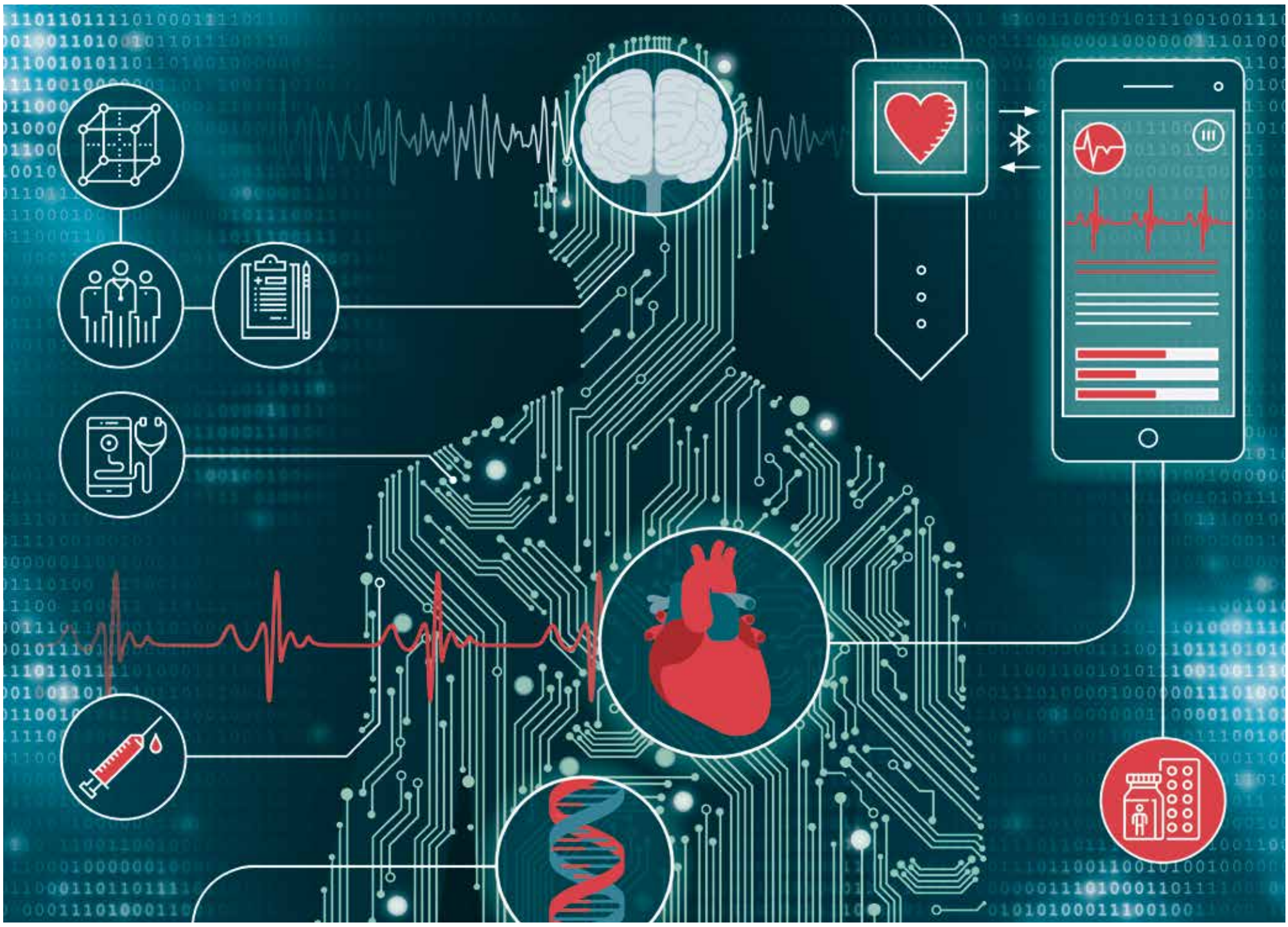
FUTURE OF HEALTHCARE



Improve outcomes with your healthcare data

PROMATIX
BUSINESS INTELLIGENCE

- ✓ SELF-SERVICE ANALYTICS
- ✓ POPULATION PROFILING
- ✓ RISK STRATIFICATION
- ✓ PREDICTIVE MODELLING
- ✓ UNSTRUCTURED DATA

PROMATIX

+ableau®
PARTNER

Extensive experience working with NHS organisations in

- Implementing advanced analytical techniques
- Informatics & digital healthcare strategy authoring & review
- Data visualisation & visual analytics
- Self Service Analytics
- Tableau Software training & Consultancy

Tableau Software helps people see and understand data.

Tableau delivers fast analytics, visualisation and rapid-fire business intelligence.

GET IN TOUCH

0844 693 1535
promatixbi.com

TRY TABLEAU FREE

FUTURE OF HEALTHCARE

DISTRIBUTED IN THE TIMES

RACONTEUR

PUBLISHING MANAGER
Alexandra Bowman Bassin

PRODUCTION EDITOR
Benjamin Chiou

MANAGING EDITOR
Peter Archer

HEAD OF PRODUCTION
Natalia Rosek

DIGITAL CONTENT MANAGER
Sarah Allidina

DESIGN
Samuele Motta
Grant Chapman
Kellie Jerrard

CONTRIBUTORS

MARTIN BARROW
Former health editor, news editor, foreign news editor and business news editor at *The Times*, he specialises in the NHS and social care.

DANNY BUCKLAND
Award-winning health journalist, he writes for national newspapers and magazines, and blogs on health innovation and technology.

VICTORIA LAMBERT
Award-winning journalist specialising in health, she contributes to a wide range of national newspapers and magazines.

ROWLAND MANTHORPE
Associate editor of *WIRED* magazine, his co-written book on the philosophy of confidence was published this month.

KATRINA MEGGET
Former editor of *PharmaTimes Magazine*, she contributes online to websites including *The Telegraph* and *pharmaphorum*.


Philips

Philips' Lumify ultrasound solution, which operates with compatible Android smart devices, launched commercially in the US last November

Technology can treat NHS ills

As the National Health Service tosses and turns in a fever of rising patient numbers and strain on resources, innovative new technologies could offer a cure

OVERVIEW
DANNY BUCKLAND

The NHS was founded on a wave of optimism following the Second World War when the UK population was 50 million and the average life expectancy was 65.8 years for a man and 70.1 for a woman.

In most measures, it has been a towering success. Public health education and vaccination programmes have drastically reduced disease burdens and our life expectancy has risen to 79.5 years for men and 83.2 for women.

But the NHS is almost a victim of its own success as it copes with a population of 65.1 million, featuring an over-65 age group that has increased by 21 per cent in the last decade. Although its budget has increased from the equivalent of £10 billion in 1948 to £116.5 billion for the current financial year, it is straining at the seams.

Even though the NHS is an institutional supertanker, with 1.3 million employees dealing with one million patients every 36 hours, there is hope it can be navigated away from financial disaster with the use of a suite of technologies that can revoluntionise healthcare delivery.

Apps, telemedicine, and trackers and monitors linked to smartphones open up a new landscape of patient engagement that could drive the biggest hammer on health costs – prevention. From genomics to text messages, the big players IBM, Google and Philips are investing heavily in research and development as healthcare technology surges from a cottage to powerhouse industry.

Its white-heat potential has been captured by NHS England chief executive Simon Stevens who launched a fast-track programme to bring leading-edge technologies to the health service front line. Announcing a range of measures to encourage innovation, he rallied the NHS Confederation Conference in Manchester: "Now – at a time when the NHS is under pressure – rather than just running harder to stand still, it's time to grab with both hands these practical new treatments and technologies."

His aim is to accelerate uptake of new medtech devices and apps for patients with diabetes, heart conditions, asthma, sleep disorders, and a sweep of other chronic and lifestyle health conditions by excising red tape, boosting the NHS Innovation Accelerator programme and encouraging partnerships across health, industry and academia.

£116.5bn

NHS budget in 2015-16, up from the equivalent of £10 billion in 1948

Intoxicating words, but old NHS hands feel more needs to be done to release the bureaucratic choke-hold preventing the venerable health service transforming into a slick, responsive performer.

Johnny Marshall, policy director for NHS Confederation, which represents the organisations and managers that deliver NHS care, was in the audience that welcomed Mr Stevens' rattling keynote speech in June. "The government has put aside some money for NHS innovation, but when considering the scale of transformation and investment in infrastructure that the NHS needs, it is not enough," he says.

"Leaders from New York State's $54-billion Medicaid service, who know a thing or two about these things, are among those encouraging the NHS to keep innovating, not despite the strain on the NHS, but because of it."

Funding aside, the fundamental challenge is to make sure that, when the giants of technology and the supercool startups unpack their shiny new healthcare tools, the public can actually understand and use them to make significant changes to their health and prevent debilitating lifestyle conditions.

Mr Marshall advocates an "innovation pathway" to steer digital innovations through development, approval, value-for-money assessments and adoption. "It's important to remember that innovation is not simply a matter of testing out new devices, it is about empowering citizens to be better able to care for themselves and engage in decisions about their care," he says.

Harnessing the full benefits of new technologies will also require a "monumental" change-management programme, according to Lee Francis, director at healthcare IT providers Trustmarque. He believes NHS boards and managers must prioritise IT literacy across the workforce so innovation can reach patients swiftly, safely and effectively.

Mr Francis highlights that many community trusts have electronic patient records, but poor data coverage means staff are still handwriting clinical notes. "This shows how such obstacles present a real threat to digital transformation," he adds. "This risks stopping healthcare innovation from getting to the patients that need it most."

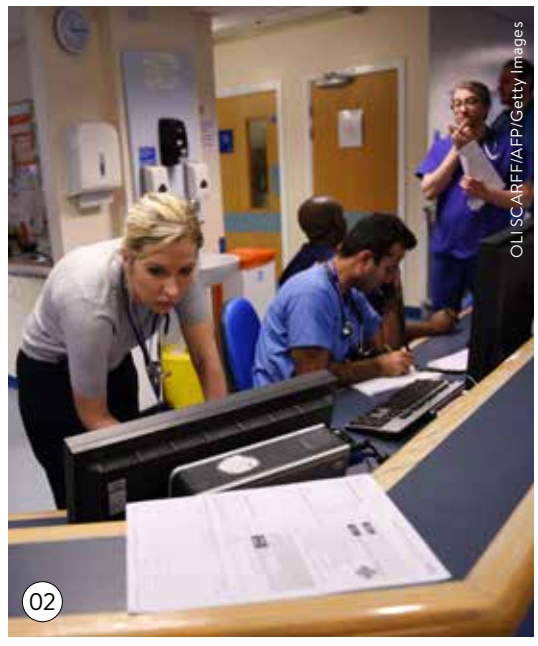
The scale is there. Around 275 million patients globally are tracked by Philips monitors, in clinical and lifestyle settings, which provide data that can help treat complex conditions and enable people to live independently with multiple conditions, says Jeroen Tas, the company's chief executive for connected care and health informatics.

