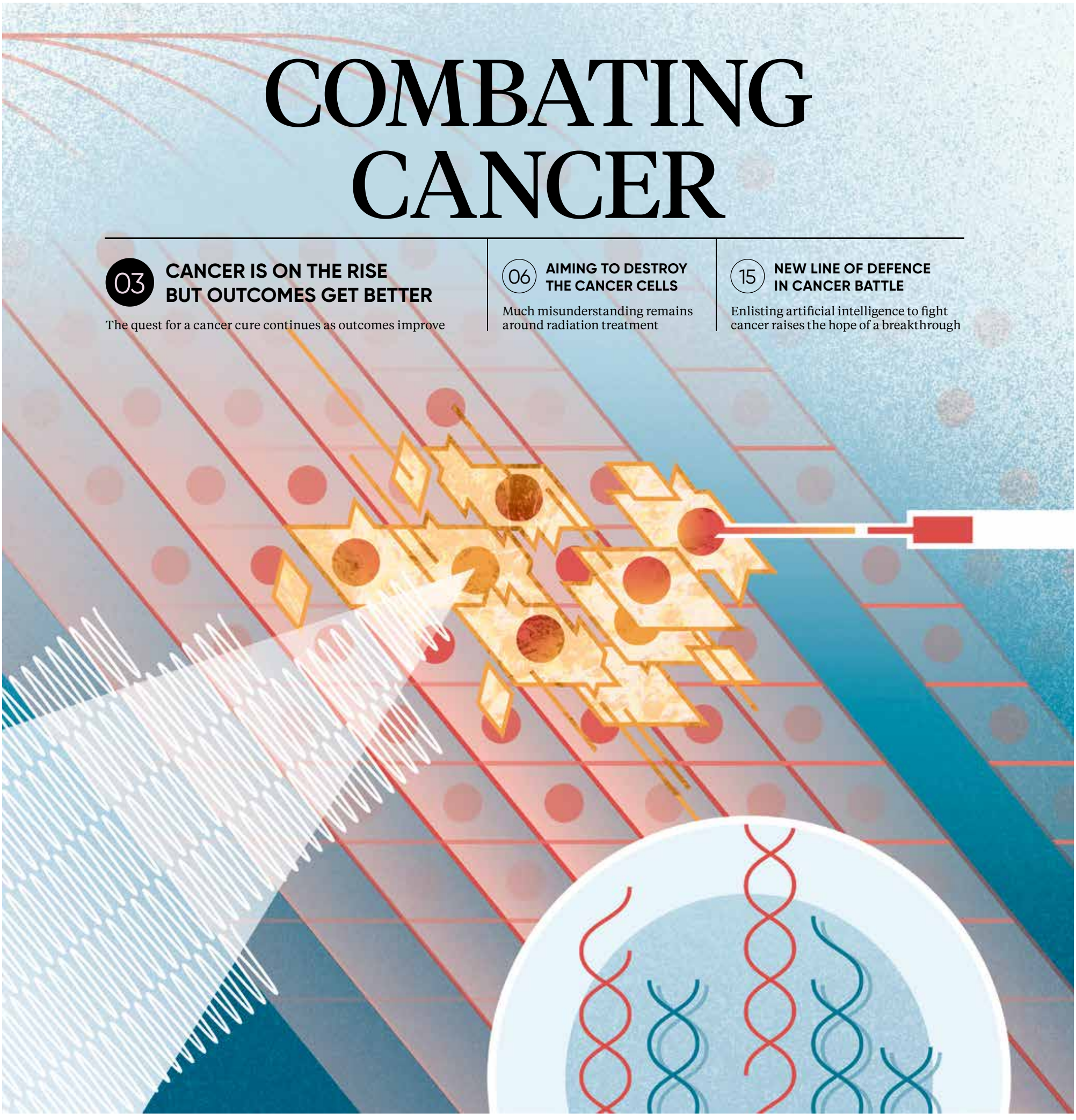
COMBATING CANCER



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PUBLISHING MANAGER
Senem Boyaci

PRODUCTION EDITOR
Benjamin Chiou

MANAGING EDITOR
Peter Archer

PRODUCTION MANAGER
Antonia Bolcas

DIGITAL CONTENT EXECUTIVE
Elise Ngobi

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.

