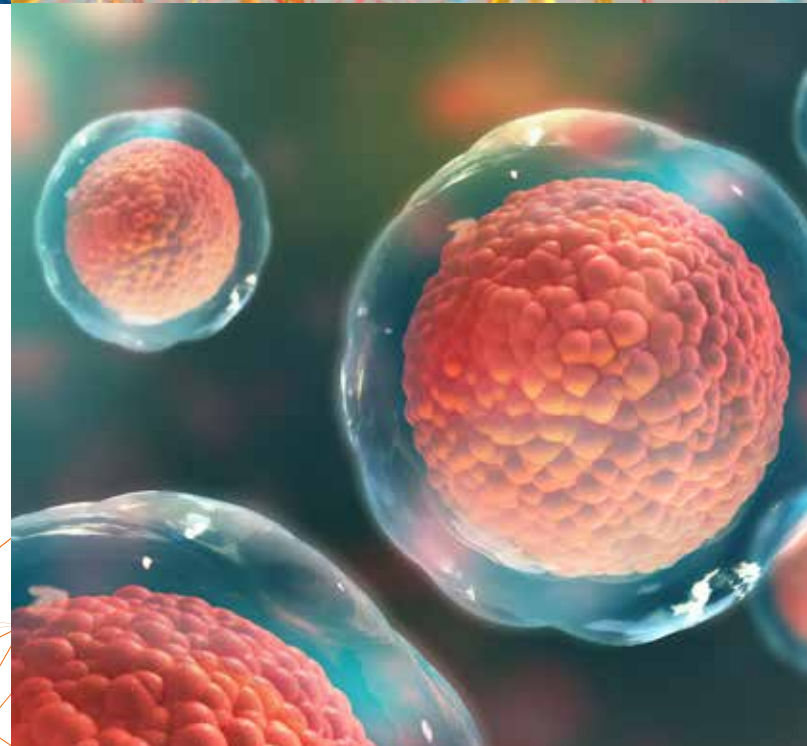
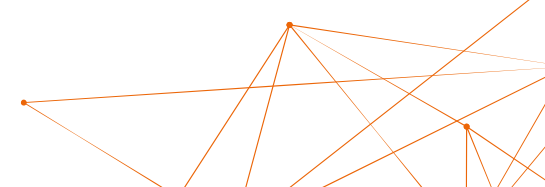
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Throughout this special, we use LSH as an abbreviation for the Life Sciences and Health sector.





Pieter Jeekel
Chair of Healthcare taskforce
of the Dutch AI Coalition

From innovation to transformation

How the Dutch AI Coalition healthcare taskforce aims to scale-up innovation today and prepare the ground for new innovations tomorrow.

As chair of the recently-launched Healthcare taskforce of the Dutch AI Coalition, Pieter Jeekel's role is to help put in place an infrastructure that can identify the most promising Dutch AI solutions and help them scale up and become adopted across the country. Here he discusses the importance of such a coalition, its role and where he believes the future lies.

Though it's early days, the AI Coalition has already hit the ground running. "We only launched our taskforce in April but are delighted to already have over 200 participants, covering all the relevant stakeholders in the Netherlands: care providers, hospitals, universities, knowledge institutes, startups, scale-ups, corporates, investors, funds, ministries and government."

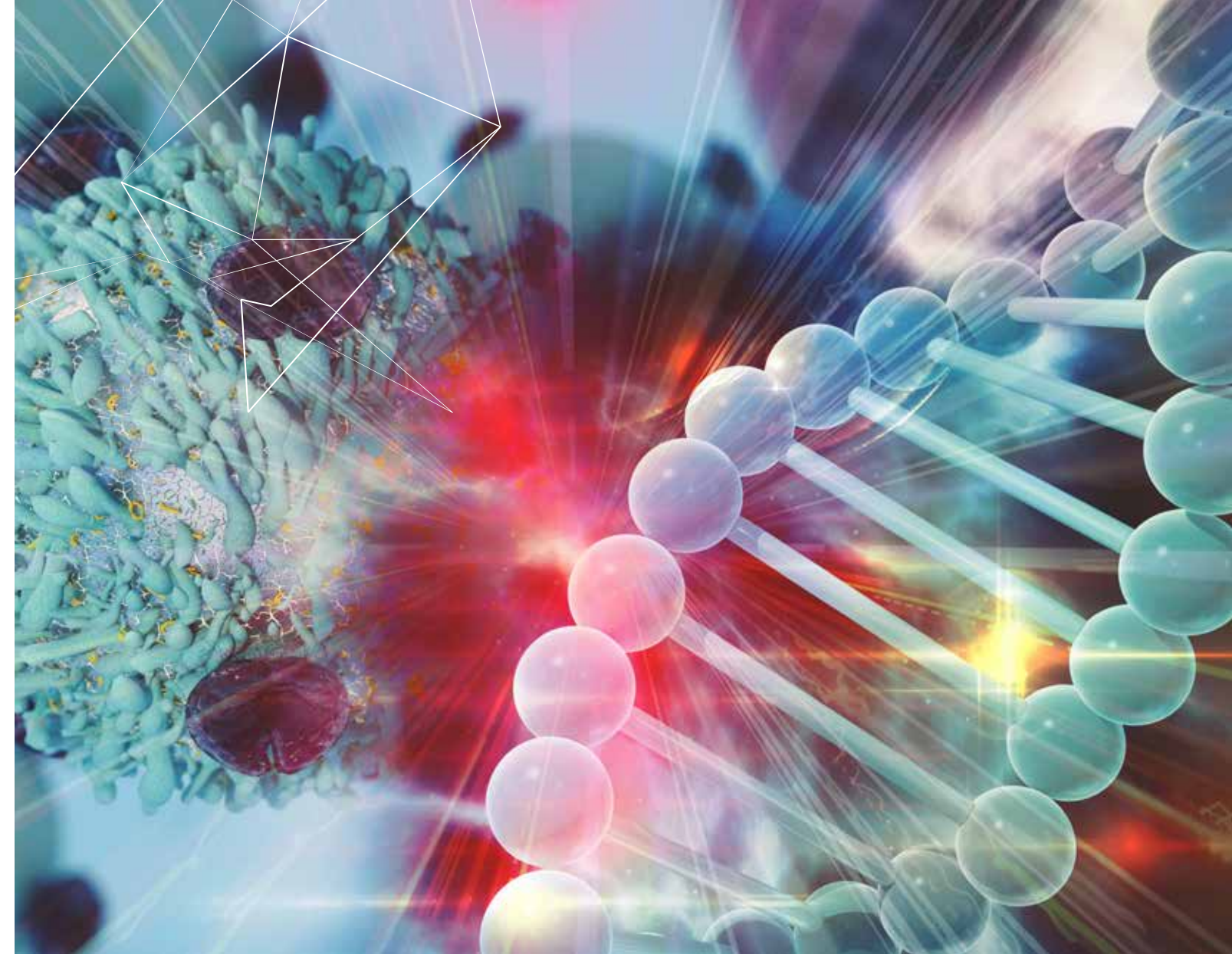
Within the taskforce, Pieter and colleagues have set up eight teams charged with transforming the AI climate in the Netherlands, and identified three initial use cases to help scale up: Pacmed Critical (aimed at improving

intensive care), MS sherpa (digital biomarkers to help MS patients) and U-Prevent (personalised medicine). "We see huge possibilities both to help scale-up these projects and to change the playing field so it becomes easier for others to follow them."

"The Netherlands is too small to go it alone, even if we wanted to."

Harnessed scattered potential

Pieter believes the right AI innovations can have an increasingly positive impact on citizens' health and healthcare, strengthen care providers, help transform the Dutch healthcare system and consolidate the Netherlands' competitive position. "We have a lot of AI expertise in the country: in universities, knowledge institutes, hospitals, care providers, as well as startups, scale-ups and major companies. However, that knowledge is scattered across the country and will mostly stay local if we don't coordinate, squandering its potential. We want to positively impact the health of our citizens and state of our healthcare system. The AI Coalition will help us address the technical, data-related, ethical, legal and social barriers and opportunities around scaling up valuable AI solutions. Funding and subsidies are also scattered and must be channelled to create maximum leverage. There's also a need to develop a strong health data infrastructure."



The AI Coalition can also play a crucial role in advancing the Netherlands' prospects internationally. "AI innovation is spread across the world and the Netherlands is too small to go it alone, even if we wanted to. So it's vital in this phase that European countries, for example, exchange valuable innovations so that we can economically scale-up, grow and innovate in order that everyone reaps the healthcare benefits."

Making connections

The AI Coalition is equally innovative in how it defines healthcare and looks for solutions. "As a coalition, we know prevention and healthy living play an increasingly prominent role in innovative healthcare. So we're making connections across ministries and recently, for example, set up a joint team from the AI and Agro/Food working groups to gain more focus and traction in this area."

One of the key roles Pieter sees for the AI Coalition is as 'spokesperson' and 'orchestrator'. "Alongside facilitating innovation and enterprises, we'll give our stakeholders a voice."

And finally, what role does Pieter see for the Innovation Attachés? "We're amongst the world's frontrunners in AI and healthcare, with exciting solutions and ideas in everything from oncology, radiology and pharma to primary care, prevention and lifestyle. Almost all these solutions and innovators will benefit from international collaboration. If the IAs can contribute to bringing together our businesses and institutes with potential partners in their countries, they'll be doing a great service to the Dutch economy and global healthcare."

Get in touch

As the article makes clear, Pieter Jeekel would love to hear from anyone wanting to discuss these issues or possibilities for collaboration. You can contact him at

gezondheidszorg@nlaiic.com



Wiro Niessen
Professor of Biomedical Image Analysis
at Erasmus MC and TU Delft

Harnessing the power of data

How data-driven technology will enhance quality of care.

Drawing on 25 years' experience in the field, Wiro Niessen describes the Netherlands as a “frontrunner” in the increasingly vital area of data-driven healthcare: the expertise is there, the commitment to collaborate is there. But still he feels we have a way to go before we start to leverage the huge potential data science offers patient care.

Data science is obviously dependent on the quality of its data, which in turn depends on institutes integrating their data and therefore collaborating closely. As Professor of Biomedical Image Analysis at both Erasmus MC and TU Delft, Wiro has been closely involved in merging the work of technical universities and academic hospitals.

“TU Delft and Erasmus MC are a good example of two institutes strengthening their relationship. Universities and hospitals have very different academic cultures, but we're gradually developing common research, innovation

and teaching agendas to ensure data science can support healthcare as effectively as possible. But to make progress you really need to work in multi-disciplinary teams, sharing lab facilities and data infrastructure. Our ecosystem is good but could be better.”

Strengthening networks

At a more strategic level, Wiro feels we must work towards a national healthcare data infrastructure where all relevant parties are providing and using data for research and innovation, from research institutes to insurers. He cites Covid-19 as a case in point. “To treat tomorrow's Covid-19 patients more effectively, we need to group the data from every hospital that's treated Covid-19 patients to date. And that would require a better health data infrastructure than we currently have.”

How can the Netherlands Innovation Network help? “Globally, we need to make a coordinated effort to lower barriers to collaboration and data sharing. I'm not sure how, but if the Innovation Attachés can contribute in any way to strengthening international networks, by connecting the right people so we can align different initiatives and regions, then they'll be helping create a better environment for healthcare innovation to flourish.”

Time to accelerate

While he doesn't doubt the Dutch government's commitment, reflected in initiatives like the Life Sciences and

Health Top Sector, Wiro feels more could be done. “The Netherlands invests poorly in health data infrastructure compared with many European countries. It's ironic, as we're renowned for our world-class physical infrastructure; but the economies of the future will rely on a virtual, data-driven infrastructure. So that increased investment is urgently needed.”

Another area where Wiro feels the Netherlands could do more is cross-governmental collaboration. “The ministries responsible for health, education and economic affairs are collaborating, but things are moving too slowly. They need to embrace a common roadmap for data-driven healthcare in order to support researchers, educators and business. After all, any investments the government makes here will deliver a massive Return on Investment in terms of quality of care, level of research and economic activity.”

“The Netherlands is renowned for its physical infrastructure, but the economies of the future will rely on their virtual infrastructure.”

Wiro's 3 future data-driven trends

1. Precision medicine

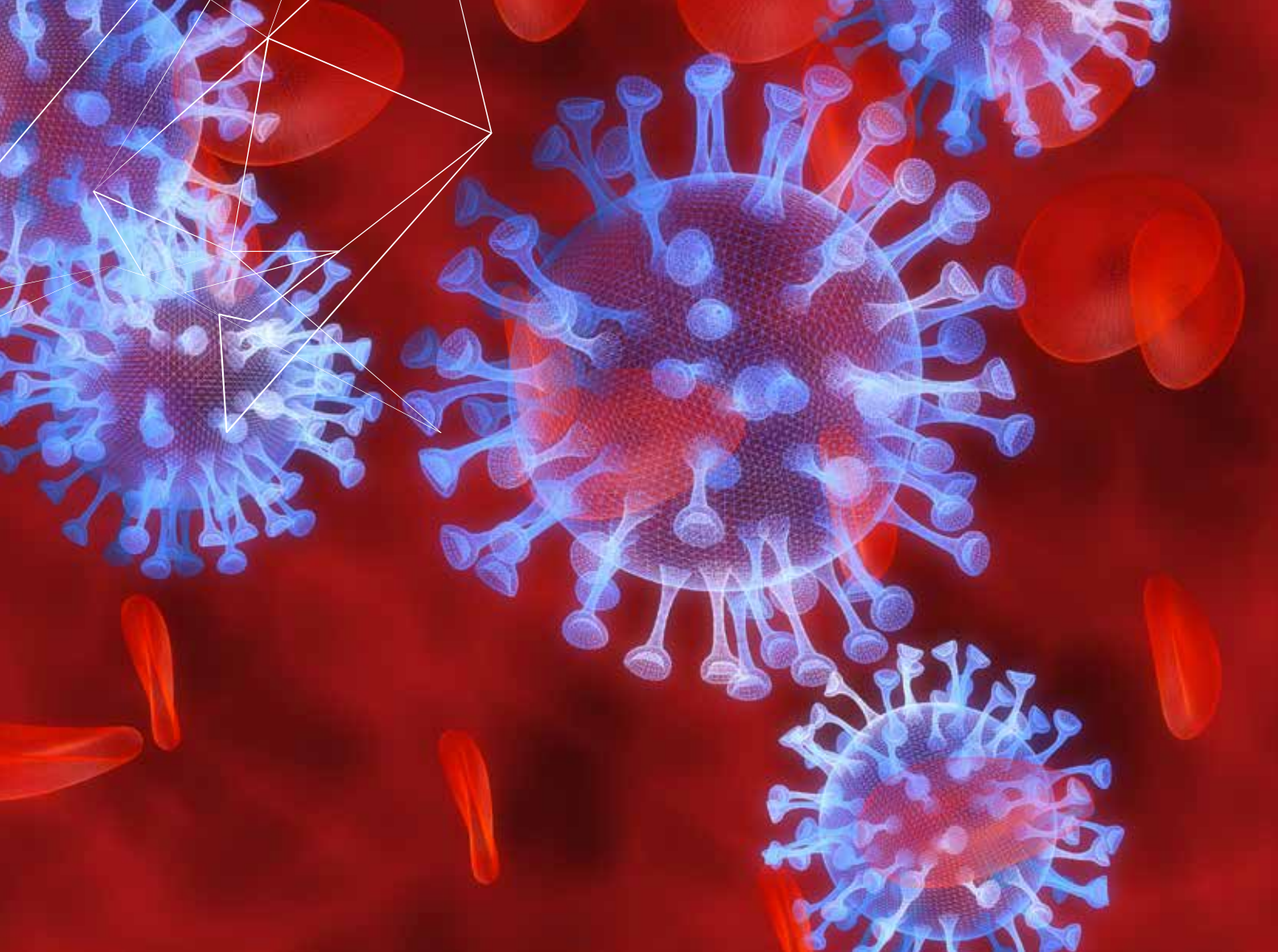
Advances in data-driven healthcare will enable us to treat patients in a more personalised way, by developing models that identify which treatments will be most effective.