That data, when refined, can make a difference, but the public must be involved. "Patients, care providers, payers and other stakeholders need to collaborate, and create a shared understanding and vision on how best to apply digital technologies in meaningful ways," says Mr Tas.

Technology is already proving a salvation for NHS services and budgets. When Pennine Care NHS Foundation Trust redesigned its protocol for wound infections, by using text messages to encourage self-management backed up by nursing care, it reduced patient appointments by 53 per cent with 100 per cent patient satisfaction.

The road to a new, wired and connected health service and a revolution in public responsibility will be bumpy, but establishing the NHS in 1948 was far from easy.

Share this article online via **Raconteur.net**



01
Boris Johnson during the Vote Leave battle bus tour in May

02
Clinical staff at a busy A&E department in Wigan

Brexit shock could hit the NHS hard if the UK economy flatlines...

Despite promises of extra cash for the NHS, health services in Britain could face severe trauma following the vote for Brexit

NHS AND BREXIT
DANNY BUCKLAND

The big red bus emblazoned with the pledge to channel £350 million in European funds to the NHS is one of the most enduring and incendiary images of Brexit. Fronted by Boris Johnson and a series of high-profile Leave campaigners, it symbolised a high watermark in the divisive public campaign for Britain's future.

Its significance in persuading 58 per cent of the public to turn away from Europe will be debated well into the future, but the present problem is how to stabilise the NHS as it lurches towards a critical existence on financial life support.

The health service's ability to withstand sudden surges is being questioned as it expends every ounce of capability dealing with ever-rising demand and an inexorable demographic tidal wave. The population is growing and we are living longer with more chronic conditions at the very time national finances are being squeezed by global economic forces and the uncertainty caused by the referendum decision to leave the European Union.

The NHS is largely funded by general taxation, so its fiscal health is linked to the state of the economy. With two-thirds of NHS trusts in England running a deficit, the balance is precarious.

Despite huge criticism, the last two governments have spared health the full blade of its austerity cuts, but the fallout from Brexit contaminates the NHS's future. Aside from the ideology, the cold numbers post-referendum are chilling: the UK's trade deficit widened to a seven-month high in August and the pound slipped below $1.30; it was $1.50 pre-Brexit.

Markets fluctuate on trading positions unrelated to public health services and their capricious nature alone is no reason to push the panic button but, taken with a prolonged period of efficiency savings or cuts, the fear is the NHS is being hampered by the frostbite of an advancing economic ice age.

"The direct impact of Brexit is already happening and one of the key issues is related to the value of sterling. If people in the NHS are working here partly on the basis of sending money back home, then the value of that money has plummeted," says Sally Gainsbury, senior policy analyst for the Nuffield Trust, the independent health research charity.

"This is compounded by the fact that NHS wages have been all but frozen for the last five years and few people think Brexit will have a positive impact."

A down-graded economy will make it harder for NHS trusts to keep pace with the 4 per cent annual savings required to bridge a funding and delivery gap of around £22 billion over the next four years. NHS costs are basically outstripping funding, but the government believes 4 per cent annual savings will balance the books.

"That level of saving has never been achieved and doubles what has been possible over the last four years of cuts," says Ms Gainsbury, whose report *Feeling the crunch: NHS finances to 2020* questions if the NHS can make the savings without compromising services.

> Brexit can only compound the perilous position the NHS is in – the NHS was already in a perfect storm and it has just got a whole lot worse

"The ability of the NHS to withstand shocks such as a sudden winter crisis has been degraded; people are saying that winter lasts all year in the NHS now. There is already an inability to deal with the volumes of patients coming through and it will take three years of double those cost cuts before we would have some money to invest," she says.

"In an ideal world, commissioners will be able to come up with schemes that successfully and genuinely reduce demand for NHS services or reprovide services in different settings that are cheaper without damaging public access to health. But I fear the only way they can spend less is by rationing. We already have examples where CCGs [clinical commissioning groups] are raising the thresholds saying you can't get treatment until you reach X, Y or Z. I think people are now looking at clinical justifications they wouldn't have looked at before."

Crude rationing, such as restrictions on hip operations and cataract surgery, will spread with non-urgent operations postponed, she says. It is a view shared by the Royal College of Surgeons, which is concerned that patients will be forced to endure longer waiting times unless NHS funds are boosted.

But the Department of Health appeared to have fared well in last November's Spending Review when then-chancellor George Osborne pledged an additional £8.4 billion above inflation for the NHS by 2020-21. Investments were promised across scientific research, mental health, cancer, dementia and new hospitals in a strategy aimed at providing 800,000 more operations and treatments, 5.5 million more outpatients' appointments and over 100 million more free prescriptions.

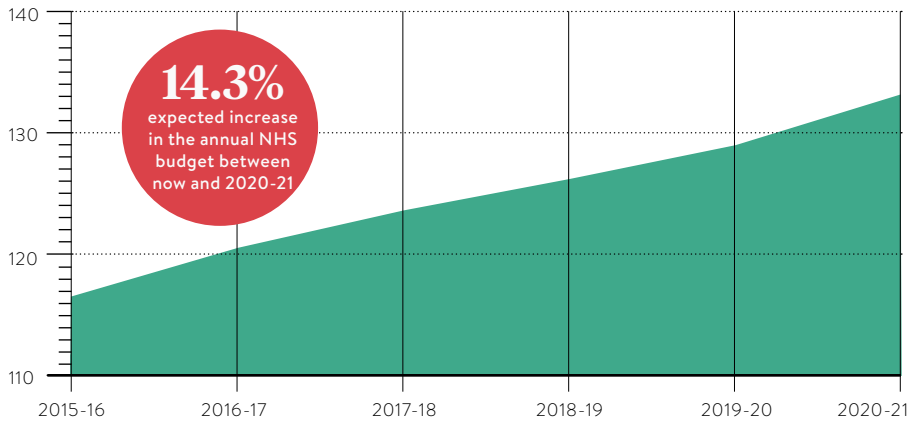
But the cross-party House of Commons select committee on health warned it was simply not enough to meet targets set out in the government's showpiece NHS regeneration strategy, the *Five-Year Forward View*.

Their concern was echoed by Richard Murray, director of policy at independent health charity The King's Fund, who says: "The government must review its priorities for the NHS and be honest with the public about what the service can deliver with the funding it has been allocated."

Ben Bradshaw, Labour MP for Exeter and a health committee member, is also concerned that a post-Brexit malaise will slow innovation, reduce the nation's medical research potency and discourage the brightest brains from viewing Britain as a fulcrum for scientific advancement.

"The impact of Brexit will depend on how the government responds to the economic shock it has caused," he says. "We were very clear in the select committee that the current level of NHS funding is not sustain-

NHS SPENDING BUDGET TO 2020-21 (£BN)



Source: Department of Health 2015

SUSTAINABILITY AND TRANSFORMATION FUND

Marbury / Shutterstock

The £14 billion set aside for the radical transformation of the NHS seems like a lottery win with funds showering down over five years into 44 clusters of trusts and clinical commissioning groups to promote better, more responsive and cost-efficient services that will improve public health and wellbeing.

The designated areas will be able to access £2.1 billion a year from the fund to launch coherent and effective services that meet local needs, with the aim of treating more patients outside hospitals as different elements of care unite for a seamless service.

But the fear is that it will be used to cover the operational deficits that infect two-thirds of NHS trusts.

"It is supposed to be about new services, but the bulk of it may have to go to bailing out hospitals because the NHS has systematically cut the amount they get paid over the last five years, which is why we have ended up with hospital deficits," says Sally Gainsbury of the Nuffield Trust.

"Hospitals are leaner and cheaper, but have only managed to make half of the 4 per cent cuts needed, so if that continues the Sustainability and Transformation Fund will get swallowed up, leaving little money for modernising and reshaping the NHS. The danger is that it will be used as a sticking plaster that won't even cover the deficits."

She predicts that £1.8 billion of next year's allocation will go on deficits, leaving just £393 million for transformation.

able if services are going to be maintained, let alone improved.

"It will have an effect on the public finances unless the government responds with a radical change of direction on the NHS and public spending in general. But the negativity will hit the NHS quite quickly because there is huge uncertainty on the status on EU nationals who keep the NHS going in many parts of the country. Confidence and morale are important, and morale was already at rock bottom

"Given the importance of science and technology in helping us manage increasing demand and develop new and effective treatments, I am concerned that progress with technology and innovation will be slowed. One of the very alarming things we were told by Sir Bruce Keogh [NHS England medical director] when he and Simon Stevens [NHS England chief executive] came before the committee just before recess was that the referendum has already had an impact on our ability to tap into shared science and funding, and also to attract scientific talent."

The select committee is now restructuring its work schedule to cope with the complexities of a European exit, which will involve unravelling EU legislation covering public health issues such as food safety, and water and air quality, as well as health issues.

"Brexit can only compound the perilous position the NHS is in," adds Mr Bradshaw. "The NHS was already in a perfect storm and it has just got a whole lot worse."

Health secretary Jeremy Hunt, commenting before the referendum, said it was inevitable a Leave vote would cause volatility, and hit the NHS and all public services if the economy contracted by a predicted 5 per cent. His stark message was: "This would inevitably mean less money for public services like the NHS."

NHS FACTFILE

1m
patients are dealt with by the NHS every 36 hours

15.9m
hospital admissions were registered in 2014-15, up 31 per cent over ten years

81.7%
increase in NHS net spending between 2003-04 and 2015-16

£1,994
spending per capita on medical services, health research, central and other health services in England in 2013-14, an increase of £153 from 2009-10

Source: NHS Confederation

NHS Improvement, the body that oversees NHS-funded care, has launched a series of incentive measures to ease the NHS trusts' quest to defray their deficits and the £14-billion Sustainability and Transformation Fund, which aims to provide new models of care, promises light at the end of the tunnel, if the compelling urge to use it to plug funding gaps can be resisted.