NIGEL HAWKES
Science and health journalist, formerly with *The Observer* and *The Times*, he is a regular contributor to *The BMJ*.

JOHN ILLMAN
Award-winning author, he is a former national newspaper health editor and medical correspondent.

SHARON THIRUCHELVAM
Writer specialising in culture and innovation, she has contributed to *The Independent*, *i-D*, *Vice* and *Forbes*.

HEIDI VELLA
Freelance journalist specialising in technology and energy innovation, she is a regular contributor to the Institute of Engineering, Shepherd Media, Hybrid and Newsbase publishers.

@raconteur /raconteur.net @raconteur_london

RACONTEUR.net /combating-cancer-2017

PROGNOSIS

Cancer is on the rise but outcomes are improving

The search for a cancer cure should not diminish advances which enable people to live better and longer lives with the disease

DANNY BUCKLAND

Cancer. A word so full of dread that it has to be mouthed or whispered. A super-foe, cloaked in mystery and armed with lethal intent.

Science and medicine have been grappling with its malevolent complexities for generations and huge advances in genetic knowledge have brought significant victories that deliver cancer-free, extended lives.

Breast cancer has five-year survival rates that have improved by 34 per cent in just 40 years. An arsenal of pharmaceutical firepower, molecular manipulation, scientific innovation and reservoirs of patient data are turning the tide against other malignancies and the word "cure" is shouted across the cancer landscape.

But, despite evident progress, cancer rates in the UK are still rising and many experts believe our approach, in some cases, needs to be refocused on controlling as well as curing disease. And, better still, preventing it.

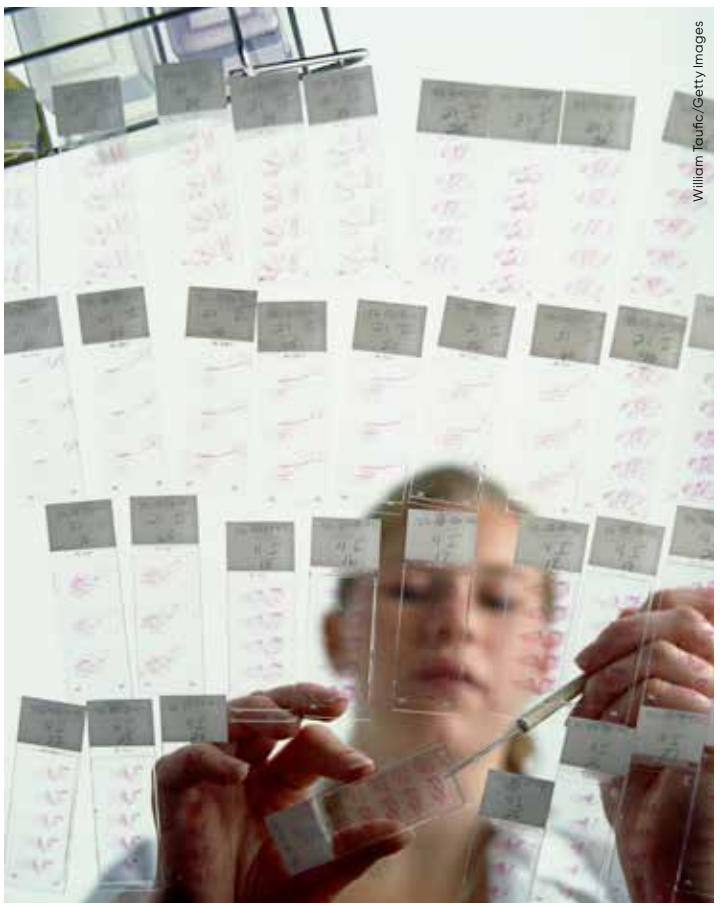
It is hard not to be inspired by cancer survivor stories or to feel uplifted by the research driving novel therapies. But that hope is tempered by the knowledge that the 1,578 drugs licensed to target diseases cover only 3.5 per cent of the 20,000 human proteins that could harbour defective elements which could trigger cancer, according to one study. The research, by the National Cancer Institute and US Food and Drug Administration, found huge swathes of human biology yet to be targeted.