2. From reactive to proactive

Today we generally have to wait till someone is ill and then try to cure them. Better models will mean we can intervene at an earlier stage, before the patient shows any symptoms or even before they become ill.

3. More local and online healthcare

Healthcare will increasingly be provided more locally and online, with people only visiting GPs and hospitals once it's already been established a visit is necessary.



A good pathfinder clears the way for progress

Ron Roozendaal, Director of Information Policy and CIO at the Netherlands' Ministry of Health, Welfare & Sport, took a moment out from the pressures of the Corona crisis to reflect on the government's role in driving technological innovation in healthcare and what's needed from the sector itself.



Ron Roozendaal
Director of Information Policy and CIO
at the Netherlands' Ministry of Health, Welfare & Sport

"Healthcare in the Netherlands is delivered privately, which means it's private parties who will use AI to improve treatment or research. The government's role is to help the sector do that, and identify and remove obstacles that get in the way of progress. For example, through legislation or by reassuring sections of the public concerned about the use of data for AI."

Crisis as catalyst

Ron is closely involved in his government's response to Covid-19. For example he led the development of its Corona app. So he is seeing first-hand how a crisis can accelerate innovation. "A private healthcare sector uses many different IT systems. The resulting lack of interoperability makes dataflows less easy than in a more centralized public healthcare system."

"Before Corona, we were developing legislation to require, step-by-step, greater interoperability between healthcare institutes. But when during the pandemic patients started being transferred to less busy hospitals, Philips helped introduce a nationwide secure 'dropbox' for transferring patient images and records where the data can only be sent, received or accessed by the two hospitals in question. The system was developed within a week and implemented by almost all hospitals in just two weeks."

Interoperability vital

Ron sees interoperability as vital not just for dataflows, but innovation in general. "It's critical to create a common ground on which innovation can flourish. Suppose a startup develops an innovative healthcare product. It can only enter markets where it's compatible with the system(s) used. The Netherlands is therefore an active member of the intergovernmental Global Digital Health Partnership which, amongst other things, focuses on improving the flow of data and use of IT in healthcare worldwide. This includes working towards universal standards, use case by use case. And in the Netherlands, we then enforce those interoperability standards by law."

Ron's ministry also runs various initiatives to drive and encourage innovation in the healthcare sector. Like the Healthcare Innovation School, where healthcare workers learn how to innovate, and different seed funds that have been set up to support healthcare tech startups and scale-ups.

Innovation thriving

Ron feels the Netherlands is well-positioned to seize the opportunities offered by the emerging AI in healthcare global market.

"First, the upside of our private healthcare system is that institutes can go direct to tech companies with their needs, without having to wait for government approval or a civil servant to take the lead. Secondly, we have thriving clusters, for example around Eindhoven and Amsterdam, that are catalysing innovation. Thirdly, we have a government able and willing to create the legal and standards framework to facilitate product development. And finally, we're very active internationally at European and global levels."

"It's critical to create common ground where innovation can flourish."

Obviously it's not all rosy. "Unlike the US, for example, Dutch doctors don't do a science degree before medical training, so we need to somehow include innovation in their education. Secondly, like many countries, we're struggling to find an optimal way to facilitate scale-up. So if there's a successful introduction or pilot of some AI technology in one hospital, how do we get other institutes to adopt or trial it?"

Culture gap

Ron contests the view that the Netherlands has a poor digital infrastructure. "I think we have the infrastructure. The question is, are we using it effectively? For example, our system is fixated on the importance of physical contact between patient and carer. How do we get doctors and patients used to the idea that effective healthcare can be delivered remotely, as-and-when needed; and not just at pre-planned times in expensive purpose-built buildings. And the doctor or nurse who shops online in the evening doesn't question using a fax at work. There's currently a cultural gap between what's happening in the 'real world' and what happens in healthcare."

Effective support

Ron is proud of the Netherlands Innovation Network. "They're very effective in helping our thriving community of innovators get their feet on the ground in other parts of the world. And if we can develop internally-agreed standards, the Innovation Attaché can also help healthcare tech parties from abroad collaborate with Dutch companies and institutes, so that technology becomes available to the Dutch healthcare sector."





Nico van Meeteren
Professor at Maastricht UMC and
Executive Director at Health-Holland

Even the best in class can still do better

Nico van Meeteren, professor at Maastricht UMC and Executive Director at Health-Holland, is ideally positioned to assess the Netherlands' position and prospects when it comes to innovation in Life Sciences & Health. For the government and other Dutch stakeholders, the picture he sketches should be both a source of pride and a warning against complacency.

From oncology to physiatry, medical devices to elderly care, the Dutch are global top-3 players in many areas of healthcare innovation. Nico van Meeteren puts much of this down to some very traditional Dutch values.

"First, collaboration is deep in our culture: over the last 20 years, innovation in a number of areas has been facilitated in the Netherlands by a strong programmatic alignment at a national level across industry and research institutes; and we also have a track record in establishing successful Public Private Partnerships. Secondly, we have a reputation worldwide for open-mindedness: be it euthanasia or sexuality, we approach social policy issues rationally. Thirdly, Dutch healthcare

products and services are tried, trusted and in-demand: the government puts healthcare technology exports at €5.4bn; I reckon the true figure is ten times that. Combined, these three factors mean that for anyone initiating a major innovative healthcare project, the Netherlands is the go-to country to find partners."

In-the-box thinking

As an example of that mix of innovation and fresh thinking, Nico cites the Personal Health Train, which breaks through the usual concerns about privacy and healthcare data through one simple but ingenious step: instead of bringing data to the means of data analysis, it brings the analysis tool to the data. So the person or organization whose data it is controls who can access which elements of their data and for what purposes. "This really is a game-changer, which is why major bodies like the EU and WHO see it as the future. And it's the product of a collaboration between a number of Dutch research institutes applying what I call 'in-the-box thinking', as you have to be operating within the system to effect real change."

Nico praises the role of the Dutch government in all this. "I think it's impressive how our government has integrated healthcare, agriculture, energy transition and other key policy areas into a mission-driven national experiment. However, it could do more to communicate this to the public. Many citizens are already doing their bit, through care for elderly relatives, home solar panels or whatever. The government needs to harness that engagement to generate widespread enthusiasm for this national project."

"For anyone initiating an innovative healthcare project, the Netherlands is the go-to country for partners."

Success narrative

Nico would also like to see the government do more to develop a 'success narrative' around what's being achieved in healthcare. "Healthcare is always seen as expensive, but as experts like economist Mariana Mazzucato argue, it's actually a huge economic engine and in Netherlands' case a key part of our 'brand' as a nation."

Nico feels the Innovation Attachés are doing a great job but has two requests. "As well as hearing from us the areas where we seek potential partners, Innovation Attachés could brief us better on which companies and knowledge institutes in their country are looking for collaborations, and in which areas. It'd also be great if Innovation Attachés could work with ministries and others to develop an overview of Dutch innovation successes around the world, which could work as a handy resource and a great marketing tool." As Nico confirms, they won't be short of impressive stories.

Trends in healthcare: Nico van Meeteren's '5 to watch'

1. Perceptions of prevention

In 150 years, life expectancy in the Netherlands has risen 40 years, largely thanks to preventative healthcare in everything from education to urban planning. There are many gains still to be had, for example by reducing air pollution or improving diet, but we'll need to market the preventative success story better so people realise its importance.

2. Clicks replacing bricks

Experts agree that many hospitals will close in the coming years. Partly due to demographics but also because new technology will help us manage healthcare data remotely. Insuring, for example, we only visit a GP or hospital when really necessary.

3. Lifestyle-friendly technology

New technology will increasingly provide healthcare that doesn't compromise a patient's participation in society. For example, we've had dialysis machines for 70 years, but till recently they've required patients attending hospital 3-4 times a week. Self-administered dialysis machines enable overnight home treatment so patients can, for example, continue working full-time.

4. Rethinking dementia

Ground-breaking experiments, such as in Weesp in the Netherlands, are showing how people with even relatively severe dementia can remain in the community, hugely improving their quality of life, provided the community is aware of these patients and their (minimal) additional needs in everyday situations such as visiting the supermarket.

5. Merging formal and informal healthcare

In the Netherlands, there are some 1.2 million formal healthcare workers and 3.8 million informal healthcare providers. Currently, the two systems run largely in parallel, but we're now starting to merge them through initiatives such as the Personal Health Train. This will have a major positive impact on healthcare quality, efficiency and costs.



**“IF YOU HAVE HEALTH YOU
PROBABLY WILL BE HAPPY,
AND IF YOU HAVE HEALTH
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ALL THE HEALTH YOU NEED,
EVEN IF IT IS NOT ALL YOU
WANT.”**

ELBERT HUBBARD

A thriving collaborative ecosystem built on unique medical databases

Digital Health's roots in Israel go back over 20 years to the revolution in biological sciences. It got a boost a decade later when Israel set up a national agenda on cybersecurity to protect critical infrastructure and data. Then a couple of years ago, Israel launched its national AI agenda, aiming to build on and match its cybersecurity success story in the AI domain.

Strong data infrastructure

Israel has a well-developed medical data infrastructure. The country's 4 Health Medical Organizations (HMOs) insure the population, maintain electronic medical records (EMRs) with data going back more than 20 years, and make investments in medical AI technology.



Vascular bifurcations background.
Shallow depth of field 3d render.
Source: Getty Images.



The country has a booming medical AI-startup sector

For example, one of the HMOs, Meuchedet, has incorporated technology developed by American Well, a telemedicine company in which Philips has invested. While Israel's university hospitals have strong virtual data infrastructures including EMRs, and digitized patient tests and medical imaging. And all this data is regulated by the Ministry of Health.

Thriving startup sector

The country also enjoys a booming medical AI-startup sector that delivers technology to healthcare organizations in Israel and overseas in such areas as medical imaging, personalized medicine, preventative care, pharmaceuticals and computer-aided diagnoses.

The COVID-19 pandemic triggered the birth of a flourishing cooperation between startups and the medical sector to provide technological solutions for diagnostics, treatment and prevention: the local medical sector scouts for

digital health technology, while AI startups search for hospitals abroad to carry out proof-of-concept projects for innovative medical solutions.

Preventive and precision medicine

Preventive medicine is a growing part of the Israeli medical ecosystem, as initiatives by startups and HMO build digitalized solutions to intervene and protect people from chronic diseases from birth onwards. For example, Clalit, an HMO, is developing tools to monitor diseases and predict acute myeloid leukemia risk. While another HMO, Maccabi, is developing an AI system to predict the presence of colon cancer through blood tests.

The sheer wealth of data is opening up possibilities for truly personalized medicine. Maccabi has been building tools to personalize drug treatment for hypertensive patients. Numerous companies and solutions are

focusing on genetic-based personalized treatment. While, armed with comprehensive genomic databases, local companies like FDnA are leveraging AI to detect physiological patterns that reveal disease-causing genetic variations.

The Israel Precision Medicine Partnership (IPMP) funds projects to advance the implementation of personalized healthcare, with all the research projects using data from Israel's unique and vast medical databases. Israel's Ministry of Health itself runs Psifas ('Mosaic'), a huge AI program in precision medicine.

Bilateral opportunities

There have been 29 EU Health-related AI projects funded involving Israel, some of which have included Dutch partners. There are currently various Israeli companies and research bodies involved in Netherlands-funded initiatives that engage foreign partners. For example, the

Healthy.io project, a large-scale population screening study on Chronic Kidney Disease in Breda; and the collaboration between Micompany and UMC Groningen on asthma and allergic diseases. Philips also has a large subsidiary in Israel that focuses on radiology and personal medicine, and also serves as a bridge for Israeli companies interested in collaborating.

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Hospitals taking the lead in research and commercialization

At 70.4%, the rate of growth of South Korea's AI healthcare market is significantly faster than the 60.3% average for major economies globally. From €1.3 million in 2015, it is expected to reach €18.7 million by the end of 2020.

AI-based digital healthcare products are mainly developed by large hospitals, which have their own big data centers and utilize that data for a variety of purposes. An example is the 'Doctor Answer' software, which is based on AI and big data technology and adopted by 25 hospitals. Another is the Voice Recognition Electronic Medical Record system (which a.o. includes voice to text in medical records) implemented by Seoul Catholic Medical Center and commercialized by Puzzle.

Korea's AI healthcare market is growing some 10% faster than the average for major economies

Bureaucratic bottleneck

An issue is that South Korea's laws & regulations can't keep pace with the speed of technological development. Products that are technologically ready for market first need approval from three different governmental organizations, which takes about a year. As a result, many Korean companies in the AI healthcare industry are looking or heading overseas for business opportunities.

Thriving medical imaging sector

The medical imaging sector is one of the most active areas for AI applications. One of the leading Korean companies in this field is VUNO, whose solution assists bone-age assessment of a child's hand x-ray image, reducing reading time and significantly improving accuracy. VUNO have now expanded their technology to brain analysis of neurodegenerative disorders, detection of major abnormalities in chest x-rays and screening

solutions for the fundus of the eye. LUNIT, who have developed AI analysis for chest x-rays, mammography and tissue slides to detect lung diseases, have now opened an office in the Netherlands. Selvas AI provide predictive services that look at yearly medical examination data to identify possible risks of disease in four years' time.

New medicines

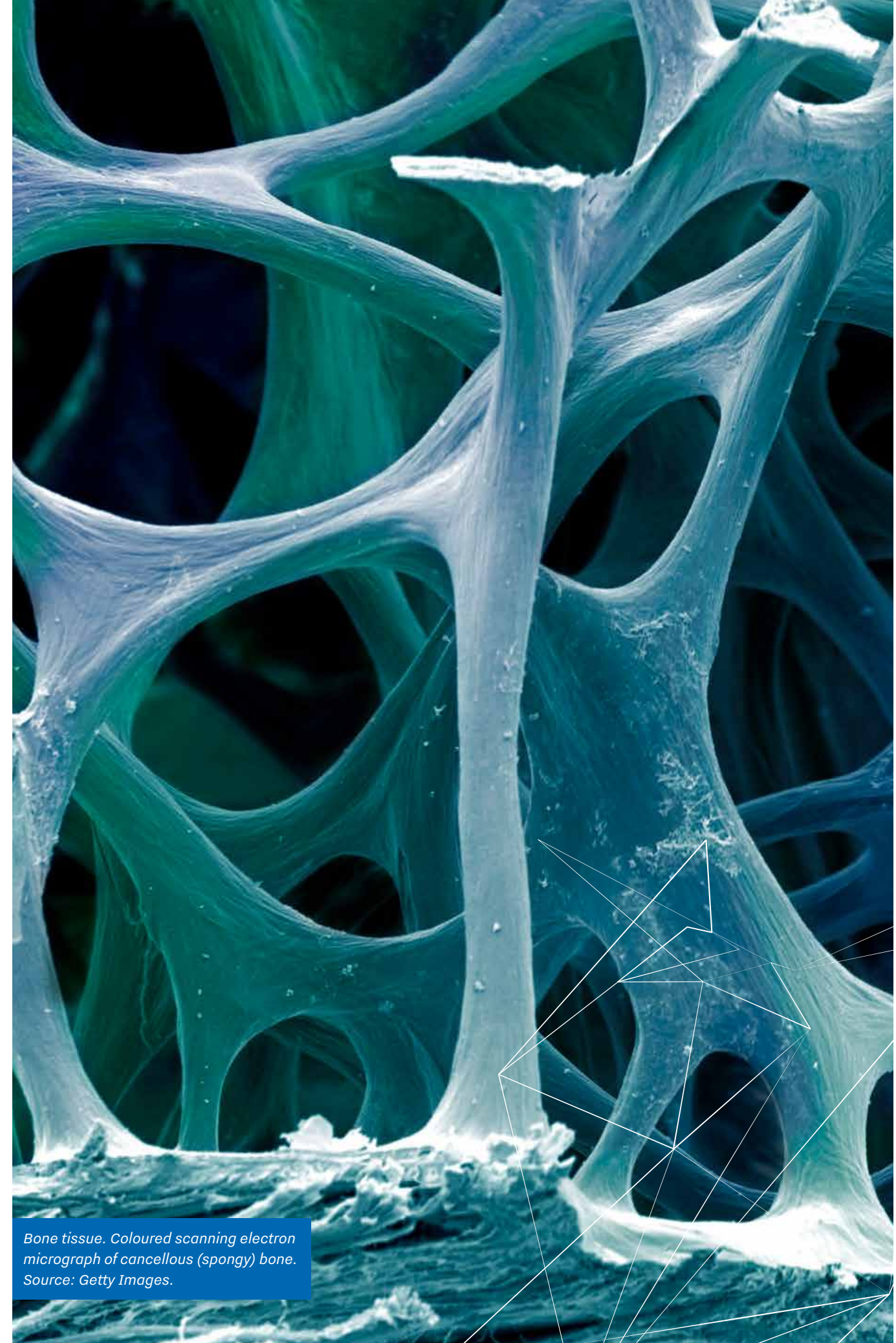
Because AI-related work in Korea around the development of new medicines is not yet globally competitive, the government has increased its budget to support this field, which it believes will dramatically reduce the time and costs of developing new drugs.