Share this article online via **Raconteur.net**

Meet Olivia, the virtual nurse on duty

Virtual avatars and chatbots look set to supplement health services as artificial intelligence revolutionises healthcare

ARTIFICIAL INTELLIGENCE
ROWLAND MANTHORPE

Olivia is patient and tireless, with soft brown eyes and a gentle bedside manner. She wears the light blue scrubs and fob watch of an NHS nurse, which in fact she is. But Olivia is also a robot, a virtual avatar accessed on a smartphone app.

Currently on trial with the groups responsible for Vanguard in NHS Dudley Clinical Commissioning Group in the West Midlands, Olivia will check your symptoms, give advice on treatment and help schedule an appointment, whether that's in English, Spanish or Dutch; she speaks all three, as well as Czech and Japanese.

Is it the same as talking to a live nurse? "We would all like that attention," says Ivana Schnur, co-founder of Sensely, the Californian start-up behind the device. "But the sad truth is our systems can't afford it."

Until recently, computers weren't good at this kind of messy interaction. They could respond to commands, but only in the exact form they were programmed to understand. Now that's beginning to change. New techniques in applied mathematics and computer science are being used to create machines that can learn without being explicitly programmed – that can, in effect, think for themselves. Applied to healthcare, it's an insight with potentially revolutionary consequences.

Take diagnostics, known in the profession as triage. When most people feel unwell or injure themselves, they take one of three steps: they check the internet, call 111 or turn up at Accident and Emergency. The first is unreliable, the second and third are costly. Hence the appeal of automated healthcare.

"The most expensive part of healthcare is the human being," says Ali Parsa, chief executive of Babylon. "The only way to solve the supply-and-demand issues so many health services face is to leverage artificial intelligence or AI."

Babylon's AI-powered health app checks patients' symptoms and medical background against a vast database of diseases. The service is currently being used in two hospitals in Essex, with what Mr Parsa claims are human-beating results. "We're 91 per cent accurate," he says. "That makes us about 17 per cent more accurate in tests than a nurse and 14 per cent more accurate than a GP."

01

This is the promise of AI – speed and accuracy at scale. For patients, that means remote check-ups, even in areas with relatively little healthcare provision. Babylon is working on making its system available in Rwanda. For doctors, it brings much needed assistance keeping track of records and making clinical decisions. IBM Watson – the supercomputer that crushed human champions at *Jeopardy!* in 2011 – is being used by clinicians at the Memorial Sloan-Kettering Cancer Center in New York, where it is fed with papers and patient records related to cancer. The resulting data is then made available to hospitals and clinics around the world.

In June, Watson was able to diagnose a 60-year-old woman's rare form of leukemia, after oncologists at the University of Tokyo had puzzled for months over the illness. Watson sifted through 20 million research papers to come up with the proper diagnosis. The entire process took ten minutes.

What makes these machine-learning systems so powerful is their ability to find patterns in datasets too large and complex for human brains to comprehend. In healthcare, where data is plentiful, albeit in practice sparse and poorly connected, the range of possibilities is tremendous. Add in data from digital interactions and it becomes positively dizzying.

One recent project from Microsoft Research Labs showed that search engine logs could be used to pre-empt diagnoses of pancreatic cancer. Another, from new startup HealthRhythms, uses AI in smartphones to track signifiers of bipolar disorder, monitoring everything from movement to speed of typing. "AI is perfect for making sense of the thousands of data points our app collects each day," says Mark Matthews, HealthRhythms' co-founder.

02

01
Olivia, developed by Sensely, is able to schedule GP appointments, check symptoms and give advice on treatment

02
DeepMind is working with Moorfields Eye Hospital to develop an AI system to spot sight-threatening conditions in OCT scans

Medical imagery is especially amenable to machine-learning. In July, Moorfields Eye Hospital in London announced that it was working with Google's AI research division, DeepMind, to develop an AI system to spot sight-threatening conditions in digital scans of the eye.

"We've millions of scans," says Pearse Keane, a consultant ophthalmologist at Moorfields, who is leading the study. "But the amount of imaging data is far outstripping our ability as clinicians to derive the maximum benefit from it." DeepMind's system will be trained on Moorfield's library. The study is in its early stages, but Dr Keane is optimistic it will soon be able to identify cases which warrant a referral.

DeepMind, which was acquired by Google in 2014 for $500 million, came to international attention when it's Alpha Go AI defeated the world champion at the game of *Go* in March 2016. Now it is turning its attention to healthcare, with the launch in February of DeepMind Health. "In many areas of healthcare there are front-line clinicians saving lives every day using technologies that were developed a decade ago," says Mustafa Suleyman, DeepMind's co-founder and head of applied AI. "The margin for impact is unlike any other sector."

> What makes these machine-learning systems so powerful is their ability to find patterns in datasets too large and complex for human brains to comprehend

The firm's first venture into the field – a collaboration with London's Royal Free NHS Trust to detect acute kidney injury – was marked by controversy, after complaints that the firm had access to private patient data. Mr Suleyman says the row stemmed from a "lack of understanding" about the role DeepMind was playing. "We're basically at this point plumbers. We're processing data on behalf of the controller," he says.

Basic plumbing might seem an odd use of DeepMind's capabilities, but Mr Suleyman says a great deal of it is necessary before the NHS is ready to reap the benefits of AI outside research projects. "The precursor to that is to build super-secure infrastructure, the likes of which haven't been seen in healthcare," he adds.

So when will the machines be able to take over? Mr Suleyman frowns. "For as long as I can see forward – more than ten years, maybe twenty years – there is no way a machine-learning algorithm is going to be making those decisions without human oversight," he says. "In most other areas, humans combined with an algorithm is always the best combination. That's the paradigm – human-assisted decision-making." Everyone, meet Olivia. You'll be spending a lot of time together.

Share this article online via **raconteur.net**

HEALTH APP SOLUTIONS DESIRED BY UK CONSUMERS

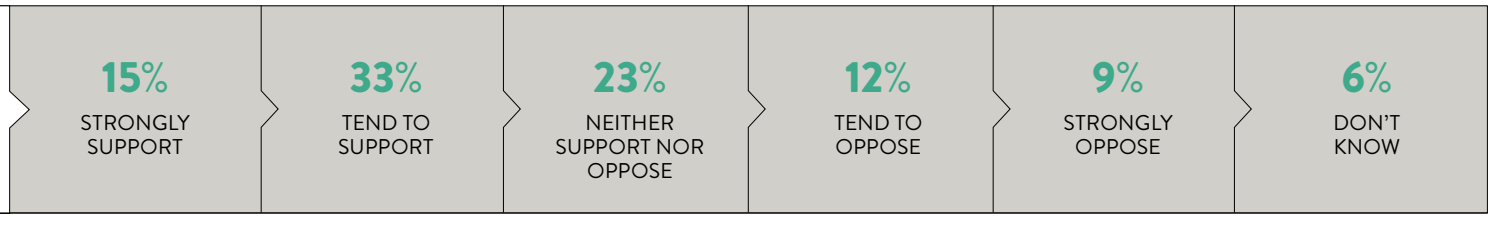
EITHER AN APP RUN BY THE NHS OR APPROVED VIA A SO-CALLED NHS KITEMARK

Source: YouGov/Trustmarque 2015

CONSUMER ATTITUDES TOWARDS VIRTUAL HEALTHCARE

To what extent do you think you would support or oppose the NHS giving patients the option of virtual consultations, over Skype for example, where appropriate?

Source: YouGov/Trustmarque 2015



COMMERCIAL FEATURE

WIN-WIN HEALTH PLAN BENEFITS EMPLOYEES AND EMPLOYERS

A health cash plan can boost employees' wellbeing and cut their time off from work due to illness

Simplyhealth

With demand on health services at an all-time high, and people more health-aware than ever before, employees are increasingly looking to their employer for help and support with their health and wellbeing.

Consequently, workplace wellness is a top priority for organisations. However, issues such as changing workforce demographics and a rise in mental health issues have also made employee wellbeing a challenge for business.

In addition, sickness absence represents one of the biggest costs to businesses in terms of lost productivity and staffing costs.

One solution that can help employers and their staff tackle the myriad of health and wellbeing challenges in a practical way is to introduce a health cash plan as part of a wider wellness strategy. This provides employees with access to a range of everyday health benefits, from dental check-ups and new glasses, to physiotherapy treatments and online GP consultations.

Because they can claim back the cost of these healthcare expenses (up to annual limits), employees tend to seek treatment more quickly, and therefore prevent health issues from becoming more serious and leading to absence from work.

According to Simplyhealth, the UK's leading health cash plan provider, many organisations are not fully aware of the real value of these benefits. Chief commercial officer Dan Spacie says: "Independent research commissioned by Simplyhealth in 2015 has shown that health and wellbeing benefits feature regularly among the top three things that employees would like to see from their employer. We also know that millennials are increasingly looking to employers to provide cost-effective healthcare solutions.

"Health cash plans help to cover an employer's duty of care responsibilities and, unlike private medical insurance (PMI), which is more expensive and often available to more senior members of staff, they are cost effective and allow the entire workforce to benefit from them.

"They benefit the employee, by helping them with their everyday healthcare expenses; the employer, by reducing sickness absence and improving employee retention and engagement levels. By encouraging employees to take greater responsibility of their health needs, it can also help ease some of the burden on the NHS.

"According to findings from the *Simplyhealth/YouGov Everyday Health Tracker*, the majority (56 per cent) of UK adults believe the NHS can't do everything when it comes to covering all areas of healthcare."

One advantage of implementing a wellbeing strategy is that it can help people to identify health issues, through regular check-ups and health screening, before they become serious enough to force them to take time off work.

"Dental check-ups are a great example of this," says Mr Spacie. "Because they are covered by a health cash plan, people will have them on a regular basis. Prevention is always better than a cure and any minor problems caught early can be treated very quickly. Oral health can also be a good indicator of other health conditions, so a visit to the dentist can flag up signs of ill health that can then be dealt with as soon as possible, again reducing the risk of taking time off work."

Musculoskeletal problems and mental health issues are two of the biggest causes of long-term sickness absence, according to the 2014 *CIPD/Simplyhealth Absence Management Survey*, and a comprehensive wellbeing strategy can help employers to tackle both.

"Health cash plans that include access to counselling services can be extremely beneficial in managing a number of mental health issues, such as stress and anxiety, and helping individuals to remain supported in the workplace or make a speedier return," says Mr Spacie.

56%
of UK adults believe the NHS can't do everything when it comes to healthcare

1/3
of employers said that absence levels had increased because of staff with caring responsibilities outside work

People are living longer and staying in work longer, with the result that workforces comprising four and five generations of employees are becoming more common. It is important for employers of these multi-generational workforces to understand the differing and often complex health and wellbeing needs of an age-diverse workforce.