Combating cancer is multi-faceted with social and economic factors as important as scientific discovery and medical application. Early detection from better diagnostics and monitoring can be as impactful as a eureka moment in the laboratory.

Venerating the pursuit of cures can destabilise the public perception of cancer survival, says Professor Steven Miles at the University of Minnesota's Center for Bioethics.

"This kind of reckless hype has long been repeated and long been discredited," he says. "Cancer is not one disease. It is a vast archipelago of different diseases. In this respect, it is like infectious disease. One might find a cure for a particular infectious disease, but the proposal that we are on the cusp of curing all infectious diseases for all time is untenable."

Professor Mel Greaves, director of the Centre for Evolution and Cancer at the Institute of Cancer Research, London, is equally forthright, advocating for a fresh perspective where living with cancer can provide extra years and a quality of life beyond incremental gains from drug discovery.



William Taufic/Getty Images

"Maybe it is more realistic to talk about finessing and restraining cancer; the more modest objective of keeping it under control," he says. "Take someone who is 75 and, if you could control the disease with good quality of life for ten to fifteen years, then that is a success for me.

"The drugs regime would be less toxic, there could be a good quality of life and, although you may lose some years of life, it is effectively a cure."

More than 250,000 people are diagnosed with cancer and 130,000 die as a result of it every year in England with an overall cost to society of £18.3 billion, according to Department of Health figures.

With an ageing population – the number of over-65s is predicted to reach 23.6 per cent of the population in 2035 compared to 15.9 per cent in 2005 – recently revised calculations by Cancer Research UK (CRUK) reveal that our risk of developing cancer is one in two, up from one in three.

That figure is already evident in statistics showing that the number of people diagnosed with cancer has risen by 12 per cent since the mid-1990s and CRUK predicts the rise will hit 33 per cent over the next 15 years.

"It could be that most of us will be living with cancer," adds Professor Greaves. "The idea that you can come up with patient-specific cocktails of drugs that you keep switching is unaffordable for the NHS and it is not practicable. We need something subtler, less expensive, more manageable and less toxic."

He highlights the treatment of chronic myeloid leukaemia in adults, which corrals mutant cells so they cannot break free and cause damage around the body. It is a less complex disease than some advanced cancers, but the principle of control and restraint in place of cure has been proven.

The thrill of a laboratory discovery will never diminish and questing science needs to have full rein, but efforts at the more prosaic end of the cancer challenge, prevention, public health campaigns, the timely use of diagnostics and how to manage cancer holistically need to be factored in.

Professor Winette van der Graaf, a specialist in personalised oncology at the Institute of Cancer Research, London, believes that the life-changing success of some therapies, which have boosted survival from one year to ten within 15 years, need to be viewed as test cases to inform the approach to combating and managing other cancers.

She is conducting a study to discover why some patients receive late diagnoses with the aim of making it easier to catch cancers earlier. "We also can learn more from the link between detailed clinical and all other data. It all starts with asking the right question and collecting the relevant data," says Professor van der Graaf.

"The role of patients will certainly increase in the next decade. They are also taking a role in the start of research, which is a very interesting development."

Studies have indicated that anywhere between 40 to 70 per cent of cancers are preventable. Professor Greaves adds: "New ideas about cancer evolution and drug combinations are good, and we should be actively pursuing them. But if we take our eyes off the ball on the prevention, it is a missed opportunity.

"We should keep looking for cures, but we should not be afraid of living with cancer by managing it and keeping it under control."