Promising players include:

- Standigm, a startup that has developed an algorithm for discovering new medicine materials in order to minimize trial and error, better predict the synergy of different drug combinations, and identify the patients most likely to benefit from the drug.
- twoXAR, who are collaborating with SK BIOPHARM to develop an AI-based drug-design platform that aims to save years in drug development while generating a 30-times higher hit rate in vivo efficacy milestones.
- CIMPLRX, who have developed an AI-based drug-discovery platform for the earliest phase of drug discovery, which is designed to search for new compounds while simultaneously finding new uses for existing drugs.
- Syntekabio, who have discovered COVID-19 combination treatment candidates that in animal tests using an AI-solution have shown therapeutic effects twice as strong as remdesivir.

With the global AI healthcare sector so competitive, the South Korean government is supporting a number of different programs under the auspices of nurturing fourth industrial revolution technology. However, for now it is still mainly the country's hospitals taking the lead in both joint research and commercialization.

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Bone tissue. Coloured scanning electron micrograph of cancellous (spongy) bone.
Source: Getty Images.



AI supporting ambitions to be a global healthcare leader

AI can not only enhance medical care, but also help address Japan's labor shortages.

Conscious that its ageing population is due to exceed 40% by 2030, Japan aims to become a leader in healthcare, welfare and longevity by combining medical advancements with key technologies. The government sees AI not only enhancing medical care, but also helping address the country's labor shortages (in and outside the medical sector), and is therefore investing in research institutes and private cooperation's within the AI medical sector.

Under a myriad of initiatives, such as Society 5.0, Moonshot and SIP, the government has set long-term goals including ultra-early disease prediction and intervention (by 2050); a sustainable care system to overcome major diseases (by 2040); the ability to replace body functions with artificial organs; nanorobots in human bodies, surgical robots and personal healthcare technology; and finally an 'AI Hospital System' – a highly-secure multilingual database system that makes data widely available to improve medical practices and pave the way for AI-assisted auto recording, documentation and diagnosis.

Robust infrastructure

The AI Hospital System will be part of a strong medical IT infrastructure. This the government sees as a priority, with the Agency for Medical Research & Development as key player in driving efforts to standardize data exchanges and develop a robust medical database infrastructure that will support remote healthcare delivered for example by telemedicine, telecare and care robots. Remote healthcare can be particularly important during future pandemics, by supporting traditional care and reducing infection risks. Underpinning the medical IT infrastructure is Japan's general digital infrastructure ambition, including the introduction of 6G in 2030.

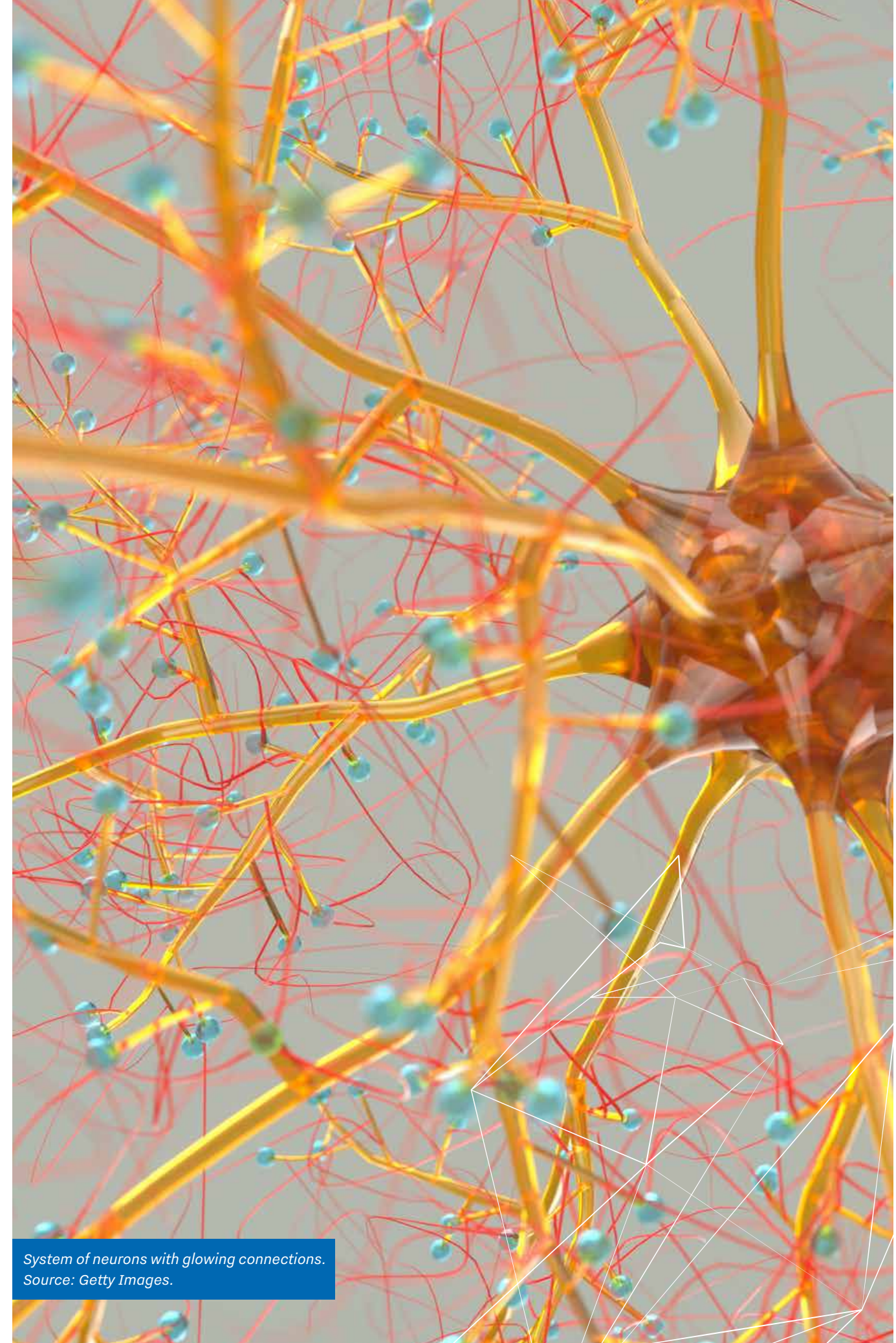
Booming ecosystem

Through a myriad of routes, Japan is developing a booming medicine-related AI ecosystem.

A snapshot of current activity and initiatives:

- New AI-focused research centers established with government support include AIP, CiNet, UCRI, AIS and AIRC. Some, like AIRC, include medical services amongst their specialisms.
- The Tokyo Women's Medical University/Waseda University Joint Institute for Advanced Biomedical Sciences (TWIns) has carried out groundbreaking AI-assisted brain surgery: a robotic system enables high-resolution brain imagery during the surgery while at the same time collecting data from connected devices to aid the surgeons' decision-making. The MRI brain scan also uses deep-learning image reconstruction. The new technique is expected to increase the accuracy and efficiency of procedures, and improve workflow and results.
- The University of Tokyo's Institute of Medical Science is researching using AI to find cancer drug combinations applicable for individual patients. While Keio University is developing AI to detect lung cancer. Hitachi is running a machine-learning pilot to detect diseases and unknown warning signs from medical data. And NEC, Yamaguchi University and Kochi University are together developing an AI application for discovering potential cancer therapeutic peptide vaccines.
- IAN Tokyo is organizing various online and hybrid events in the field of LSH, and seeking partners to join the Partners for International Business program. There is also a LSH mission to Japan. Anyone interested, or simply looking to start or strengthen their activities in Japan, please contact NIN Tokyo.

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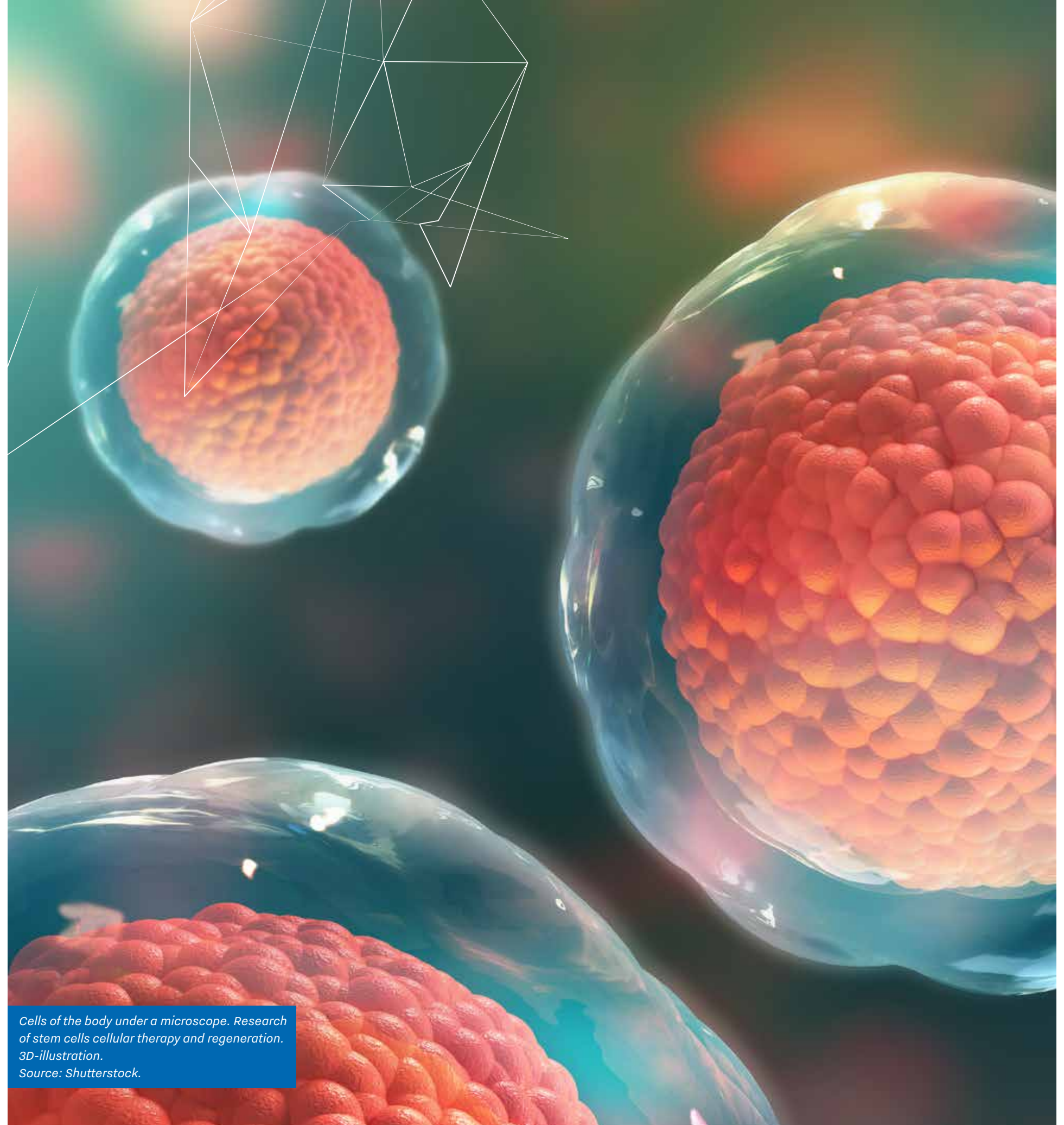
System of neurons with glowing connections.
Source: Getty Images.

Potential of AI being recognized and pursued across sectors

Comprising 8.4% (€131 billion) of Germany's total exports, the healthcare sector makes a major contribution to the country's strong economic position. And AI is widely seen as one of the most promising technologies for making healthcare more personalized, efficient and affordable.

Government catalyst

Germany was the EU's largest healthcare spender in 2019 and with costs rising, the government is well-aware of the need to continuously invest in innovation within the sector. The country's approach to AI in healthcare is characterized by clusters or ecosystems that evolve around government programs, research institutes and/or businesses.



Cells of the body under a microscope. Research of stem cells cellular therapy and regeneration. 3D-illustration. Source: Shutterstock.



Within government, the Ministries of Research, Economic Affairs and Healthcare are the main public drivers investing in and promoting AI in healthcare. The National AI strategy, launched in 2018, invests €5 billion in AI research — fundamental research at Max Planck Institutes and applied research at Fraunhofer Institutes. In addition, the government strengthens ecosystems through ‘calls’ supporting, for example, *Reallabore*.

Data-sharing and developing the EU’s GAIA-X cloud system are a central contribution of Germany to future EU AI developments being put into practice. While use cases of data-driven healthcare research are mapped out in the [Medizininformatik Initiative](#).

Geographical concentration

Ecosystems around knowledge institutes are heavily concentrated in southern Germany, where 45 of the 99 government-funded research projects are based. Examples include Cyber Valley Tübingen, that works on AI applications in clinical brain studies, and the Technical University Munich and German Heart Association

collaborating to use AI methods to understand highly complex biological cell processes and nanoscale treatment. Other regions focus on specialized research areas, such as Lower Saxony, where in Göttingen a €9.6 million BMBF-funded research project is investigating AI applications for cancer treatment.

Company-led research

World-renowned German companies are creating their own AI/healthcare clusters. Carl Zeiss in Oberkochen has developed highly sensitive cameras in combination with deeplearning algorithms. Siemens Healthineers in Erlangen uses algorithms in their CT and MRI systems to place patients correctly in the scanner and analyze images. Dutch MedTech company Sioux has also entered the German ecosystem with the acquisition of software firm 4Plus.

Berlin is home to many AI/healthcare startups sparking interest from international venture capitalists. ADA Health, for example, is a health self-assessment app that received a €40 million investment in 2017. To bring together Dutch and German startups, investors and

companies, the NBSO Stuttgart and NIN Germany organized four Dutch Digital Health Nights in parallel with Germany’s largest e-health conference, DMEA in Berlin.