Increasing longevity has created additional challenges for employers, as workers with ageing parents now find themselves needing to source good eldercare support services. According to the *CIPD/Simplyhealth Absence Management Survey*, more than a third of employers said that absence levels had increased because members of staff were struggling to cope with their caring responsibilities outside work. Access to eldercare services, advice, and age and mobility-related support can all be included in a workplace wellness plan.

From a financial standpoint, as an employee benefit, wellness plans are also an attractive alternative to PMI. Mr Spacie adds: "PMI is becoming more expensive and a number of providers are now excluding things like dental and optical care from their cover. It also tends to be an exclusive benefit. In a company employing 50,000 people, PMI may only be offered to the most senior managers. What about the rest of the employees?"

Health cash plans can be offered on a flexible basis, allowing employees to pick and choose the benefits that are most important to them, and have the biggest impact on their lifestyles. They encourage employees to be more involved in their own health and can lead to greater employee engagement, resulting in improved productivity. Employers can also offer wellness benefits through a tax-effective salary sacrifice scheme or offer benefits fully paid for by the employer.

Mr Spacie concludes: "Wellness propositions can bring huge benefits to organisations, helping them to deliver an effective workplace wellness strategy, reducing the costs of sickness absence, while also gaining an increase in talent retention, employee engagement and productivity. The NHS, meanwhile, also benefits from an easing on demand for some of the healthcare services that employees can access through a wellness plan. This is a win-win business scenario that makes a significant contribution to health and wellbeing in the UK."

> From a financial standpoint, as an employee benefit, wellness plans are an attractive alternative to private medical insurance

RIGHT
Dan Spacie
Chief commercial officer

For more information please visit www.simplyhealth.co.uk/corporate

NHS has lessons to learn from nations around the world

The UK is lagging behind other countries in its readiness to meet the healthcare challenges of the 21st century with connected technology

GLOBAL HEALTHCARE

MARTIN BARROW

The National Health Service is going through a period of unprecedented change. The NHS *Five-Year Forward View*, published at the end of 2015, is a blueprint for a sustainable health service that delivers high-quality care to patients, still free at the point of delivery.

At the heart of the transformation proposed by Simon Stevens, NHS England chief executive, is a profound re-engineering of the health service through technological innovation. It will require greater integration between the multiplicity of providers of health and social care, and a sharing of data on an unprecedented scale, while protecting the integrity of a system holding the most sensitive information.

It is a mighty challenge for an organisation with a poor track record in information technology, where referral letters, trolleys groaning under patient notes and fax machines are still part of its fabric. While the NHS remains a source of national pride for the care it provides, it is increasingly difficult to defend the health service's slow progress in embracing the latest technology for the benefit of patients.

This is certainly true when the performance of the NHS is measured against that of health systems in other countries confronted by similar challenges, including an ageing population and prevalence of long-term conditions at a time of economic austerity. The 2016 *Future Health Index*, which measures a country's readiness to meet some of these key healthcare challenges, places the UK ninth out of thirteen countries, based on a range of measures.

The UK scores highly on access, due to its universal healthcare coverage. But the country performs well below the 13-country average when it comes to integration of healthcare systems and the adoption of connected healthcare. And that will be a major concern for Mr Stevens as he embarks on his NHS revolution.

The index was commissioned by Philips, the technology company, and produced by the Institute for the Future, an independent non-profit research group dedicated to identifying emerging trends that will transform global society. The index is based on the input and self-reported behaviours of patients and healthcare professionals throughout 13 geographically and developmentally diverse countries to produce a snapshot of how healthcare is experienced on both sides of the patient-professional divide.

Some of the countries that lead the index, such as the United Arab Emirates (UAE) and the Netherlands, are prosperous; China comes in third place, well ahead of the United States and the UK. Japan, the world's third-largest economy, comes in last, trailing less-developed countries including South Africa and Brazil.

Emerging countries tend to lag their developed counterparts when it comes to access to healthcare, from prevention to diagnosis and treatment. For example, just 40 per cent of Brazilian patients agree they have access to the information and resources they need to live healthily, compared with 68 per cent in Australia and 70 per cent in Singapore.

> The UK performs well below the 13-country average when it comes to integration of healthcare systems and the adoption of connected healthcare

Yet optimism around connected care is strikingly more pronounced in emerging countries, perhaps because they are not burdened by ageing legacy systems. Almost three-quarters of healthcare professionals in emerging economies see a future where everyone owns devices, software and mobile applications to help manage health. In developed countries, 44 per cent think the same. Emerging countries also appear to be earlier adopters of technology.

Bringing together the disparate segments of healthcare systems has proven elusive everywhere. But there are often more positive assessments of the state of integration in emerging countries. In the UAE, 43 per cent of patients feel the health system is very or completely integrated, the highest rate among countries polled, followed by China (28 per cent) and Singapore (25 per cent). This compares to 11 per cent in the US and 6 per cent in France.

The UK's poor overall ranking reflects low perceived levels of integration and adoption of connected-care technology. On integration the UK scores 53.7 against the index average of 55.8 and on technology adoption it scores 45.3 against 47.8.

The index provides a number of key findings for the UK. Healthcare professionals and patients are acutely aware of the lack of integration in the health system, as well as the importance and potential benefits of integration. Patients are more likely than healthcare professionals to believe technology can play an important role across the health continuum. Healthcare professionals have reservations about connected-care technologies in general, which may limit their willingness to embrace these technologies fully.

Finally, concerns over cost and bureaucracy are significant, and must be addressed in the implementation of healthcare integration and connected-care technologies.

What does market leadership look like? The UAE is first among the 13 countries surveyed for the index, ranking above average on all measures. Satisfaction with the healthcare system, particularly with regard to access, is high. The gap between the UAE and 13-country total is greatest in perceived access to homecare. Connected-care technology is viewed positively by healthcare professionals and patients, and there is a high level of knowledge and usage. Interest in online interactions and digital information-sharing is high, especially among healthcare professionals.

The Netherlands, whose healthcare system is more directly comparable to the UK, comes second in the index, outscoring the UK on all principal measures. A blend of private insurance and state funding gives the edge in terms of access.

The UK would do well to acknowledge the principal learnings from the index, shared by this unique survey of healthcare professionals and patients around the world. It is clear that in developed countries rigorous data and privacy regulations present challenges to the free flow of information needed in more technology-driven healthcare systems.

Technology is a generational issue, both for healthcare professionals and for patients, suggesting that adoption will rise in the years ahead as a digitally native generation comes of age. Data is proliferating, but doesn't travel as more data than ever is being gathered although it is not yet being shared between institutions or agencies.

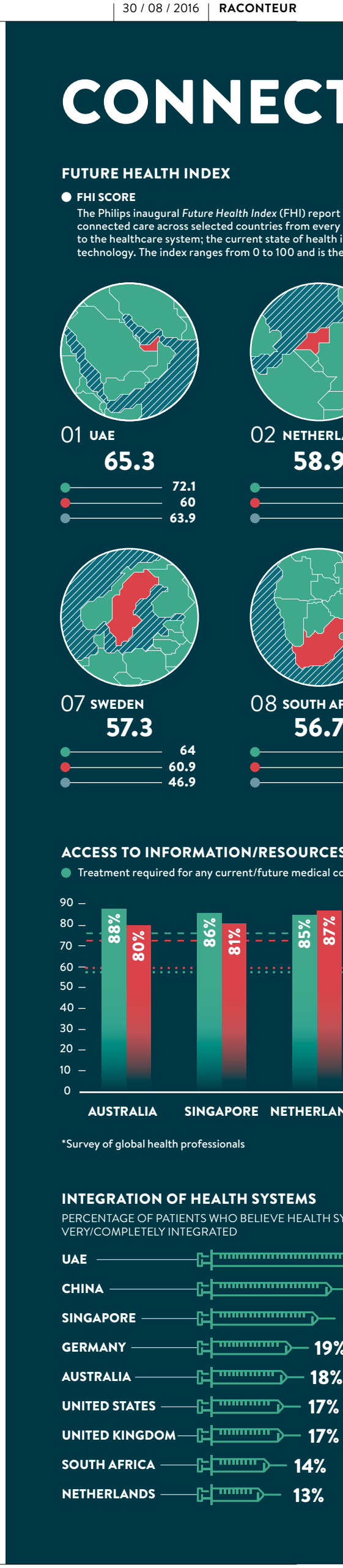
Bureaucracy is a major stumbling block to the further co-ordination of healthcare, particularly in countries with large publicly funded systems such as the UK, the Netherlands and Sweden. Trust is key and in many cases is lacking, which creates mistrust around the sharing of sensitive data.

Sizeable majorities of healthcare professionals and patients view integration as an important goal with a positive impact on the health of a population. But perceptions of high cost are a significant concern across developed and emerging economies.

Most of these concerns have come to the fore in the UK, as the NHS grapples with the complexities of implementing a genuinely connected healthcare system for all. They are certainly high on the agenda for Professor Bob Wachter, who has been asked by the Department of Health to review computer systems across the NHS. His review is seen as a crucial step to support the NHS in its ambition to be a paperless organisation by 2020, with all patient records held digitally.

The Wachter review will be delivered later this year to the National Information Board (NIB), which was established by the Department of Health to put data and technology safely to work for patients and healthcare professionals. An example of NIB's work is the My NHS website, which brings together information from a range of data sources to make it possible to compare services and organisations. The ambition is that intelligent transparency will drive a cultural shift that will permeate the entire health and social care system, and be embraced by the public and patients.

If this can be achieved it will represent a major step towards lifting the UK towards the top of the next *Future Health Index*, to the benefit of patients and healthcare professionals.