15.9%
of the UK population were aged over 65 in 2005

23.6%
will be over 65 by 2035

33%
estimated increase in the number of people diagnosed with cancer in the UK over the next 15 years

Cancer Research UK

PROSTATE CANCER

Marketing a life-saving message for men

Typically men do not talk about health issues and are slow to check out symptoms that could cost them their lives

01

SHARON THIRUCHELVAM

Prostate cancer is the most common form cancer among men. It affects one in eight men in the general population and is twice as prevalent among black men, of whom it affects one in four.

Yet public awareness of the cancer is still dismally and dangerously low. In 2014, when the campaigning and research organisation Prostate Cancer UK began monitoring awareness of prostate cancer among the general public, 53 per cent of men didn't know where the prostate is in the body. Two years later, the charity found 54 per cent could locate the prostate while 17 per cent were unaware they even had one.

Yet every year 11,000 men die from prostate cancer in the UK. Consequently, it is even more crucial that men are aware of the risk factors, and take measures to monitor their health and to go to the GP to request tests if something seems amiss.

Men who are most at risk are aged over 50, have a family history of prostate cancer and are obese, and particularly black men. Unlike the cancers that uniquely affect women – cervical cancer and breast cancer – there are no failsafe national screening programmes for prostate cancer.

A lot then must be done around awareness. Two thirds of men (66 per cent) with a family history of prostate cancer are dangerously unaware of their increased risk of the disease, according to Prostate Cancer UK, and more than half of all men across the UK (52 per cent) are in the dark about the threat posed by a family connection to the disease.

Part of the process should be making men at risk aware of early warning signs. Though often asymptomatic, prostate cancer can affect urination in various ways from difficulty starting to urinate, a weak flow when urinating, a feeling that the bladder hasn't emptied properly, needing to urinate more often, especially at night, and a sudden urge to urinate. Men exhibiting any of these symptoms are encouraged to contact their GP.

Campaigns such as Movember, which began as a fundraising and awareness-raising initiative encouraging men to grow a moustache during November in aid of men's health charities, have done much to highlight that many men rarely discuss health issues.

01
Campaigns such as Movember have done much to raise awareness and encourage men to discuss health issues

02
Prostate Cancer UK launched their Stronger Knowing More campaign in January featuring celebrities including Linford Christie to raise awareness among black men of their heightened risk of prostate cancer

Encouraging men to talk openly and take their own wellbeing seriously, in particular neglected and undiagnosed health conditions such as mental health problems, as well as testicular cancer and prostate cancer, is a crucial first step.

Movember has cleared a path for further campaigns to create further impact. This year, the unofficial, word-of-mouth 8-ball campaign spread through Facebook raising awareness around prostate cancer specifically. Simple and straightforward, users were encouraged to change their profile picture to an 8-ball emoji and to forward a message to their male friends, saying: "Hi mate, trying to raise awareness of prostate cancer. Can all you men please put it on your wall, don't comment, then send this on to all your male mates."

In an effort to reach black men, who are among the most at risk, Prostate Cancer UK launched their Stronger Knowing More campaign in January this year. Not only do black men have the highest risk of being diagnosed with prostate cancer, compared with other men, 86 per cent are unaware they are at higher-than-average risk.

The campaign, which runs for a year and is targeted at London, the South East and West Midlands, features former WBA world heavyweight champion David Haye, Olympic gold medallist Linford Christie, writer and musician Benjamin Zephaniah, ex-England footballer Viv Anderson, actor and *Red Dwarf* star Danny John-Jules, and Labour MP Chuka Umunna. It is also fronted by two of the charity's supporters who are personally affected by prostate cancer, Errol McKellar and Godfrey Fletcher.