Broader questions

While AI applications in healthcare continue to multiply rapidly across the country, the German Academy of Natural Sciences stresses that many fundamental questions around the use of AI in healthcare need further investigation. Issues such as privacy, skills development and creating data that remains usable even when technology systems change. Many of these ethical, legal and social aspects are being studied in the BMBF-funded ELSA Research Framework, with the aim of ensuring the future shape of AI in healthcare takes account of all society’s needs.

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World-renowned German companies are also creating their own AI/healthcare clusters



**“TO KEEP THE BODY IN GOOD
HEALTH IS A DUTY...
OTHERWISE WE SHALL NOT
BE ABLE TO KEEP OUR MIND
STRONG AND CLEAR.”**

BUDDHA

Ecosystems across the country working on gamechanger breakthroughs

The game-changing potential of AI in LSH to speed up diagnosis and drug discovery times, improve patient and clinical outcomes, and maximize cost savings have attracted interest from traditional stakeholders like drug developers and health providers, but also from specialized big tech and platform companies with the resources to make substantial investments in the sector.

Coronavirus COVID-19 under the microscope.
3D illustration.
Source: Shutterstock.

AI's potential in life sciences & health is quickly attracting big tech and platform companies

Trends, challenges and opportunities

There are three main trends at the interface of LSH and AI in the US: diagnostics & medical imaging, drug discovery and natural language processing. The challenges and opportunities of AI for healthcare are explored in a comprehensive [study](#) by the National Academy of Medicine.

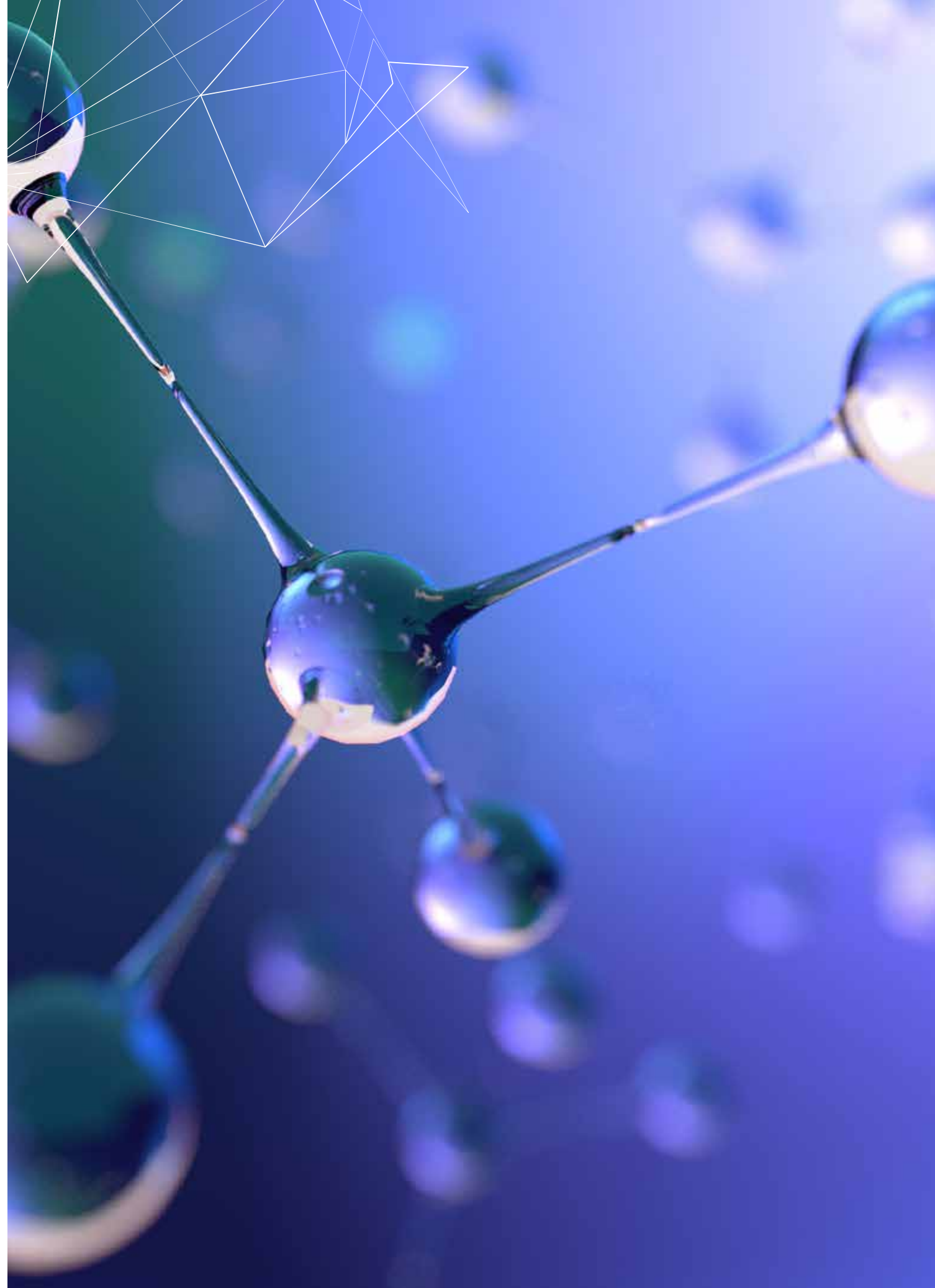
Medical Imaging and AI for diagnostics

AI strategies have been supporting the fight against COVID-19 since early 2020. To explore AI's potential to reduce preventable errors and oversights, the National Institutes of Health (NIH) launched the Medical Imaging and Data Resource Center, a collaboration between academia, professional societies, industry and government to develop diagnostic tools for early detection and personalized patient therapies.

In its battle against COVID-19, the NIH community has access to a unique tool: Biowulf, the world's most powerful supercomputer dedicated to biomedical research, which is helping researchers make sense of data in fields as diverse as genomic analysis, image processing and statistics, as well as 24 [COVID-19](#) related studies.

Groundbreaking approach in drug discovery

Machine learning can significantly reduce the cost and time of new drug discovery and a team of MIT researchers have developed machine-learning models that can be trained to analyze molecular structures of compounds and correlate them with particular traits. It is the first time AI has discovered new antibiotics without the use of any human assumptions. This groundbreaking



approach holds the potential for discovering other types of drugs, for instance cancer or neuro-degenerative disease treatments.

Natural language processing

Communication between humans and machines is facilitated through translating written and spoken words into a machine-readable format. The health care sector is rich in applicable data from different sources, user settings and legacy systems. Numerous companies are commercializing NLP for dictation, generation of medical codes, billing and patient care. Including Google, which is testing a Healthcare Language API.

Key ecosystems

The most important US ecosystems focused on AI and LSH can be found in the Bay Area; Southern California; the Greater Boston Area; the Washington DC, Maryland and Virginia Area Houston and New York. Each of them hosts a large concentration of R&D facilities, an educated workforce and top-tier research hospitals that are global leaders in their specialties. There are also several Dutch players active in this field in the US, including Philips, Quantib and Gilde Healthcare. Quantib recently received FDA clearance for the US market, which marked the first time a comprehensive AI prostate solution will be available to radiologists in the United States.

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COVID-19

AI in Health

A government-driven approach is delivering results

Singapore has a rapidly-ageing population due to declining birthrates and rising life expectancy. Combine this with a high disease burden, especially for cancers as well as metabolic, cardiovascular and infectious diseases, and it's clear why the government expects a significant growth in public healthcare expenditure over the coming years. In response, it has developed a strategy for healthy ageing, digitalization in healthcare, and improving diagnostics and quality of life around priority diseases.

Leader aspirations

The Health & Biomedical sector is one of the four domains in Singapore's current innovation strategy (RIE2020), and will continue to be a priority for RIE2025. The country has also allocated €313 million to AI-related R&D, with Healthcare one of the 5 key areas (along with Security, Smart Estates, Education and Logistics).

The national healthcare project focuses on chronic disease prediction and management. The aim is to get a better control over diseases like diabetes, hypertension and high cholesterol by developing and deploying AI-based tools both for patient self-management and to support clinical decisions. The Ministry of Health is also developing an AI Governance Framework specifically for the healthcare sector.

Singapore also plays an active role in the WHO-led global development of standardized AI assessments for health, diagnosis, triage and treatment decisions.

From early detection to enhanced efficiency

One of the chronic diseases that Singapore is struggling with is diabetes. The Singapore National Eye Centre's (SNEC), Singapore Eye Research Institute (Seri) and the National University of Singapore's School of Computing have together developed a deep-learning system to recognize signs of diabetic eye disease. Selenia+ (Singapore Eye Lesion Analyser Plus) scans photographs for signs of diabetic eye. The AI technology can also screen for glaucoma and age-related macular degeneration.

AI is also being used to increase efficiency within the health sector. IHiS (Integrated Health Information Systems, the technology agency for Singapore's public healthcare sector) and Tan Tock Seng Hospital have together developed a Command, Control and Communications (C3) system for healthcare that provides real-time visibility of the hospital's ground operations, and uses AI to predict situations and optimize resources allocation.

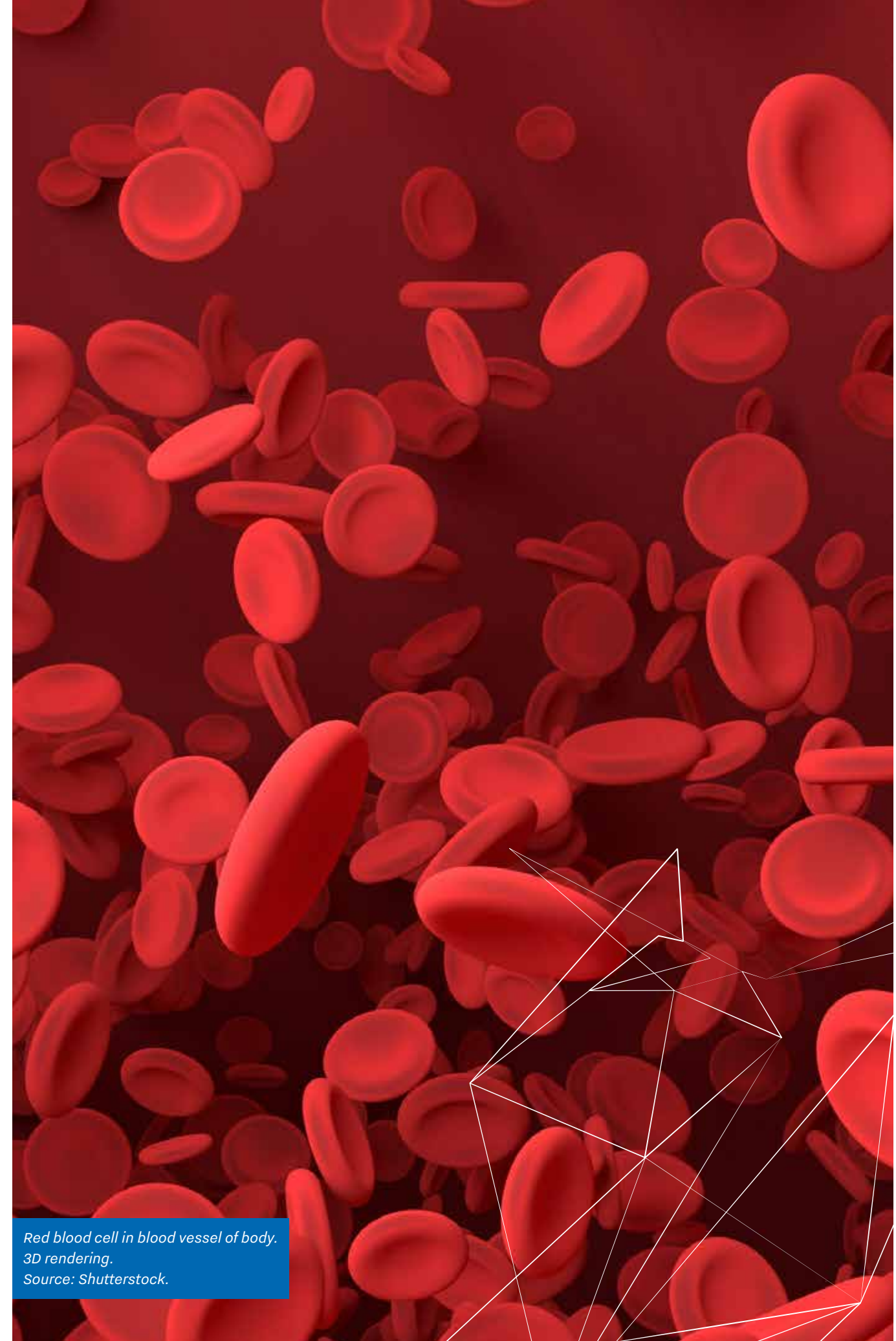
Healthcare continues to be a top priority in Singapore's transition to a smart nation

AI and Covid-19

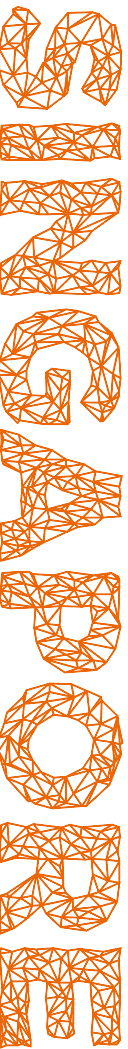
The investments made in the health and biomedical sector in recent decades have equipped Singapore to respond rapidly to Covid-19. Three examples: first, temperature screening was a key part of Singapore's Covid-19 strategy from the start, using iThermo, a solution for automated temperature screening developed by local startup KroniKare, IHiS and the national accelerator AI.SG. Secondly, Singapore's national platform for drug discovery and development, EDDC, partnered with pharmaceutical company Auransa to leverage their predictive AI to fast-track the discovery of new therapeutics for viral pandemics. And finally, a multidisciplinary team of researchers at NUS developed 'IDentif.AI', a platform to identify effective combinations and dosages from billions of different drugs in order to combat infectious diseases.

[Read more>>](#)

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Red blood cell in blood vessel of body.
3D rendering.
Source: Shutterstock.



Investing seriously in health strategy with AI as high priority

France is at the forefront of AI in Europe and actively seeking international cooperation. As early as March 2018, President Macron set out his plan to invest €1.5 billion in AI over the following 5 years, highlighting health as a priority area. A strategy to transform the healthcare system was also launched, Ma Santé 2022, with a €3.24 billion budget, of which €500 million for the digital transition.

The form the transition will take was given further shape with the launch in 2019 of the roadmap for digitalization in health. Since then, the Covid-19 crisis has demonstrated all-too-clearly the importance of digital tech solutions such as AI. Which is why in 2020 the government launched the Ségur de Santé, a major consultation process to examine the future of health services in France in the aftermath of the pandemic, which saw €2 billion dedicated to digitalizing the healthcare system.

Data-driven healthcare

In December 2019, the Health Data Hub was launched to foster the development of AI projects and help improve quality of care. The hub will bring together all French health data sources and make the data available for researchers, patient associations, institutes, startups and other health sector stakeholders. The strategy is to leverage existing initiatives and use local platforms to create this national data infrastructure. The data is hosted by a cloud provided by Microsoft.

AI Institutes

In the implementation of Macron's strategy, four interdisciplinary AI institutes were set up to arrange AI courses and research: MIAI (Grenoble), 3IA Côte d'Azur (Nice), PRAIRIE (Paris Artificial Intelligence Research Institute) and ANITI (Toulouse). The first three have a particular focus on health.