TED HEALTHCARE WORLDWIDE

measures the level and preparedness of continent. It is split into three sub-indices: access integration; and adoption of connected care average score of the three sub-indices

ACCESS
Perceived level of access for all people to a range of healthcare solutions and services across all health needs

INTEGRATION
Perceived state of functional integration and interoperability between healthcare systems

ADOPTION
Perceived proliferation, take-up, use of and familiarity with connected care technology

ANDS
72.4
58.8
45.5

03 CHINA
58.1
64.8
57.3
52.3

04 AUSTRALIA
57.9
71.5
55.1
47.2

05 SINGAPORE
57.7
70.1
54.8
48.2

06 UNITED STATES
57.4
68.4
54.7
49

FRICA
63.2
55.3
51.6

09 UNITED KINGDOM
56.4
70.2
53.7
45.3

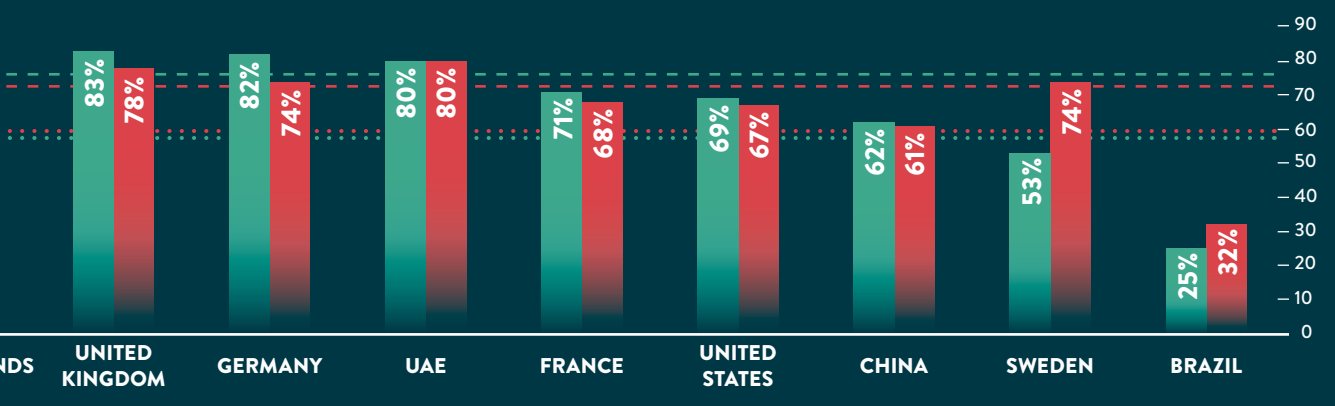
10 FRANCE
54.6
66.9
54.4
42.6

11 GERMANY
54.5
69.2
52.8
41.5

12 BRAZIL
50.6
45.4
57
49.4

S AND TREATMENT*

onditions
Information/resources needed to live healthily
Emerging average
Developing average



Source: *Future Health Index*, Philips 2016

TOP BARRIERS TO CONNECTED CARE TECHNOLOGY ADOPTION

SURVEY OF GLOBAL HEALTH PROFESSIONALS

46%
Cost of devices

29%
Privacy concerns/ data security

25%
Health system bureaucracy

24%
Training for patients to use new systems/technologies

22%
Attitude of patients to adopt new systems/ technologies

22%
Trust in accuracy of data collected by the devices

19%
Awareness of devices

19%
Government health-related regulation/policy

19%
Training for healthcare professionals

19%
Technology to run/ charge devices in people's homes

Source: *Future Health Index*, Philips 2016

YSTEMS ARE

43%
28%
25%
%

TOP COUNTRIES FOR HEALTHCARE SPENDING

Healthcare spending as a percentage of GDP
FHI score

01 UNITED STATES
17%
57.4

04 NETHERLANDS
11%
58.9

07 SOUTH AFRICA
9%
56.7

02 FRANCE
12%
54.6

05 GERMANY
11%
54.5

08 BRAZIL
8%
50.6

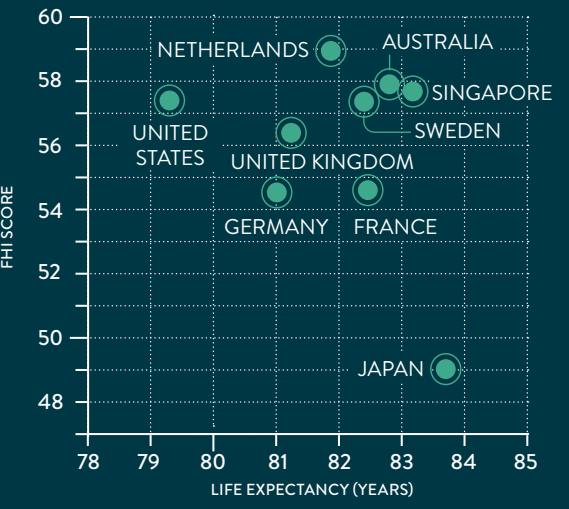
03 SWEDEN
12%
57.3

06 JAPAN
10%
49

09 UNITED KINGDOM
8%
56.4

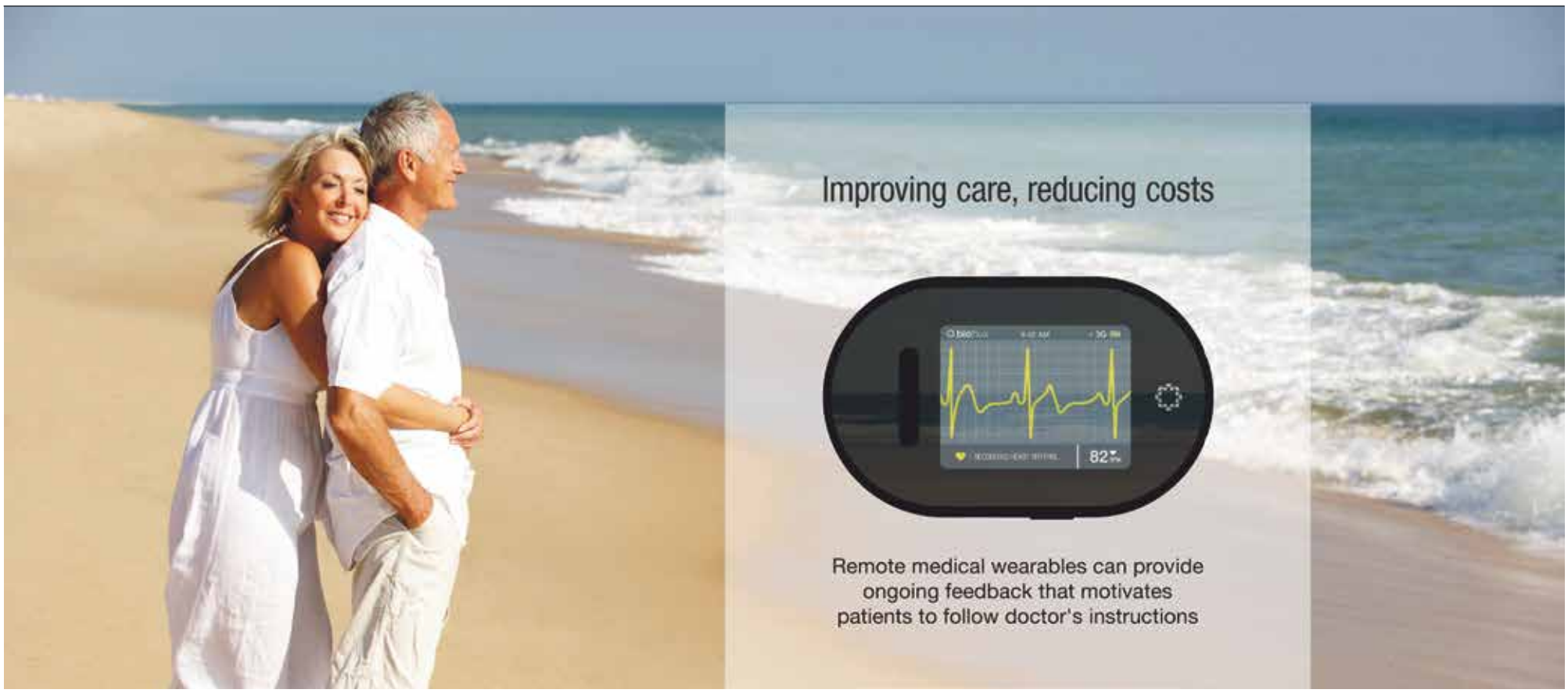
Source: *Future Health Index*, Philips 2016

TOP COUNTRIES FOR LIFE EXPECTANCY



Source: World Bank 2014 / World Health Organization 2015

COMMERCIAL FEATURE



WEARABLES ARE A GOOD FIT FOR HEALTHCARE

Medically relevant wearable technology can relieve the overstretched NHS while engaging patients in their healthcare and promoting preventive medicine

biotricity | MEASURING VITALS

Healthcare systems are facing a crisis. Chronic illnesses combined with an ageing population and rising healthcare costs are rapidly increasing the burden on the NHS. The pressure will continue to rise because 23 per cent of the UK's population will be aged over 65 by 2039.

The Department of Health estimates that patients not adhering to their physician's guidance cost the NHS up to £300 million a year in unused medicines. According to the Center for Disease Control, 86 per cent of all US healthcare spending is on treating chronic medical conditions. Globally, health-risk behaviour, such as physical inactivity and poor nutrition, costs healthcare systems $53 billion. With chronic illnesses on the rise, the demand for long-term care increases and patient compliance is crucial.

All too often, patients who have gone through some ordeal and are forced to live with a condition for the rest of their lives are not compliant with health regimes and swiftly fall back to their old habits. In order to avoid this type of relapse and the subsequent treatment costs, long-term patient care must be improved and, most importantly, the current healthcare landscape must be changed.

biotricity, a leading-edge healthcare technology firm, believes that compliance rates can be increased and quality of life enhanced with diagnostic and monitoring support.

We are accustomed to people with diabetes routinely monitoring their own glucose level, and adjusting diet and regime. But what if that principle could be extended to a cardiac patient so they could detect an alarming arrhythmia and share ECG data with their physician? The integration and ultimate adoption of wearable technology into healthcare practices has the ability to reduce patient visits, as physicians will be able to monitor and track patients' health remotely.

The big challenge is to change the current healthcare model where physicians diagnose and treat conditions and diseases after manifestation. "Costs are spiralling out of control because we have a population growing older and suffering from chronic illness. We have increased demand at a time of dwindling resources and these demographics are pushing healthcare systems around the world into bleak territory," says Waqaas Al-Siddiq, **bio**tricity's founder and chief executive. "The fact that patients don't comply is a further drain, so we must switch from a reactive approach to preventative care."

biotricity is a front runner in the race to bridge the healthcare gap by employing innovative monitoring technology that is initially designed to help patients and physicians deal with a range of heart problems.

Patient monitoring devices have the potential to disrupt the healthcare industry by aiding the self-management and prevention of chronic disease. As a result, research into such technology is becoming more prevalent. Rapid integration into existing healthcare diagnostic and billing systems will position such solutions to resolve a number of health-related problems by making it easier to track compliance and health outcomes.