02

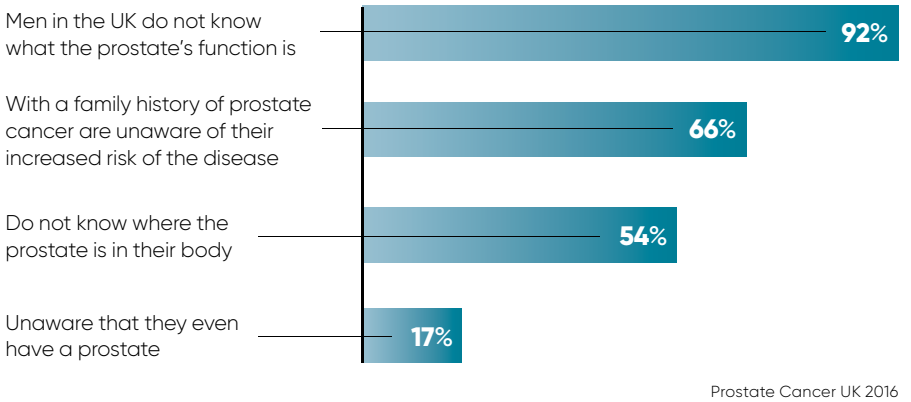
Talking openly about prostate cancer will do a great deal to catch early-stage cases, and prevent it from affecting men's personal and sexual lives in more severe ways. In worst-case scenarios, prostate cancer can be fatal, but even in those cases where it is treated and managed, complex side effects, including erectile dysfunction, fatigue and feelings of frustration, will have to be managed.

Every 45 minutes, a man dies from prostate cancer in the UK. But Prostate Cancer UK is striving to get its message across. This Christmas, the charity is fundraising for research into precision medicine that aims to discover and test new biomarker-treatment combinations in men with advanced prostate cancer as soon as they're diagnosed.

This means using each man's cancer DNA to discover the genetic change driving his particular prostate cancer and matching it to the treatment most likely to halt the disease.

It is hoped that this revolutionary clinical research programme will change the way men with advanced prostate cancer are treated and lead to better outcomes.

PROSTATE CANCER AWARENESS



Prostate Cancer UK 2016

OPINION COLUMN

‘To increase survival, the ability to detect the disease at its early onset is vital’

DR DAVID CROSBY
Head of early detection
Cancer Research UK

Scientists need to take advantage of the technological revolution to help more people survive cancer.

Catching cancer early, before the disease has spread, is one of the most powerful ways to improve cancer survival. But to revolutionise the way we diagnose and treat cancer, we need to change the focus and process of research.

The largest challenge in detecting cancer early is knowing what to look for. Cancer is usually diagnosed after people present with symptoms; a lump they can feel, a chronic cough, blood in their stool. Often, by the time these symptoms appear, the disease is already at an advanced stage. Most cancer research, in both universities and the private sector, has focused on this later-stage disease.

For many cancers, because they evolve over time, we don’t know what early-stage disease looks like, let alone what to test for to detect it. To increase survival, the ability to detect the disease at its early onset is vital; earlier treatment is significantly more effective.

The challenge of early detection of cancer is momentous; tumours at their earliest stage are a fraction of the size of a grain of sand. Scientists often try to detect tumours using biomarkers, molecules made by tumours, which normal cells do not produce or produce at lower levels.

The problem is that the tiny amounts of biomarker produced by an early tumour are dwarfed by the much higher amounts of the tens of thousands of molecules routinely produced by normal cells. The proverbial needle in a haystack. Except it’s worse than that as the biomarker you are looking for may actually be very similar in structure to hundreds of normal, healthy molecules – you’re actually looking for one special strand of hay in a haystack.

A further challenge is to ensure that detection technologies also tell us about how aggressive the disease is likely to be. This will then help deliver the appropriate manner and level of treatment.

The good news is that our biological understanding of cancer has grown over the decades and technology has advanced hugely, providing opportunities for research we never had before. This means we’re at a turning point that researchers need to take advantage of and must act now.

Scientists need to work across disciplines, bringing together the best minds and most novel concepts from chemistry, physics, engineering, mathematics and computer science, alongside biomedical experts. It’s only through this collaboration that we’ll be able to develop new technologies to find the incredibly small signals emitted by early tumours and to extract these signals from the sea of normal, healthy biological molecules.