Together the institutes will receive €100 million over 4 years, the business community matching public

investment euro for euro. PPPs are seen as key. At PRAIRIE, for example, the National Centre of Scientific Research, Inria and the PSL University have joined forces with private companies such as Amazon, NAVER LABS, Google, Microsoft and Nokia Bell Labs.

AI in the healthcare ecosystem

France has a vibrant AI ecosystem, from fundamental research to startups and scale-ups. In response to Macron's strategy, several major corporates, including Philips, have now located their AI R&D center in Paris. And numerous healthcare providers are actively developing AI, a good example being Institut Curie, a cancer research institute that has four projects on big data and AI.

AI Mission

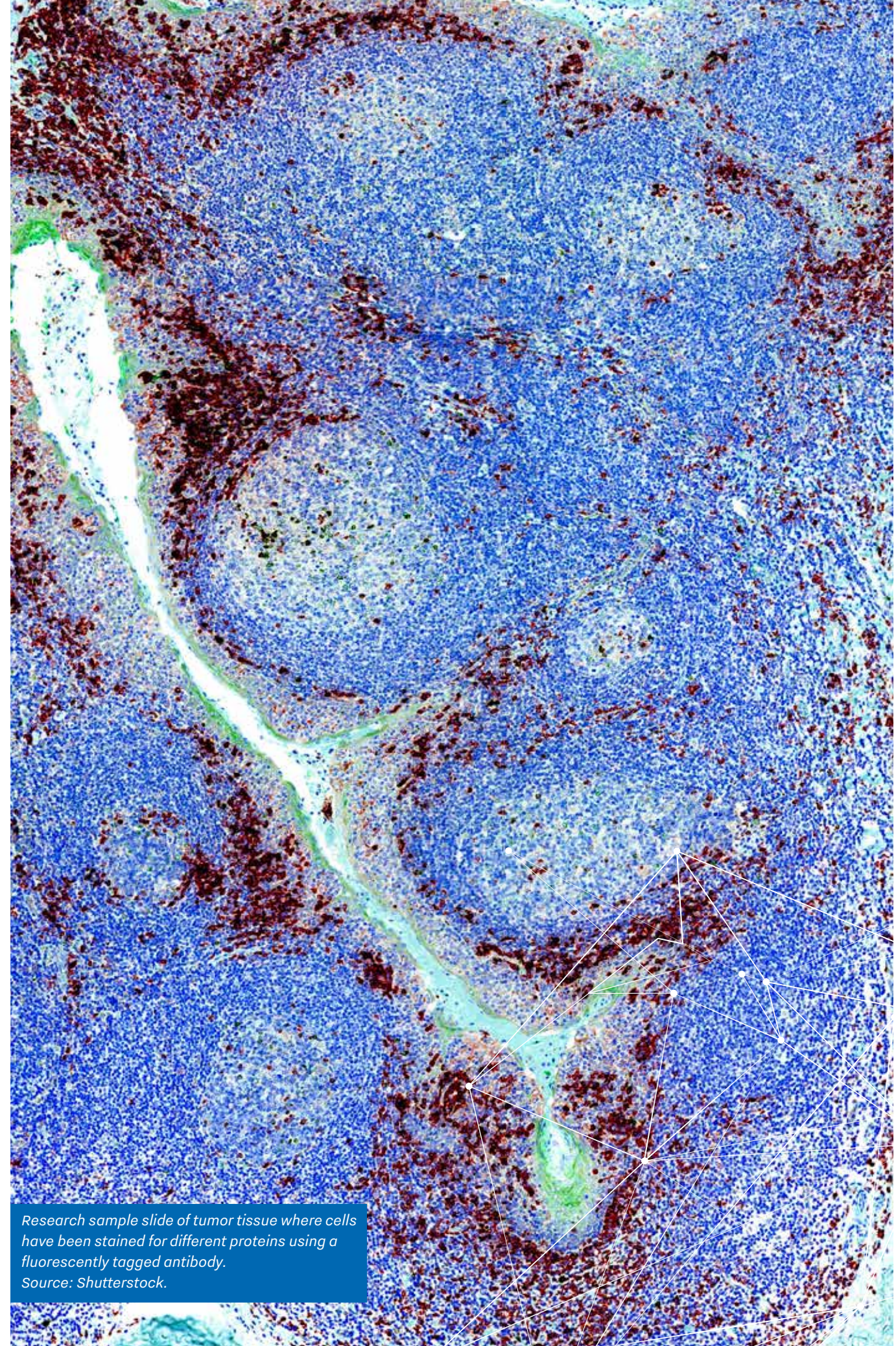
The NIN has been working on AI & health since 2018¹. Examples of activities include:

- The Erasmus-Descartes AI conference in 2018, with a special workshop on health;
- The startup mission to the AI for Health Fair in October 2019;
- In January 2021, State Secretary Mona Keijzer will lead a virtual AI mission organized with the NL AI Coalition, with Health as one of the priority themes;
- An innovation mission on AI & Health to France is planned for 2021;
- The Netherlands intends to join the Global Partnership for AI (GPAI), an initiative of France and Canada.

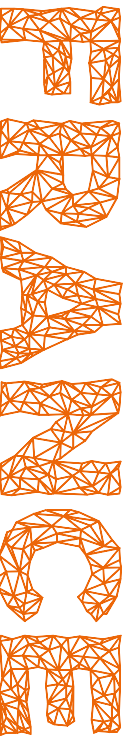
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¹For more information, see our sector study [Digitalisation of the Life Sciences and Health Sector France](#) or our blog <https://nost-france.org/>.



Research sample slide of tumor tissue where cells have been stained for different proteins using a fluorescently tagged antibody.
Source: Shutterstock.



A golden triangle of research and innovation excellence

World's leading hub?

The UK isn't an easy market in which to get a foothold, but indisputably worth the effort. The country has powerful clusters, incubators and programmes blending data, digital, research and health. The levels of convergence and concentration in the London-Oxford-Cambridge 'golden triangle' make it arguably the world's leading digital health hub. With 4 of the world's top 10 universities and 5 of Britain's 7 Academic Health Science Centres (AHSCs), not to mention the Medical Research Council, Cancer Research UK, Cell & Gene Therapy Catapult and Precision Medicine Catapult.

The Wellcome Genome Campus for genomics and computational biology in Cambridge is one of Europe's strongest clusters. Oxford has the Harwell HealthTech cluster and London is the AI growth capital of Europe. The square mile round 'Silicon Roundabout' is one of the world's most connected technology hubs. The nearby Kings Cross Knowledge Quarter has over 100 academic, medical, research and scientific organisations, large and small, including: University College London (UCL), UCL Hospital, Google, MSD, IQVIA, the Francis Crick Institute, Alan Turing Institute, British Medical Association, Digital Catapult, Royal College of Physicians, Royal College of General Practitioners, BenevolentAI and the Wellcome Trust.

Digital eye.
Source: Shutterstock.

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Gateway to connections and capital

There are innumerable NHS institutes, the world's largest single-payer health system, including several National Institute for Health Research (NIHR) and Biomedical Research centres. The NHS also has its own expert team at MedCity, providing a gateway to the region by facilitating introductions, connections and capital.

Innovation culture

The UK scores high on availability of trained talent funding; its open regulatory environment and evidence standards; and its innovation culture and scale-up support, including mentoring, with the most tech.

In 2020, the UK ranked #2 globally on AI readiness

Much of this is down to significant funding and a government focus on innovation to create an environment conducive to AI adoption. In 2020, Oxford Insights and the IDRC ranked the UK #2 in the world on AI readiness (#1 in 2017, #2 in 2019), just behind the US.

The NHS is again important here. Unrivalled as a single payer test-bed, it has a distinguished track-record as a proving ground for technology.

The UK also has its own innovation agency, Innovate UK, and the NIHR, which fund both clinical research and health service research geared to real-world implementation.

Data sets

The availability of high-quality longitudinal data sets, combined with public support for research, gives the UK a global competitive advantage. The UK also offers world-leading transparency on data collection

and a deep focus on ethics, with bodies like the Centre for Data Ethics and Innovation (CDEI) and the Ada Lovelace Institute.

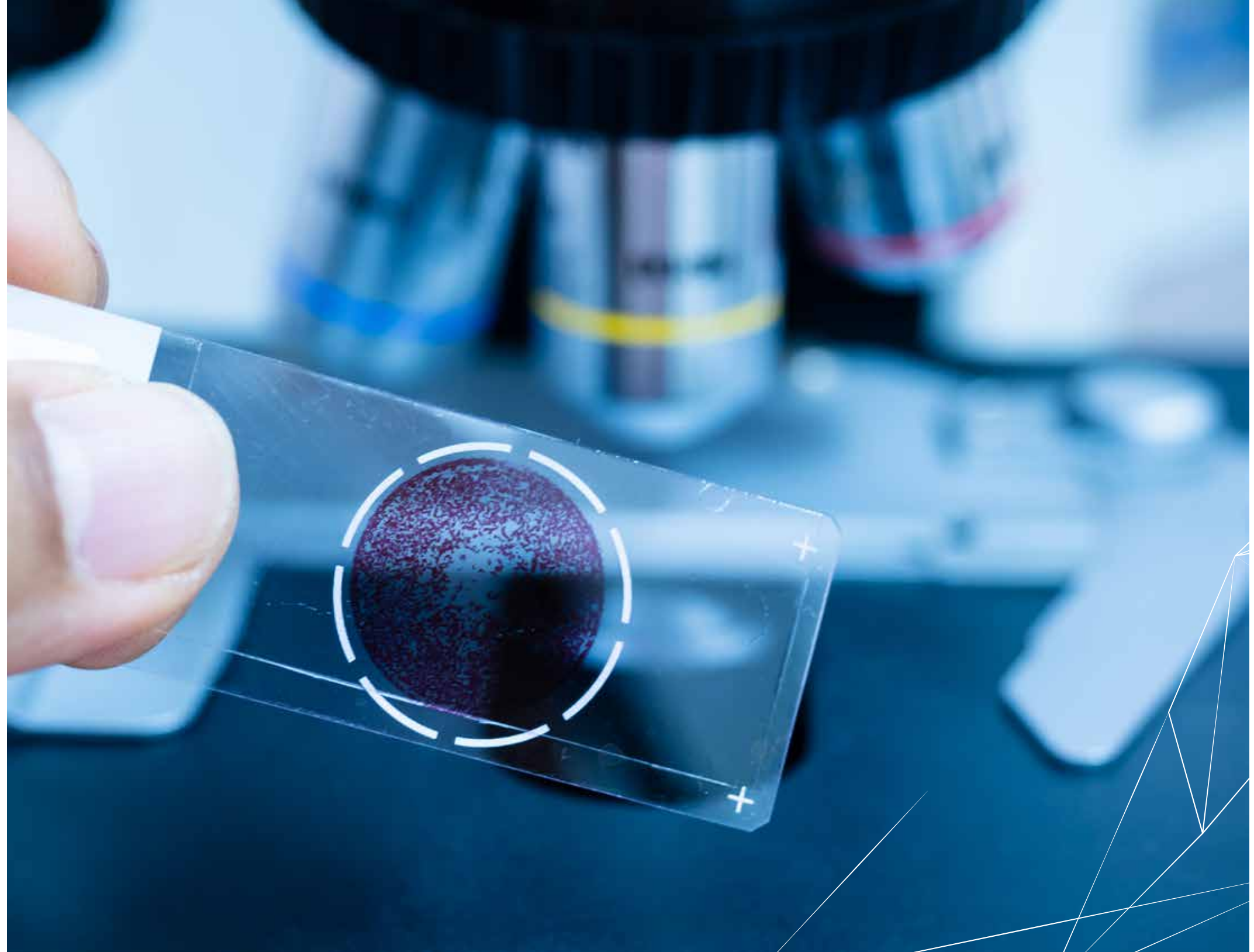
All the above factors combine to make the UK attractive to AI in health investors from around the world, particularly Silicon Valley, which in turn is an added attraction for any company thinking of setting up in the UK.


Learn more...

The NIN UK in collaboration with the Netherlands Business Support Office Manchester will be publishing a detailed

market report on AI in Health in the UK at the end of 2020, also highlighting the opportunities available that can lead to closer collaboration in areas such as health data research, clinical pathology and imaging.

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**“WHETHER AN ILLNESS
AFFECTS YOUR HEART,
YOUR LEG OR YOUR BRAIN,
IT’S STILL AN ILLNESS,
AND THERE SHOULD BE
NO DISTINCTION.”**

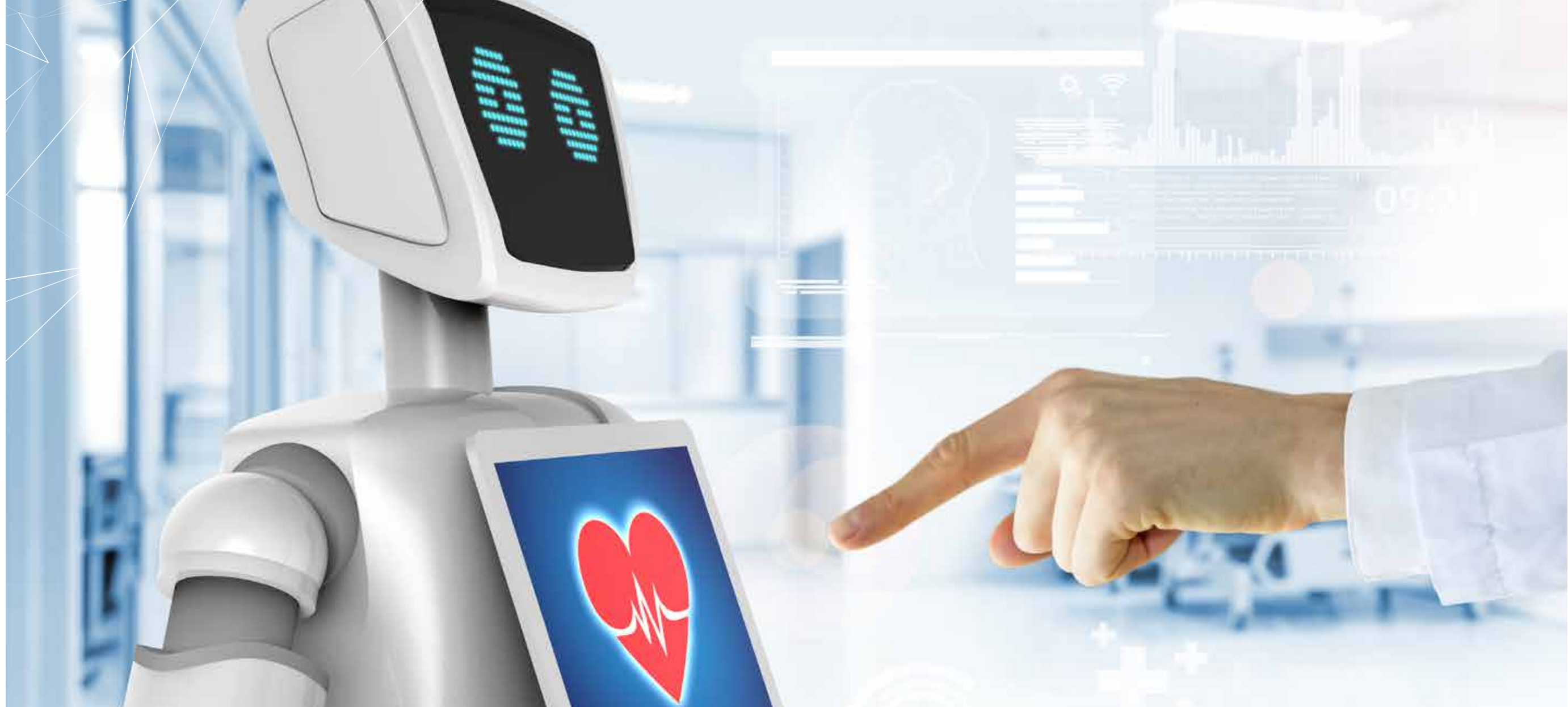
MICHELLE OBAMA

Demographic and healthcare vulnerabilities driving health tech developments

If current trends continue, by 2029 China's population will peak at 1.44 billion, with dramatically imbalanced ratios of young to old (4 grandparents, 2 parents, 1 child) putting unprecedented pressure on younger generations. This dependency ratio (non-working: working people) is set to increase from 42% to 67% by 2050, by when a quarter of the Chinese population (350 million) will be over 65. These demographics obviously have major societal and economic implications, especially around elderly care.