> **bio**tricity is a front runner in the race to bridge the healthcare gap by employing innovative monitoring technology

Sensor worn technology is now at a point where it can be utilised to guarantee health and wellness transparency from the inside out. Tomorrow's medical-grade wearables will connect into a system of constant monitoring, improving healthcare by collecting real-time biometrics from the body, and will become a key to incentivising physicians and individuals to utilise the devices themselves.

biotricity's approach is to provide intelligent diagnostic and post-diagnostic solutions for physicians, and then make the technology available to the consumer for long-term care management. This offers the ability to reverse the trend so that costs drop and physicians can maintain an accurate picture of patient health in real-time. Interventions can then be timely and more effective. The company has chosen to enter the cardiac market with its first product as cardiovascular disease is the number-one killer in the US and UK.

biotricity has created two wireless ECG monitoring devices. **bio**flux, which already has been submitted to the US Food and Drug Administration, improves a doctor's ability to test and diagnose patients with cardiovascular problems. **bio**life, the company's second offering currently in development, is a wearable medical device for individuals to track their progress in real time and stay motivated while making lifestyle changes.

For example, **bio**flux can provide a critical function via its unique 30-day monitoring option, which adds to the accurate ECG diagnostic. The device will monitor a patient's heart rhythm and transmit the data in real time to a 24-hour monitoring lab, which can provide early warning to both patient and physician on any changes in heart rhythm.

"Based on our research, it is clear that if an individual has a feedback loop, it incentivises them to follow doctor's instructions," says Mr Al-Siddiq.

In addition, wearables are tapping into social circles, encouraging users to exchange information, measure progress and provide extra support.

Mr Al-Siddiq, a former investment adviser and an expert in wireless technology, believes medical wearables can contribute to significant savings for health systems and be a beacon for preventative care. The innovations illuminate a pathway from the current financial gloom afflicting global healthcare systems.

"If we don't solve this, we are going to see a lot of bankrupt healthcare systems," he concludes. "The only way to address the deficiencies in healthcare is to encourage disease prevention and drive up patient compliance. Patients with long-term conditions deserve better care and **bio**tricity's monitoring devices pave the way for a fundamentally new approach to help them lead long, healthy lives."

For further details on the launch of **bio**flux and **bio**life, please visit www.**bio**tricity.com

Wearing your heart rate on your sleeve

Self-monitoring medical conditions with connected wearable devices offers the prospect of cutting NHS costs while involving individuals in their healthcare and promoting healthier lifestyles

WEARABLE TECHNOLOGY
VICTORIA LAMBERT


Shutterstock

We've never been more in control of monitoring our health. From wristband step and heart-rate trackers to weighing scales that monitor body fat, wearable and self-monitoring medical technology is changing the way we think about our own biology. Soon there will even be implants with sensors, which can measure blood data in people with diabetes.

This high-tech approach to healthcare is popular too. According to a recent survey by software service company Trustmarque and YouGov, 81 per cent of respondents said they would like to see more connected and wearable devices used in healthcare, with half of respondents saying they thought wearables were potentially most useful to monitor vulnerable people.

Collette Johnson, director of medical at electronics consultancy Plextek, believes the use of self-monitoring devices has enormous potential and could help the NHS save at least 60 per cent on the average cost per patient. Crucially, she thinks, the public is ready for it.

"Wristband monitors like Jawbone and Garmin vivofit are helping us become more aware of how our bodies work," she says. "They have taught us to be more aware of what is normal for our bodies.

"And in a patient with a chronic condition, such as diabetes or chronic obstructive pulmonary disease, a wearable monitoring device might alert them earlier to a change in their health which needs medical attention. So wearables can help patients engage with the medical community sooner."

Cédric Hutchings, vice president for health at Nokia Technologies, agrees. "The greatest benefit from wearables is in chronic disease management through empowering the patient," he says.

The key, Mr Hutchings says, is finding ways wearables can be part of everyday life for users. For example, Nokia has just launched a set of scales, called Body Cardio, which use pulse wave velocity (PWV) measurements. This means users can log accurate measures of weight, body composition (fat, muscle, water and bone mass), standing heart rate and PWV, which is a key indicator of cardiac health and associated with hypertension and risks of cardiovascular incidents. The scales, available from Apple, are Nokia's most advanced product to date.

Developments in the internet of things (IoT) – the network of physical devices, vehicles, buildings and other items embedded with electronics, software, sensors and network connectivity, enabling them to collect and exchange data – are allowing healthcare to be administered more remotely.

Roman Chernyshev, senior vice president of healthcare and life sciences at global technology consulting firm DataArt, says: "It is a matter of time before medical devices collect continuously vital data from millions of patients around the world in real time and simultaneously compare them.

"These developments will change how diseases are diagnosed. Medical conditions will be predicted as a result of data and constant monitoring of health information.

"Technological advancements will result in healthcare being everywhere, although it will be almost invisible. One IoT device that is being developed will be used to prevent metabolic diseases such as diabetes. An implant will constantly collect and analyse blood data from diabetes sufferers and independently inject insulin without the need for human interaction or prompting."

But the experts acknowledge there are concerns over self-monitoring devices too, not least from the public. Trish Birch, global healthcare consulting practice leader at IT consultancy Cognizant, says: "The amount of data being collected via IoT in this way is growing quickly, with the market expected to be $5.8 billion in 2019, according to analyst firm IMS.

"However, consumers are sceptical of sharing health information, with only 32 per cent sharing information collected by apps with their providers."

Cyber crime is also a worry for some, not unreasonably says David Emm, principal researcher at security software experts Kaspersky Lab. "Medical devices are a potential target for cyber attackers," he says.

"In the case of medical devices and wearables, such an attack could be highly targeted; for example, altering the dosage or combination of medicines to cause harm to a specific individual, or to damage the reputation of the company that has developed the device or the medication.

"And fixing flaws in medical devices may be far from easy. For example, with pacemakers, if a vulnerability is found then it may not be possible to roll out a patch, as you could for a smartphone or PC. So it may be difficult to secure these devices once implanted, as the whole thing may need replacing – a costly and logistically difficult process."

> We will be able to filter and aggregate information better, generating insights and outcomes

Ms Johnson at Plextek also warns that for some, self-monitoring devices can induce competitive urges which are not healthy. "We don't want people losing weight, for example, and going too far. The interface has to be able to warn, in the right way, when enough is enough," she says.

"There is also the danger of creating a new worried well. We don't want people to become alarmed."

And there has been a backlash in the United States against that type of tech. Last year the Federal Trade Commission fined two companies which created apps promising to "diagnose" skin cancer. In January, a fraud class action lawsuit on behalf of consumers nationwide was launched against Fitbit Inc. over complaints that certain of its heart-rate monitors failed to measure user heart rates accurately.

"The industry must be responsible," says Ms Johnson. "It is not good enough to give consumers personal data without context. We need to make it clear that self-monitoring devices can show you only what is normal for you."

This will be even more important, she believes, in the future as self-monitoring moves into the home connecting families and collecting community data.

The solution for designers may lie in creating products which are easier to use and interpret. Nokia Technologies' Mr Hutchings says: "As we get more sophisticated, we will be able to filter and aggregate information better for patients, their doctors and nurses, generating insights and outcomes. But there is work to be done on the user-interface."

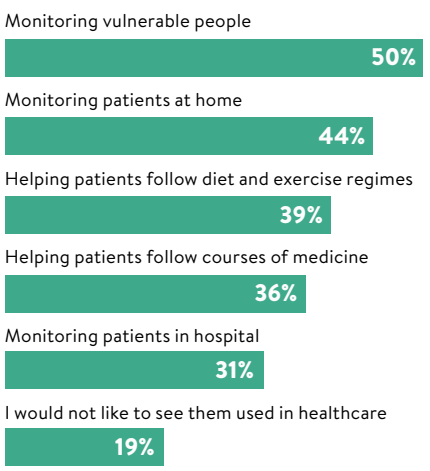
He compares it to the latest cars. "There are hundreds of sensors in a modern car, but they don't all provide data for the driver. Indeed, the dashboard offers quite simple information.

"Our scales are the same – they won't overwhelm you with biometrics. They are not going to give you a full diagnostic picture every time you use them, but they may alert you to a trend worth talking to your doctor about."

CONSUMER ATTITUDES TOWARDS CONNECTED AND WEARABLE HEALTHCARE DEVICES

WOULD YOU LIKE TO SEE DEVICES USED IN HEALTHCARE?

HOW UK CONSUMERS WANT DEVICES TO BE USED



Source: YouGov/Trustmarque 2015


Withings

BELOW
Withings Body Cardio, developed by Nokia Technologies, uses pulse wave velocity to monitor weight, BMI, body composition and heart rate

Share this article online via **raconteur.net**

Tailor-made tablets set to transform prescriptions

3D printing has generated a buzz across multiple industries and its promise in medicine could transform how we deliver healthcare

3D PRINTING
KATRINA MEGGET

The air has the acrid tang of chemicals. Flasks with colourful liquids sit in fume hoods, while purple-gloved researchers in white lab coats study chemical structures on their computer screens. Pharmaceutical sciences lecturer Dr Stephen Hilton hands over a pair of safety goggles and the tour of the lab at University College London begins.

It's not the chemicals that are of interest per se, but rather the row of box-like machines which line the back wall. This lab is home to the Stephen Hilton Group; 14 researchers with a particular interest in 3D printing and chemicals. There are 11 3D printers here; one makes a buzzy whirr as it spits out a mould.

3D printing, also known as additive manufacturing, takes a computer-generated design and turns it into a three-dimensional object via a special printing machine that deposits successive layers of a material, such as plastic or metal, on top of each other. The technology is well known for making quirky pieces of jewellery and plastic replicas of the Eiffel Tower. But as costs have decreased, interest has surged and the technology is now common in mainstream manufacturing from car parts to toys.

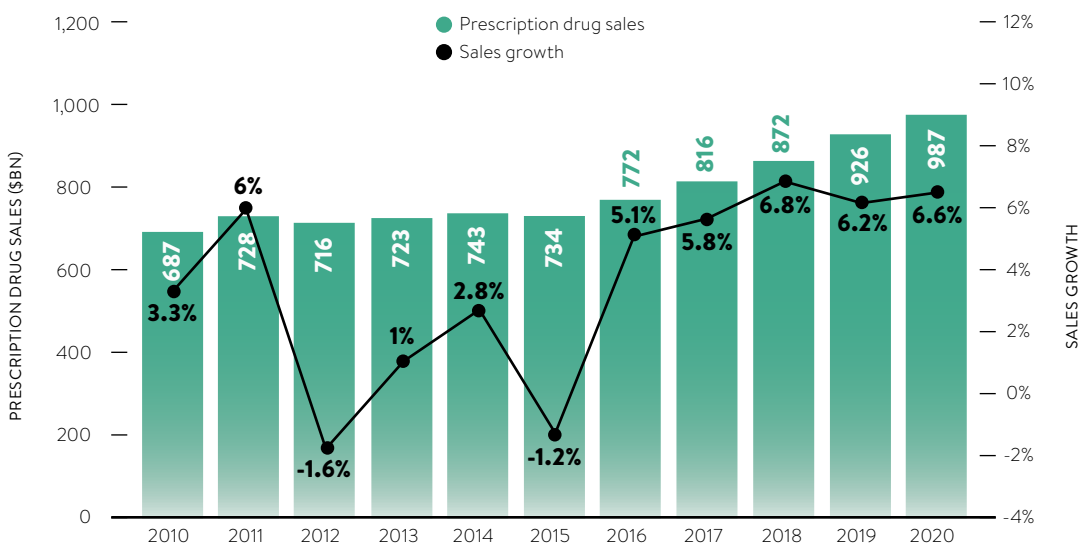
Healthcare is set to be a big winner from 3D printing, with hearing aids, prosthetics and implants already transforming the space. According to consultants Frost & Sullivan, the healthcare industry will drive 3D-printing growth, which will balloon into a $6-billion market by 2025.

> Healthcare is set to be a big winner from 3D printing, with hearing aids, prosthetics and implants already transforming the space

But it's what 3D printing might mean for the pills we pop that is really sparking interest and a flurry of research activity. Last year, the US Food and Drug Administration approved epilepsy drug Spritam (levetiracetam), the world's first 3D-printed pill. The tablet, manufactured by Aprecia Pharmaceuticals, is printed with alternate layers of powder and droplets of liquid, creating a very high-dose drug with the ability to dissolve quickly. These features together are unachievable by conventional manufacturing.

Spritam's approval is a milestone moment and now paves the way for a future of 3D-printed medicines. But these medicines won't be anything like today's. As Dr Hilton notes, 3D printing allows concepts to move "beyond imagination". "It's amaz-

GLOBAL PRESCRIPTION DRUG SALES FORECAST



Source: EvaluatePharma 2015


Shutterstock


Aprecia Pharmaceuticals


Aprecia Pharmaceuticals

ABOVE
3D printing machine at Aprecia Pharmaceuticals lab

LEFT
Epilepsy treatment Spritam, produced by Aprecia Pharmaceuticals, became the world's first approved 3D-printed drug in August 2015

$6bn
estimated value of the healthcare 3D-printing market by 2025

Source: Frost & Sullivan

ingly exciting," he says. "There's a lot of hype about 3D printing, but a lot of potential as well. In theory we can make anything we want."

With this in mind, we may be popping pyramid-shaped pills in the future or 4D-printed medicines that change shape in the stomach. This is based on research by Dr Hilton's group, which found that different shaped drugs, which can only be made through 3D printing, had different rates of drug release. Complex "polypills" could also become a reality, as seen with research at Nottingham University, where one pill containing five drugs was successfully 3D printed.

These innovations would change how patients take their medications in the future, with doses tailored to individuals and one pill a day or week replacing the multitudes of tablets that might normally have to be taken. Drugs would be easier to take, work better and have fewer side effects.

Even more futuristic is research at the University of Glasgow, where regius professor of chemistry Lee Cronin is creating 3D-printed chemical reactors that carry out reactions to make new molecules. Using a digital code, changing the shape of 3D-printed vessels and altering a mix of 3D-printed base ingredients, Professor Cronin can create chemical reactions and produce different drugs. He is validating this approach to develop a 3D-printer-like chemical robot to accelerate the discovery and manufacture of new novel drugs in the future.

Yet 3D printing won't just change the types of medicines we take in the future, but also how we access them or rather where they will be printed. 3D printing pills at home is a possibility, but still a long way off, with numerous issues to address.

More likely, and what many experts speculate, is that pharmacies will become 3D-printing medicine hubs. Here pharmacists would be handed a prescription, download a recipe from a pharmaceutical company, then 3D print the drug from basic ingredients while the patient waits.

"This is something pharmacists are waking up to," says Professor Jayne Lawrence, chief scientist at the Royal Pharmaceutical Society. "They're starting to realise this is a possibility." And the time-frame? About ten years.

There are, of course, a number of challenges with this future scenario, including quality control, cyber attacks and illegal or counterfeit use. Meanwhile, regulatory hurdles, safety liability issues and outdated healthcare infrastructure could potentially delay adoption.

> Experts speculate that pharmacies will become 3D-printing medicine hubs

Regardless, this future is very real. Printing drugs on demand would cut storage and shipping costs, and improve access to medicines. For developing countries, this alone would be monumental. "The beauty of 3D printing is it reduces health inequalities worldwide because medicine becomes accessible for everyone," says Dr Hilton.

Simple tablets will be printed initially, but the ultimate outcome is for personalised 3D-printed drugs. "People would be able to have medicine tailored to their age, size, gender and medical requirements, rather than having to conform to current mass-production standards," says Lucy Ackland, senior development engineer at the Institution of Engineering and Technology.

She believes personal information will be entered into the pharmacist's computer where an algorithm will adjust the recipe, producing a drug tailored to the patient. In this way, people with swallowing difficulties could get quick dissolve tablets, pills in fun shapes could be printed for children, ten drugs could be combined into one pill or brail bumps added for those with poor eyesight.

Back in his lab, Dr Hilton denies 3D printing medicines is revolutionary. The technology already exists, he says. It's just the matter of linking it together. The breakthrough is in exploring concepts you couldn't think about before. "Now you can take the concept of 'what if' and use the technology to explore its limits," he says. "This is beyond imagination. That's exciting stuff."

FIVE 3D-PRINTING MEDICAL BREAKTHROUGHS

01 PROSTHETICS
3D printing allows the customised production of prosthetics at a fraction of the cost of traditional prosthetics. Arm prosthetics are the most notable current use, with the technology particularly popular in war-torn countries. But research into other 3D-printed prosthetics such as ears is underway.

02 EQUIPMENT AND DEVICES
A variety of medical equipment can be 3D printed, such as forceps and clamps, which can drastically cut costs and could be particularly useful in developing countries where access and sanitation can be a problem. Already customised 3D-printed hearing aids are widely available.

03 MODELS
While models of any part of the human anatomy can be 3D printed, it's the fact these could be patient-specific based on CT and MRI scans that is exciting. Such models can be used in preparation for surgery or as tailor-made implants, such as in facial, dental or cranial reconstruction.

04 SCAFFOLDS
Researchers have been able to 3D print porous biodegradable scaffolds. These could be implanted in the body where cells migrate into the scaffold, forming new tissue and effectively regenerating a new organ. New bone has been grown in this way, while customised nose and ear scaffolds are also being explored.

05 3D-PRINTED TISSUE
Researchers have successfully 3D printed live cells to produce different tissue types including, skin, liver, cartilage and blood vessels. This 3D bioprinting can be used to test new medicines, but the future potential is to 3D print new organs using the patient's own cells, which would reduce organ rejection.

COMMERCIAL FEATURE

NEW BLOOD TEST GIVES HOPE TO CANCER PATIENTS

A new test may be a breakthrough in assessing the best treatment for cancer patients

Earlier this summer, impressive new clinical data from Chronix Biomedical showed for the first time that a cutting-edge blood test can accurately predict how a cancer patient will respond to treatment.

The test uses a pioneering technology called Next Generation Sequencing to detect fragments of DNA shed by cancer cells into the blood. Using sophisticated laboratory analysis, the test can detect tiny mutations in DNA – the fingerprints of cancer – and show doctors if their treatment regime is effective.

The results presented at this year's American Society of Clinical Oncology (ASCO) and American Association of Cancer Research (AACR) revealed the test could detect if a patient was responding to chemotherapy and, equally excitingly, modern immunotherapy as early as after the first cycle of treatment.

In recent years, a revolution in cancer therapy has provided doctors with a spectrum of new therapies. But despite major advances, many patients still fail to respond to treatment. The next frontier in personalised cancer medicine is for doctors to know quickly when a treatment is not working so they can move a patient on to an alternative.

Oncologists believe this type of blood test will become an invaluable piece of the cancer treatment puzzle.

Dr Glen J. Weiss, director of clinical research at Cancer Treatment Centers of America at Western in Arizona and principal investigator on both studies, says the results are very encouraging.

"There is potential value in using liquid biopsies to monitor how a patient's cancer might be changing. Liquid biopsies can be obtained more frequently and might help in the selection of the best possible treatments to combat the cancer. It could be an advantage in helping the patient if results of liquid biopsies give us the ability to know weeks in advance how a cancer is responding to treatment," he says.

Although a scan can show if a patient is responding to treatment, the latest trial showed the Chronix blood test – a liquid biopsy – provided this information between three and twelve weeks sooner. This can prove pivotal for patients and their oncologists while also helping hospitals to stop spending limited resources on drugs that don't work.

Chronix Biomedical is a pioneer of liquid biopsies and their new Delta Dot Test is the world's first liquid biopsy to predict the success of immunotherapy in a blinded trial.

The ASCO study, which involved 23 patients suffering from a range of cancers including breast, ovarian, lung, pancreatic and gastrointestinal tumours, quickly showed how each patient was responding to immunotherapy, with 88 per cent accuracy.

The separate AACR study showed equally impressive results in 24 patients with advanced cancer who were receiving chemotherapy.

Justin Stebbing, professor of cancer medicine and medical oncology at Imperial College London and Imperial College Healthcare NHS Trust, says liquid biopsies could deliver significant benefits.

"Liquid biopsies are going to be a major part of our anti-cancer armoury in the future. They will be used for diagnosis, prognosis and most importantly prediction, providing a real-time measure from a simple blood test of how a patient is responding," he says.

"They also provide enormous scientific and clinical knowledge regarding unique cancer populations, such as stem cells which are rare, but we will hopefully be able to use this to tailor our therapies to our patients, to personalise them, in the future."

> Oncologists believe this type of blood test will become an invaluable piece of the cancer treatment puzzle

Chronix Biomedical already provides doctors with screening for breast and prostate cancer. Their Second Opinion Test allows clinicians to differentiate between cancer and other prostate conditions, so patients can avoid more invasive needle biopsies.