Blue DNA structure.
Source: Shutterstock.



Given China's strengths, the focus on AI makes sense

To complicate matters, healthcare isn't exactly China's strong point. There are a number of structural problems with the healthcare system, like a shortage of qualified doctors and an uneven distribution of medical resources throughout the country. In academic health journals worldwide, only 11% of publications have Chinese affiliations (compared with, for example, 29% in engineering) and Chinese articles receive only 52% of the citations per article Dutch articles get. Chinese articles also tend to have a lower impact due to their relatively modest quality and less-wide reach.

Logical focus

Though the Chinese government doesn't currently have a cohesive nationwide approach, healthcare providers are looking to other sectors to help meet the growing market for elderly care. For example, through AI-based automatization at the various stages in the healthcare process, from diagnostics and tracking to personal care and therapy. One example being smart home technology, with a number of big players including Alibaba, Tencent and Xiaomi successfully developing apps and/or caring robots.

Given China's strengths, the focus on AI makes sense. Commercially, the country has a fast-growing tech sector with domestic AI players rivalling Silicon Valley. And when it comes to research, computer sciences is China's strongest performing area in terms of citation impact (and no surprise that AI keywords are severely overrepresented in Chinese health articles).

Robots who care

In 2018, UBTECH Robotics Shenzhen, the Elderly Talent Information Center of China's National Committee on Ageing, and the Technology & Development Center for

TCM of China came together to establish an intelligent healthcare service robot research institute. The institute has developed Xiao Bao, an intelligent robot who provides healthcare support to senior citizens. Now, UBTECH is looking to widen Xiao Bao's scope of capabilities. For example, during the COVID-19 pandemic, the UBTECH robots were used in various hospitals in Shenzhen and Wuhan to provide telehealth services by monitoring vital data such as patient body temperature.

There are numerous examples of built-in 'Siri-like' applications, such as the Xiaoyi by Lanchuang Network Technology Corp; VOLTtimebank, a blockchain-based management system that processes and records volunteer services; and Alibaba's intelligent assistant, Tmall Genie CC10. All products that can potentially help the elderly with services like housekeeping, meal deliveries, telemedicine and SOS services.

Collaboration opportunities

In the Netherlands, use of voice assistants in elderly care and care facilities is not yet widespread, which offers possibilities for future collaborations. Voice-assistance apps can help reduce loneliness today, and

over the longer term provide telehealth, medical and food-related support and services.

Since 2018, the Partners for International Business (PIB) programme, led by the Task Force Health Care, has been focusing on elderly care, with the Netherlands Innovation Network China providing support to the PIB by leveraging its diplomatic network.

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Overcoming the challenges of a patchy and complex system

The quality of the Russian healthcare system varies from poor medical services in remote areas to top-level solutions in big cities. The top-down, centralized character of the economy slows the integration of new solutions but, when implemented, projects are on a large scale.

Complex processes

There is an increasing market demand for AI in LSH solutions and traditionally it is private companies in Russia who are best equipped to adapt their services to market need. However, the major role the state plays in the economy means a large part of that market is only accessible via the state procurement system, a complicated process requiring knowledge of local legislation and certification by foreign companies. Interestingly, large Russian banks are also significant players, providing various digital healthcare services to significant sections of the population. While Russian universities are also actively collaborating in research and pilots with Dutch universities.

Currently, AI services are mainly used in Moscow and other big cities with their spread to all regions projected to happen within 10 years. [This map](#) shows the implementation of AI projects across 23 Russian regions. The most developed solutions fall under three main areas:

Patient data analysis

Examples include the Med.Me app to arrange medical appointments; Docdoc, a telemedicine platform that uses a chatbot to provide anamnesis preparation for a consultation with a doctor; and a 'Siri' for doctors that Speech Technologies Center have developed which transcribes speech at offline meetings into text, delivering up to 22% time savings. Dutch Enbisy providing services in NL, has a team of developers in Russia, Tomsk.

Recognition of pathologies in medical images

The Moscow Center of Diagnostics & Telemedicine Technologies is running a 1-year pilot project that aims

to test 10 operational Russian and international AI services for radiology. The services have already processed over 700,000 CT, x-ray and mammography scans from some 900 medical radiology units. The pilot platform has become a reference center for Russia's entire medical system with participants including:

- Botkin.AI, who provide a teleradiology service that remotely transcribes CT scans in oncology. The company has also proposed re-processing CT scans made for COVID-19 identification for cancer diagnostics.
- Third Opinion, a platform detecting pathologies in medical scans, including chest x-rays, digital blood and bone marrow smears, orthopantomograms, ultrasounds and mammograms;
- Philips, who have established one of their three dedicated AI labs worldwide in Russia.

Other uses of medical images in prominent projects include helping detect signs of Alzheimer's and ophthalmic diseases; and quick-and-precise diagnostics of acute-phase heart attacks and strokes.

Clinical-decision support systems

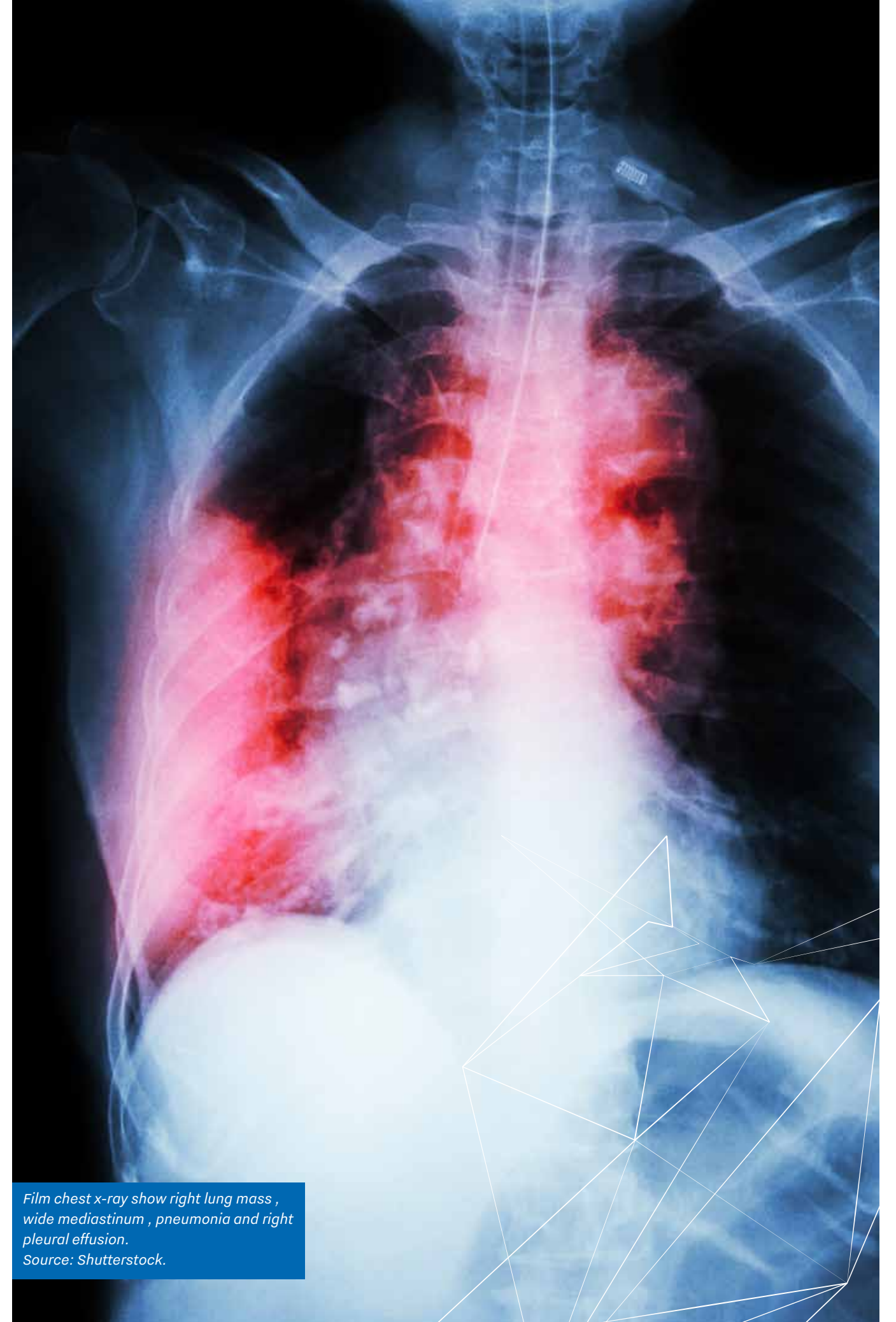
Another major project is the introduction of an AI-based clinical-decision support system based in all Moscow polyclinics. The data of some 4.5 million patients was digitalized and placed in a single electronic system. 87 protocols were then developed for the most common diseases. The system helps make a preliminary diagnosis and offers a list of confirming studies, as well as a list of doctors for further consultations. Doctors also get access to a questionnaire completed in advance by the patient.

Another example is the Dutch company Portavita, which has developed a solution that assesses the risks of patients with heart or chronic diseases, and suggests treatment programs to help drastically reduce those risks in several Russian regions.

Netherlands Innovation Network Russia

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Film chest x-ray show right lung mass , wide mediastinum , pneumonia and right pleural effusion.
Source: Shutterstock.



A perfect storm of public-private collaboration and innovation

Science and engineering are traditionally highly valued in Sweden, which helps explain why it's considered Europe's innovation leader. LSH industry and research centers play an important role in this: they contribute to key innovations, provide jobs and are a major export product.

Dynamic culture

LSH research is organized in clusters across the country, the main ones being Stockholm–Uppsala and Malmö–Lund, which in turn forms an international cluster with Copenhagen. A new cluster is now emerging in the Gothenburg region, where AstraZeneca is building a new R&D center. These clusters are private-public funded, creating a dynamic environment where public-funded research meets private investment and business drive.

Sweden has a strong focus on bringing its AI solutions to market

A good example is the private investment in AI research in life sciences by the Knut & Alice Wallenberg Foundation. This has two components: a completely new national investment in computer-driven life sciences of €304 million over 12 years; and a further €58 million investment in current support to the national research infrastructure, SciLifeLab, and the Wallenberg Centres for Molecular Medicine at the Universities of Gothenburg, Lund, Linköping & Umeå. The initiative prioritizes four research areas: cell and molecular biology; evolution and biodiversity; precision medicine and diagnostics; and epidemiology and infection biology.

Creating bigger datasets

Data-driven research requires a lot of data, and as Sweden has a relatively small population it needs to collaborate with life science clusters in other countries.

An example is the work of Kees-Jan Pronk at Lund University. Pronk is researching childhood leukemia, a data-intensive research field where AI plays an important role. To increase his dataset, he works with childhood leukemia centers in Norway, Denmark and Finland, and is in close contact with the Princess Maxima Center in Utrecht.

Getting to market

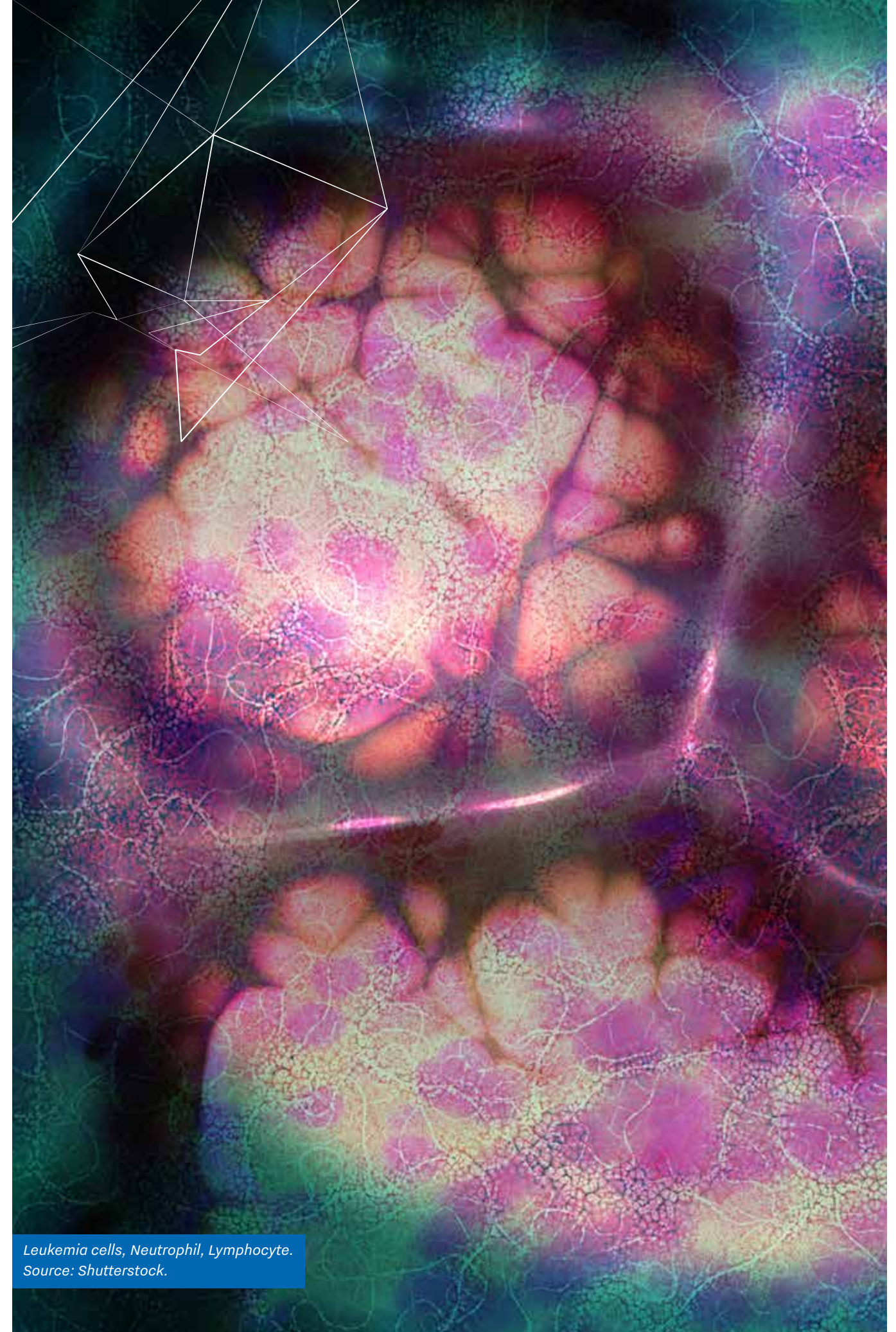
Sweden has a strong focus on bringing its AI solutions to the market. Most AI research by academics and students ends up in academic papers and patents, but some projects also spark business ideas and the University of Lund has therefore set up Innovation Lund which advises academics and students on the business and financial aspects, and coaches them through the startup phase.

From almost 500 potential business ideas in 2019, 21 companies were successfully launched. Many of these startups benefited from the AI and machine learning research done at the university. Examples include:

- Bionamic: software for handling and analyzing data in antibody drug development.
- Cell Invent: developing new human disease models to develop cures for Alzheimer's.
- SB1Pharma: a new approach to identifying and treating cancer tumors that primarily affect children.
- Cellavision: solutions for hematology laboratories to automate and simplify the process of performing blood and body fluid differentials.

The Innovation Attaché for Sweden is in close contact with Innovation Lund to see how we can facilitate collaborations between the Dutch and Swedish life-science startup scenes.

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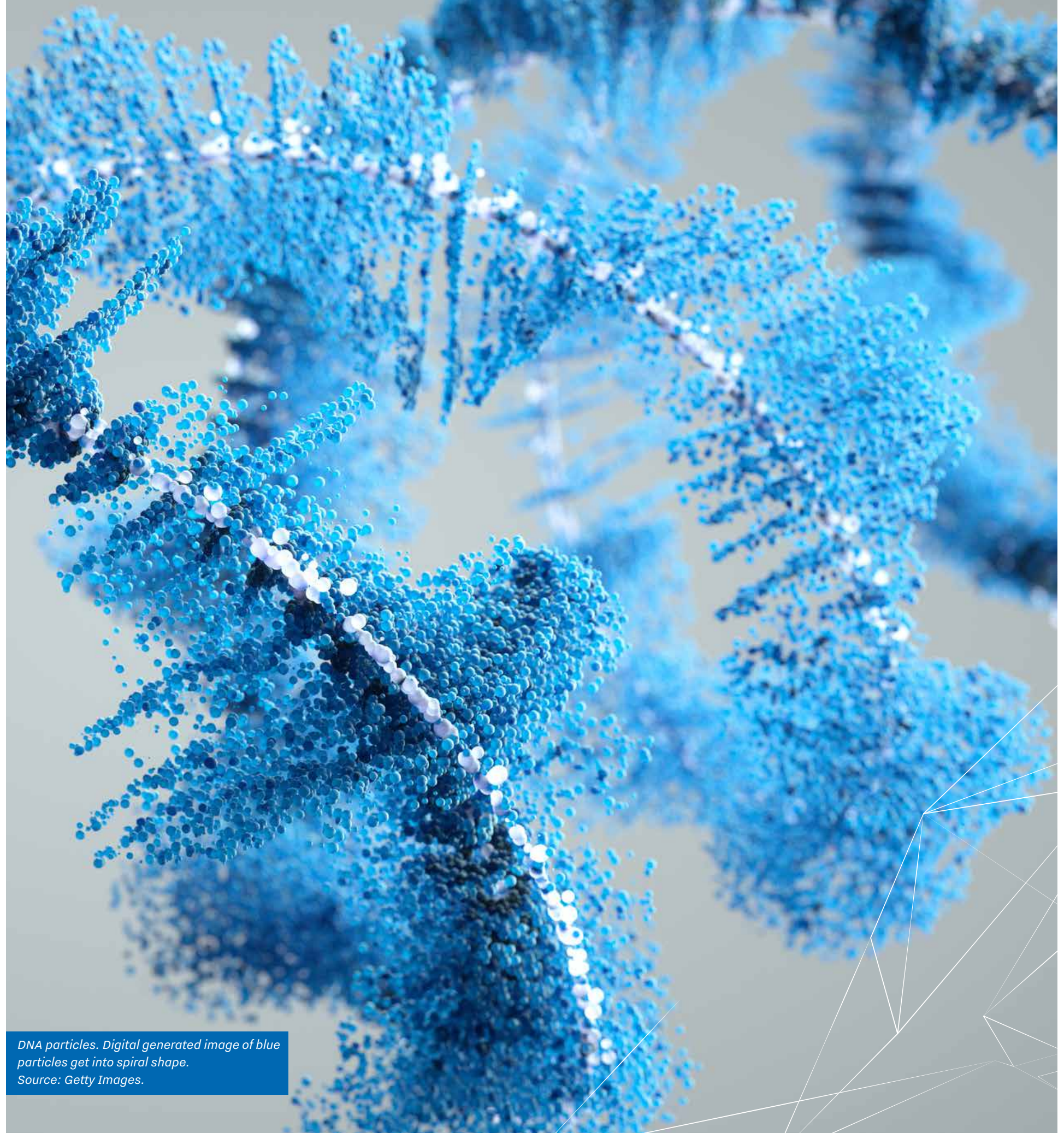
Leukemia cells, Neutrophil, Lymphocyte.
Source: Shutterstock.

High-tech strengths make Taiwan well-positioned to be a leader in AI and healthcare

Taiwan has various strengths when it comes to exploiting AI. First, it is already a world leader in the areas of semiconductors, ICT and manufacturing, which together form an excellent foundation for AI.

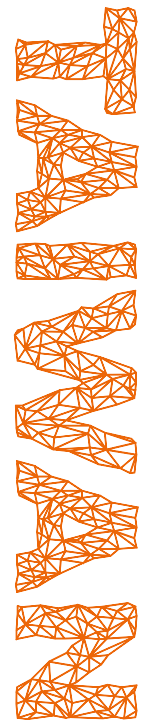
Secondly, the Taiwan government is not only actively supporting AI developments, via ambitious policies such as the AI Action Plan and AI Strategy. Its key policy objectives also include the publication of open data, encouraging AI startups, attracting multi-nationals and AI R&D centers to Taiwan, cultivating talent, and stimulating research.

Thirdly, industry in Taiwan is willing to invest in AI and believes in technological solutions. And last but not least, because Taiwan is a relatively small country it's easy to implement new policies and response times are fast.



*DNA particles. Digital generated image of blue particles get into spiral shape.
Source: Getty Images.*





Taiwan has a national database with 25 years' comprehensive medical data

Health initiatives

Taiwan is renowned for its high quality of medical care and medical expertise in general, and the Ministry of Science & Technology (MoST) has established two key institutes to drive AI-related healthcare innovation:

- MoST AI Biomedical Research Center (AIBMRC): focused on AI for biomedical research in Smart Medicine, Smart Healthcare, Smart Biotechnology and Ethics & Humanities.
- MoST All Vista Healthcare Center (MAHC): eleven research teams categorized under Medical Imaging, Mental Health, Decision Support, AI-ELSI and Precision Drug Use.

The Taiwan AI Lab, a non-profit private research organization, has healthcare among its main research areas, with topics including Precision Medicine, Medical Imaging and Genomics. They collaborate closely with hospitals, which means research can often be immediately tested and applied.

Databases

An important asset is the National Health Insurance (NHI) database, which has accumulated comprehensive medical data (patient records, drug information, medical images and laboratory test results) since 1995, with access to anonymized healthcare data available on application since 2016.

Biobanks are another important tool for translating health data and biomedical research into practice, and developing a better understanding of precision medicine. Taiwan is therefore integrating various AI and local genome databases, and in 2019 established a national

platform that integrates data from 33 biobanks, including data from 460,000 volunteers and 4.5 million biospecimens.

COVID-19

AI is being widely used in Taiwan to combat COVID-19, with several applications developed, including:

- Social distancing APP: to reduce spread of the disease while protecting personal privacy.
- Health Report APP (electronic fence system): easy monitoring and reporting during home quarantine.
- AI SARS-CoV-2 Classifier: real-time SARS-CoV-2 screening of hospital chest x-ray images via NHI service that triggers alert if high-confident cases are identified.
- AI transmission tracing system: exploring transmissions through genetic tracing with phylogenetic trees.
- Varian2literature: gene mutation and COVID-19-related literature search engine.
- Coronavirus Drug Screening: drug discovery using computational protein-ligand docking simulations.
- Realtime mask map and rationing system.
- AI-assisted development of fast screening reagents and antibody drugs.
- AI-assisted interpretation of x-ray imaging, reducing diagnostic time from 2½ hours to 30 minutes.
- AI detection if a person is wearing a mask properly.

This diversity of applications demonstrates how Taiwan embraces the potential of AI in healthcare and the speed with which it applies it.

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**“HEALTH IS A STATE OF
COMPLETE PHYSICAL,
MENTAL AND SOCIAL
WELL-BEING, AND NOT
MERELY THE ABSENCE OF
DISEASE OR INFIRMITY.”**

WORLD HEALTH ORGANIZATION

Heading towards a strong digital health ecosystem

Healthcare is one of India's most dynamic yet challenging sectors. The country's National Health Policy aims to achieve universal health coverage, including universal access to qualitative healthcare, medicines and vaccines. But while indicators have shown a marked improvement in the healthcare ecosystem over time, challenges remain around the non-uniform lack of affordability, accessibility to both preventive and curative health services, and poor infrastructure across the country.

Leveraging digital technologies

To address these challenges, transformative programs that leverage digital technologies have been successfully set up under the 'Digital India Program'. Moreover, healthcare is one of the major focus areas in India's 'National Strategy on Artificial Intelligence'.



3d rendered illustration of generic human cells.
Source: Shutterstock.



The “Ayushman Bharat” program has brought healthcare within reach for hundreds of millions Indians, significantly increasing the number of people with government-funded health insurance. The program sets to drive electronic patient records and digital health delivery by triggering significant technological innovations, including the development of a sophisticated IT system.

With the National Digital Health Blueprint, India has set the architectural framework for an efficient and secure implementation of digital health. It provides a strong infrastructure for data integration by leveraging Big Data Analytics, Machine Learning and Artificial Intelligence.

The recent launch of the National Digital Health Mission (NDHM) has brought comprehensive e-health a step nearer. Every Indian citizen will have a unique health ID linked to identifiers that will facilitate access to medical services; because under the NDHM continuity of care, international standardized data, interoperability and an open API- approach are all taken into account. Although

implementation of the NDHM has its challenges, such as inclusiveness and data quality, it shows how India clearly understands the value of health data and AI, and is willing to actively invest in enabling conditions.

Scope for collaborations

India and the Netherlands share a long-term bilateral agenda, with healthcare as one of the core themes and AI a crosscutting, key-enabling technology. And India itself sees and welcomes opportunities for collaboration in addressing the challenges around optimal use of health data and AI.

There are already several existing Indo-Dutch partnerships focused on health and AI. Maastricht University, for example, has two such projects running: TRAIN focuses on privacy-preserving AI that unlocks health data without centralizing it. The second project is a collaboration between the university, Apollo Hospitals and Microsoft to use AI to predict cardiac disease.

Potential for further collaborations

India has the potential to become the world’s IT hub, with its young, tech-savvy population. And with the two countries’ complementary talents, knowledge and resources, India and the Netherlands are optimally positioned to create further crosscutting public-private-partnerships, boost business and foster innovation-driven growth, as our collaborations in the Health sector and AI illustrate.

NIN India, is currently working on an AI opportunity report for Indian and Dutch stakeholders to explore areas for further collaborations.

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The aim is give hundreds of millions more Indians access to healthcare

Developing an e-health infrastructure that offers potential for AI applications

Turkey's 11th Development Plan aims to digitalize the country's public services and has established a Digital Transformation Office (DTO). The DTO, whose president also serves as the government's Chief Digital Officer, is currently preparing a national AI strategy in collaboration with knowledge institutes, the private sector and NGOs. As well as use cases across various sectors, the strategy will focus on ethics & law, the effect on labor, the relationship between AI and people, and AI's impact on education and human rights.

Health sector use case

One such use case is the health sector. Achieving an e-health system for Turkey is part of the Health Transformation Program launched by the government in 2003. The goals of this e-health system are to ensure the standardization of data used in healthcare and create an Electronic Health Record for citizens. This would enable healthcare data analysis that can support managers, speed up the flow of information between stakeholders, and save resources and increase efficiencies within the healthcare system.

Various elements are already in existence. These include the Health-Net, a software cluster that enables the transfer of information between family doctors, hospitals, pharmacies, operating rooms, etcetera; the Pharmaceutical Tracking System, which tracks medicines from manufacturer to citizen; a central physician appointment system; and a decision-support system that uses aggregated data to help the Ministry in developing policy.

Public-private initiatives

There is also E-Pulse, a personal health record app that makes the information in these systems accessible to citizens and healthcare professionals. E-Pulse collects healthcare data from different health institutes and facilitates communication between patient and physician. This process is helped by the ongoing digitization of

Turkish hospitals that is taking place. The E-pulse app is the result of a public-private collaboration involving the government, Turk Telekom and others.

Wide-ranging applications

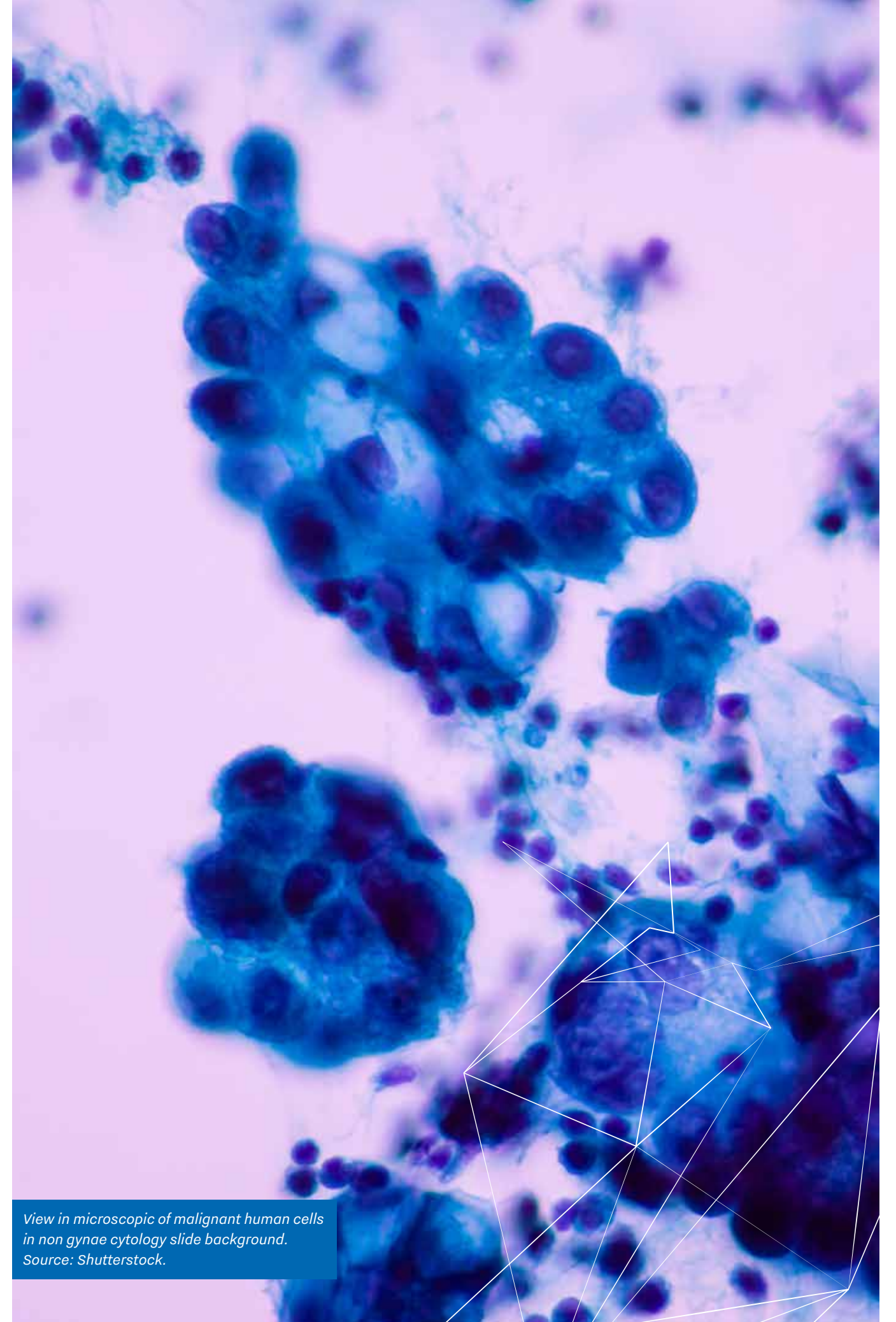
To realize the many benefits AI can offer the Turkish health sector, the Health Institutes of Turkey (TUSEB) has established the Institute of Medical Data Mining & Artificial Intelligence Applications, which carries out research itself as well as collaborating with universities to develop AI applications to aid everything from diagnosis and treatment to cost savings and control.