Their latest blood test analyses fragments of DNA that are shed by tumours into the blood plasma. A doctor takes a 10ml draw of the patient's blood and the sample is sent to the Chronix laboratory, based in Germany. DNA is extracted from the blood plasma and prepared for sequencing.

The company's groundbreaking technology can analyse hundreds of millions of DNA sequences in a matter of hours, and identify both the cancer DNA and normal DNA. Within only four days, a unique DNA profile is made for the patient, revealing how they are responding to treatment. Delta Dot provides oncologists with a colour-coded system of red, green or blue dots to indicate when the cancer is still growing, has been destroyed or is mutating.

In the last few years, the mapping of the human genome has enabled scientists to begin building the most detailed picture yet of the molecular changes that fuel cancer growth and allowed researchers to look for ways to interrupt this. While immunotherapy may offer hope for many patients, it remains hard for doctors to know when a patient would do best on traditional chemotherapy or if they should instead be given a newer immunotherapy.

Dr Nick Plowman, senior oncologist at St Bartholomew's Hospital and The Hospital for Sick Children Great Ormond Street, London, and adviser to the company, says: "Using this technology to detect cell-free DNA circulating in the blood brings a new dimension to testing. The Chronix Delta Dot analysis seems to be leading the field in this regard. Not only can we now know much more quickly as to whether therapy is working, but monitoring for new mutations and implications for early detection of a cancer or its relapse make this the most exciting of research fields."

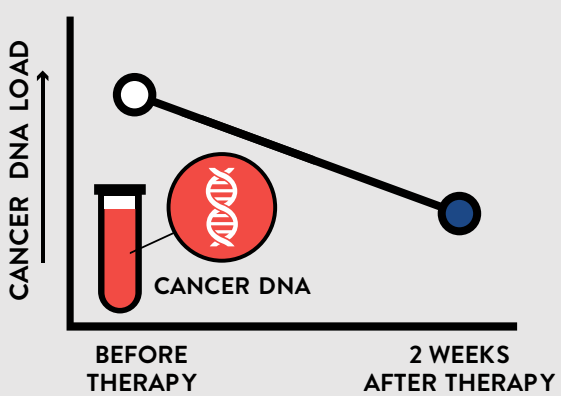
A new phase of trials of the Delta Dot analyses is now being rolled out in hospitals across the UK, with further results expected in 2017.

Howard Urnovitz, Chronix Biomedical chief executive, concludes: "We built this test to repeat history. The introduction of a HIV viral load test in 1996 gave medical researchers a target to formulate treatment approaches to stop people from dying of Aids. We believe this Delta Dot cancer DNA load test will lead to a world where no one dies unnecessarily of cancer."

For more information please visit www.chronixbiomedical.com

NEW TEST DETECTS CANCER DNA IN BLOOD

A new test specifically detects cancer DNA circulating in a patient's blood stream. This new tool enables physicians to determine if a patient is responding to therapy. A decrease in cancer DNA load indicates the therapy is working.



Getting closer in quest for a personal cure

Personalised medicine is already here, but in the future it will be more than just drugs tailored to our genetic make-up

PERSONALISED MEDICINE
KATRINA MEGGET

"I was given 12 months to live. That was three-and-a-half years ago," muses Adrian Webb, as he discusses his stage-four melanoma diagnosis. The 51-year-old distribution manager from the West Midlands had limited treatment options, but jumped at the chance to take part in a Cancer Research UK clinical trial of a personalised medicine specific for a particular genetic mutation.

"As a result of these tailored drugs, I went from having one year to live to remission. It's groundbreaking," he says. "Personalised medicine is working and saving lives – I'm evidence of that."

Mr Webb is part of a medical revolution; a shift from inefficient one-size-fits-all drugs to niche-busting personalised medicine that matches patients to drugs via diagnostic tests and biomarkers. Its aim is to improve outcomes and reduce side effects.

This isn't a new concept – breast cancer drug Herceptin (trastuzumab) led the way in 1998 – but with scientific advances and new technology, more diseases are becoming subject to tailored treatments.

Already more than 40 per cent of drugs in development are personalised medicines, a 2015 study by the US Center for the Study of Drug Development at Tufts University estimates. And over the next five years, this is forecast to increase by 69 per cent.

The driving force has been the completion of the Human Genome Project in 2003, when human DNA was fully sequenced. Now genome sequencing is cheaper and easier, explains Dr Bertalan Mesko, the medical futurist at medicalfuturist.com. "Analysis transforms my DNA information into practical data," which drives drug discovery, diagnostic development and tailors medicines to treat specific mutations, he says.

Cancer drugs have been the mainstay of personalised medicine, but new genetic insights mean a new era of personalised medicine has arrived, where any disease can be a target for a tailored therapy. In the future, there will be personalised treatments for diabetes, heart disease, Alzheimer's and obesity, among others. Both the UK and United States are investing heavily in this research.

> "Personalised medicine is working and saving lives – I'm evidence of that

The role of personalised medicine is simple – it seeks to cut down unnecessary and often expensive treatments that don't clinically benefit a patient, and might even cause them harm, says Tony Whetton, professor of cancer cell biology at the University of Manchester and director of the Stoller Biomarker Discovery Centre. The idea is to target the right treatment to the right patient at the right time. This will improve health outcomes and reduce healthcare costs.

With this in mind, the personalised medicine of the future will transform how healthcare is delivered and how diseases are managed. Within just one generation, healthcare, as we currently know it, will have changed, says Simon St Clair Carter, medical director and consultant urologist at The London Clinic, a private hospital and charity.

For instance, he has no doubt that routine genetic screening at birth, or even before birth, will occur in a bid to catch diseases early, prevent them from occurring and to tailor treatment accordingly. "Our genetic information will be as fundamental as knowing our national insurance number," he says. Such a move will allow the development of even more precise drugs tailored to our individual genetic make-up and other personal characteristics.

Dr Mesko agrees: "All trends and developments point in the direction where cheap whole genome sequencing becomes possible – probably in the next decade."

Genomic testing and disease profiling is already offered by some companies and hospitals, but as the cost of the technology – currently around £1,000 – decreases, this will become more widespread. Demand for genetic screening and personalised treatments will increase as knowledge develops and targeted medicines improve, putting pressure on governments to respond, says Mr St Clair Carter.

Technological advances, in diagnostics, analytics and digital technology, will also transform personalised medicine. We can envisage a future where technologies integrate, seen already with the rise in wearables and remote monitoring devices.

Peter Keeling, chief executive of diagnostic and personalised medicine analytics firm Diaceutics, calls it a "transformative tsunami". He says: "Personalised medicine is like the pebble in the middle of the pond, which triggers a reaction across the whole pond." Mr Keeling believes personalised medicine's greatest contribution to reshaping healthcare and the industry will be improving clinical outcomes and "taming the cost juggernaut" currently afflicting healthcare systems.

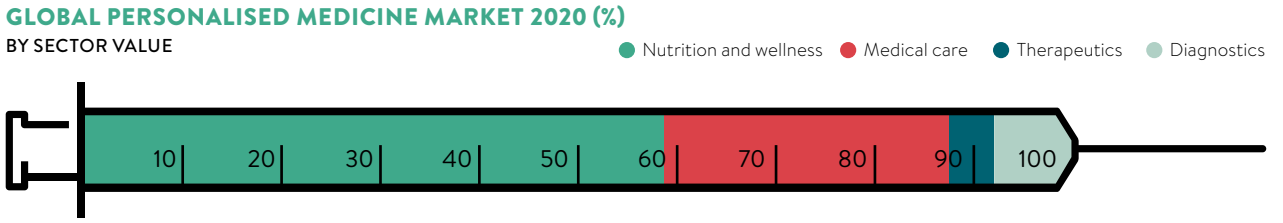
Of course, there will be challenges along the way from filling in the scientific and regulatory gaps to addressing concerns around consent and data privacy, protection and use, as well as how this might impact insurance policies. But the biggest roadblock will be the healthcare systems themselves, says Jenny Taylor, associate professor and programme director, genomic medicine theme, at the University of Oxford's Biomedical Research Centre. "For healthcare systems, the challenge will be moving from a population-based strategy," she says.

Despite the challenges, cancer patient Mr Webb sees a future that is rosy and full of promise. For him, the ultimate in personalised medicine would be a personal cure. "You have to believe. That's what personalised medicine is all about surely," he says.

Indeed, anything is possible. As Mr St Clair Carter concludes: "The future is here – we just don't understand it yet."

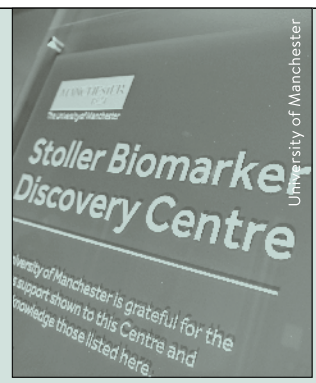
40%+
of drugs in development are personalised medicines
Source: US Center for the Study of Drug Development 2015

GLOBAL PERSONALISED MEDICINE MARKET 2020 (%)
BY SECTOR VALUE



Source: Grand View Research 2016

CASE STUDY: BIOMARKERS



Personalised medicine is already here with many advances in developing targeted therapies in cancer. But now interest is turning to accelerating these efforts. In Manchester, a new research centre opened its doors in June to do just that.

The University of Manchester's £18-million Stoller Biomarker Discovery Centre, developed in partnership with life sciences technologies firm SCIEX, will identify biomarkers of disease risk, diagnosis, response to therapy and prognosis for cancer, psoriasis and arthritis, among other diseases.

Biomarkers are molecules, traits or images, such as proteins in blood or urine samples, which can be measured. They are essential for the development of personalised medicine, and will be the future of healthcare to produce tests and treatments so individual patients can receive the right medicine at the right time and dose, says professor Tony Whetton, director of the Stoller Biomarker Discovery Centre.

"In the future, we need biomarkers to define diseases more accurately, discover more drug targets and to determine response to therapy. As we come to understand more about diseases, we are in a position to offer targeted therapies to a far greater extent than we have done in the past," he says.

Qlik

See your whole healthcare story with Qlik®

As healthcare becomes increasingly digital, analytics can be applied where decisions are needed. Analytics have massive potential to improve quality of care and patient satisfaction while reducing costs. Qlik's associative model empowers clinical, operational and financial users to see the whole story that lives within your data.

Visit healthcare.qlik.com to see why more than 200 NHS Trusts are already benefitting from Qlik's visual analytics platform.