The Institute is currently supporting projects by some 30 research groups at 20 different universities. Examples include an automated medical imaging system that pre-checks radiological images and forwards reports to the doctor. And an app called 'What have I got?' being developed by the Ministry of Health. Using underlying data regarding symptoms, the app asks up to 22 questions before advising the patient which medical specialist to see, as 60% of patients in Turkey go to the wrong doctor for their initial consultation.

Turkish-Dutch collaboration

In 2019, the Netherlands Organization for Scientific Research (NWO) launched the Science for Diplomacy fund with a specific focus on collaboration with Turkish researchers. This allows Dutch researchers to connect with colleagues from Turkish universities & institutes, but also enables Turkish institutes to participate in Horizon 2020 and Horizon Europe. The NIN in Turkey can help Dutch parties find the right contacts at knowledge institutes and government agencies to explore potential areas of collaboration.

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View in microscopic of malignant human cells in non gynae cytology slide background.
Source: Shutterstock.

Dynamic health sector offering innovation and business opportunities

The Brazilian Ministry of Science, Technology & Innovation (MCTI) is developing a national AI strategy. It sees AI as a key technology to improve productivity and quality of life, and address social inequality. MCTI is stimulating the development of AI applications in two ways. First, by creating eight new AI applied research centers, funded by the São Paulo Science Foundation (FAPESP) and the private sector. And secondly, by accelerating 100 AI-related innovation projects via the AI Open Innovation program, funded by MCTI and the private sector. Health is one of MCTI's four priority areas.

Research variety, research excellence

An increasing use of big data in Brazilian healthcare is being enabled by Brazil's research excellence — in hospitals; at the public health institute, Fiocruz (Center of Data and Knowledge Integration for Health); and in institutes like the University of São Paulo's Institute of Mathematics & Computer Sciences, Unicamp's Institute of Computing and the Federal University of Pernambuco's Center for Informatics.

Research areas include cohort studies, genomic epidemiology, tropical and lifestyle diseases, and bioinformatics. In 2018, Brazil ranked 12th globally in the number of academic publications on AI.

Examples of Brazilian AI applications already developed include risk assessment of repeat heart failure (UniCamp), diagnosis of intracranial hemorrhaging using images (medical diagnostics company Grupo Fleury), and using a cognitive AI robot to monitor patients for early sepsis risk alerts (Laura Fressatto Institute).

Open access databases

Brazil's public healthcare system is implementing a National Network of Health Data (RNDS), accessible by patients and professionals. Several Open Access research data platforms have also emerged. Including

ABraOM, the largest genome database on elderly people in Latin America, and Genomas Brasil, a new initiative to sequence 100,000 genomes for the development of precision medicine.

Covid-19 as catalyst

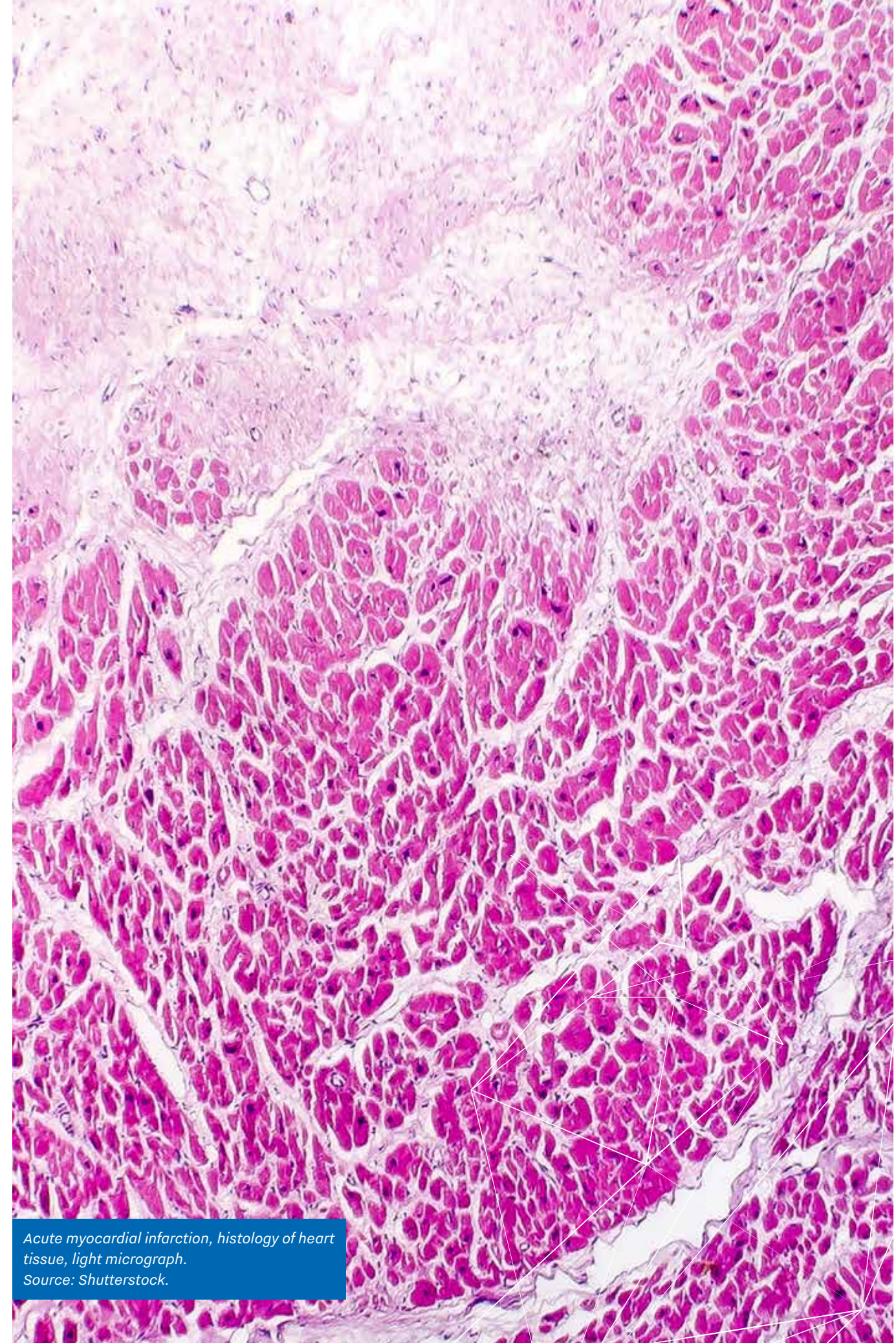
Unsurprisingly, COVID-19 is accelerating Brazil's digital transformation of healthcare. Notable examples include an application developed by the University of São Paulo to identify respiratory problems by analyzing a person's voice over the phone, and an application developed by startups at the Albert Einstein private academic hospital that combines face recognition with at-a-distance fever detection using thermographic cameras at the hospital's entrance.

Multinational interest

Brazil's sizeable healthcare market and research capabilities are also attracting multinationals into the Brazilian AI ecosystem. IBM chose Brazil for its first AI Engineering Research Center in Latin America, co-funded by FAPESP and hosted by the University of São Paulo. Microsoft (who support AI development work for example at the Nove de Julho Hospital for fall prevention) is creating an AI Industry Board to promote responsible use of AI and share best practices. Dutch academic publisher Elsevier is also active in Brazil in data-driven, value-based healthcare.

Healthcare is also a priority area for IAN Brazil. Big Data in Life Sciences & Health was the topic of a recent innovation mission to Brazil, which included the FAPESP Research Program on eScience and Data science, and connected academics from life sciences, natural sciences and engineering to academics in social sciences and humanities.

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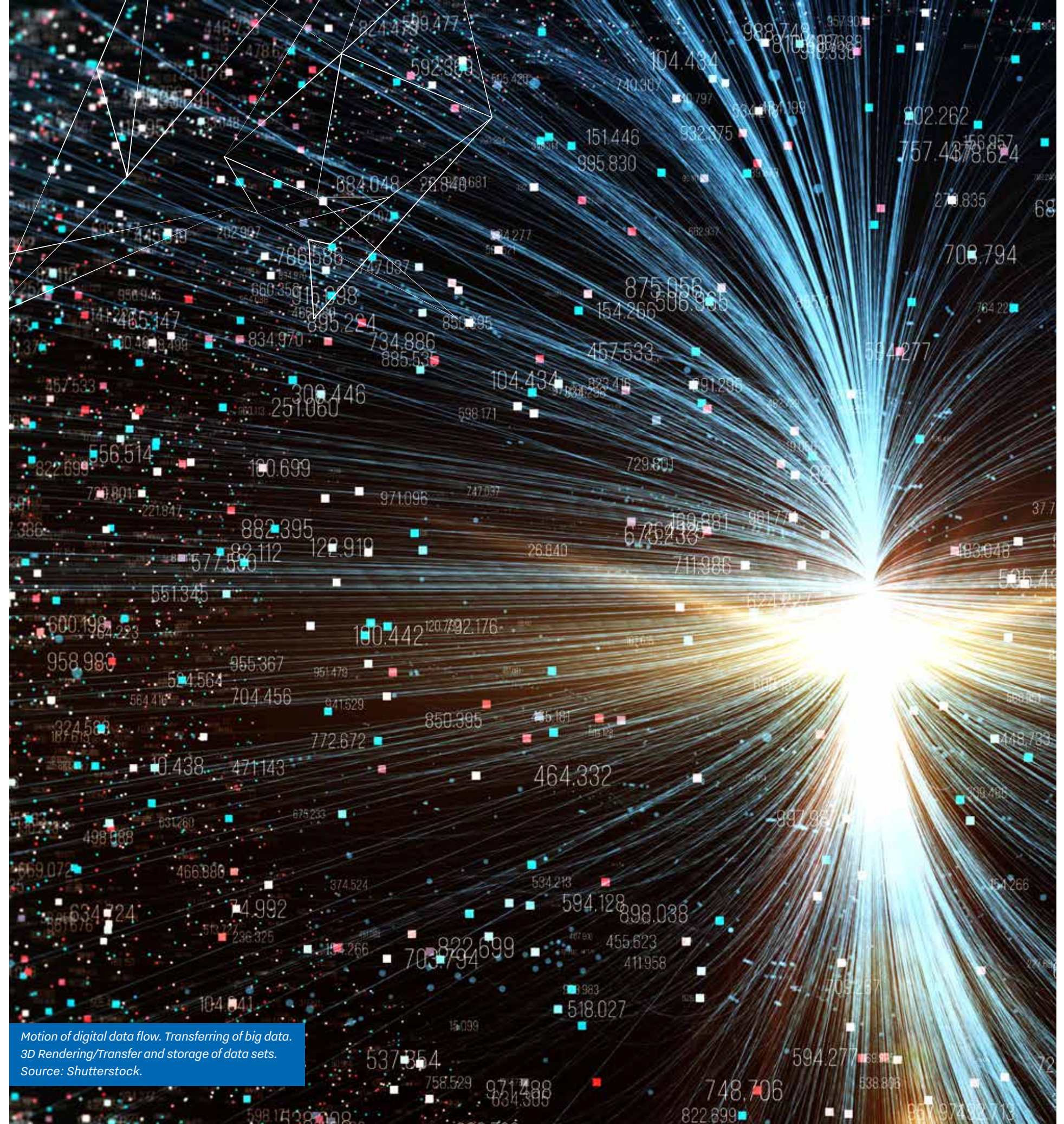


Acute myocardial infarction, histology of heart tissue, light micrograph.
Source: Shutterstock.

An AI pioneer now setting its sights on healthcare

Canadian businesses, government agencies and research institutes were quick to identify AI as a driving force for innovation. In 2017, the government asked the Canadian Institute for Advanced Research (CIFAR) to develop and lead a \$125 million National AI Strategy, the world's first. CIFAR works closely with Canada's three national AI Institutes — Amii in Alberta, Mila in Montréal and the Vector Institute in Toronto — as well as universities, hospitals and other organizations across the country.

AI has huge potential for healthcare in Canada, especially around deep learning. So to accelerate digital healthcare innovation, CIFAR is now recommending an AI health strategy, AI4H, as “the game changer for Canada”.



Motion of digital data flow. Transferring of big data.
3D Rendering/Transfer and storage of data sets.
Source: Shutterstock.





AI & Healthcare ecosystem

With Canadian healthcare systems under intense scrutiny during the Covid-19 pandemic and AI & Health becoming a real priority for key players, an ecosystem is being developed that can leverage institutes' complementary strengths. MaRS, North America's largest innovation hub, stands in Toronto's research park surrounded by world-class research hospitals, leading research institutes, and startups and other companies producing groundbreaking discoveries and solutions. The Vector Institute has made health a key strategic pillar, while the University of Toronto has received a \$250-million donation to fund a new center for AI in healthcare.

One exciting example is Bluedot, which combines public health and medical expertise with advanced data analytics and AI to anticipate infectious disease risks. Bluedot was among the first to identify the emerging risk from COVID-19 and the very first worldwide to publish a paper accurately predicting its global spread. Bluedot is used by the Canadian government to help inform its decision-making.

Toronto: Canada's AI powerhouse

The AI national strategy has helped Canada focus its efforts, thematically and geographically, to create some of the world's best AI ecosystems. Toronto, Edmonton and Montreal have traditionally been the AI hubs, with

Canada was the world's first country to develop a national AI strategy

Toronto the country's true AI powerhouse, with an ecosystem built on outstanding pioneering research; a community of top international scientists and ongoing influx of young talent; direct two-way exchange with industry; and innovation catalysts, like the [Creative Destruction Lab](#) which helps scale science- and technology-based businesses.

DEEPLARNING

Driving breakthroughs from learning bionic arms to predicting ER patient numbers: it's all possible. Many experts in deep learning see healthcare as one of the most promising areas for AI, with countless possible applications. At the University of Alberta, for example, researchers are testing an experimental bionic arm that uses machine learning to adapt to and anticipate an amputee's movements. While at the Humber River Hospital in Toronto powerful computers can now process and analyze data from across the hospital (admissions, waiting times, transfers, discharges, etc.) to accurately predict patient numbers, waiting times and bottlenecks in ER — two days beforehand.

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“HAPPINESS IS NOTHING
MORE THAN GOOD HEALTH
AND A BAD MEMORY.”

ALBERT SCHWEITZER



COLLOZ

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Netherlands Innovation Network

The Netherlands Innovation Network stimulates international cooperation between companies, research institutes and public authorities in the fields of innovation, technology and science. The network's activities help implement the international knowledge and innovation agenda of the Dutch government. We address national and global challenges, aiming to further develop key enabling technologies through international cooperation and a worldwide network of offices in: France, Germany (including Switzerland), Israel, United Kingdom, Sweden, Russia, USA (including Canada), Brazil, China, India, Japan, Taiwan, Singapore and Korea.

We develop international cooperation by:

- providing knowledge and information on the latest innovation, technology and science developments around the world;
- connecting to potential partners abroad;
- organizing innovation missions, seminars, workshops and matchmaking events abroad;
- identifying funding mechanisms for bi- and multilateral cooperation.

We look forward to the opportunity to help you become involved in sustainable innovation partnerships, so we can together advance our common innovation, technology and science ambitions.



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