Biologists have made incredible advances in helping us understand the early events in cells which cause them to become cancerous. The research community now needs to apply this biological insight to the clinic. Tests must be developed with the health service in mind to accelerate health improvements.

Cancer Research UK is in a unique position to have oversight of the development of early-detection tests and technologies from driving basic biology, seeing it through clinical testing and influencing policy to ensure tests are implemented in the NHS.

The charity’s aim is to build a critical mass of research in the UK, drawing together these fragmented strengths and resources, galvanising the research community to tackle these challenges, and engaging industry to make sure advancements make their way to the clinic.

Cervical screening and the bowel screening programme are great examples of early detection on a population scale which have saved a great many lives. But much more work is needed, especially for hard-to-treat cancers, such as brain, pancreatic, oesophageal and lung, where survival remains stubbornly low.

The ultimate goal is to develop tests that help doctors diagnose patients when they have the best chance of surviving their disease and give more patients the all clear. Cancer Research UK’s ambition is that three in four people will survive cancer by 2034; early detection will be essential in realising that ambition and, with the help of the generosity of our supporters and the brilliance of our scientists, it is within reach.

COMMERCIAL FEATURE

Know about breast lumps and biopsy

Breast lumps are very common and are often down to changes in your body that occur during puberty, pregnancy, the menopause, the menstrual cycle or when taking birth control pills

VABB
Vacuum Assisted Biopsy

It is important that you are familiar with your breasts and check them regularly, so if a lump does develop, you are able to identify and acknowledge the irregularity easily. Although finding a lump in your breast and the thought of a biopsy may be worrying at first, it is worth knowing that 80 per cent of women who undergo a biopsy do not have breast cancer. Having said that, it is important to see your doctor if you do detect an abnormality.

When consulting your doctor, firstly they will ask for your medical history. After this, the doctor may ask your permission to physically examine your breast and will always ask if you’d like a nurse present. Following this, they may further examine the affected area using a non-invasive imaging technique such as ultrasound, MRI or mammogram (X-ray). These tests can be sufficient in aiding a doctor with their diagnosis; however, if still unsure, they may opt to perform a breast biopsy.

You may be feeling that you lack control of what is going on within your body, but you can control what happens to it. Despite doctors having the professional authority to choose the best course of action for you, there is nothing from stopping you from asking as many questions as you want and exploring other options.

As a potential biopsy patient, you have a choice in your procedure and it is important to weigh up the different procedures available to you. With this in mind, here is a little more information about the different types of breast biopsy available, which you can talk about further with your doctor, if you wish.

> “It is important to see your doctor if you do detect an abnormality

80%
of women who undergo a biopsy do not have breast cancer

WHAT IS A BIOPSY USED FOR?

A breast biopsy is a diagnostic test, which involves the removal of a small sample of breast tissue from a suspicious area. This is then sent off to be examined in a lab by a pathologist. The main reason a breast biopsy is performed is to determine whether or not a breast lump is cancerous. However, a biopsy may also be used to remove a breast lump that has already been shown to be benign.

While physical examinations and imaging techniques are useful when choosing the best course of treatment for you, a biopsy is the only procedure that can definitely determine whether or not a breast lump is cancerous.

There are different types of breast biopsies available; which biopsy your doctor chooses to proceed with will depend on your condition, symptoms and medical history. Breast biopsies fall into two categories of surgical or needle.

WHAT IS THE PROCEDURE?

During a surgical biopsy, a small incision is made in the breast and the lump is partially or fully removed for examination. This is called an incisional biopsy. Another type of biopsy is performed using a needle and the doctor may use ultrasound, MRI or a mammogram to assist in the location of the area to be sampled. All biopsies are performed under local anaesthesia to minimise discomfort.

Surgical biopsies are more invasive than needle biopsies and are used to remove a larger sample of tissue, which may help pathology in diagnosis. It is a very routine procedure; however there are small risks involved and the procedure may leave a small scar.

Nowadays, there are less invasive options, such as vacuum assisted biopsy or VAB, available to most women in the form of needle biopsies that are safe, reliable, accurate, fast and can be performed under local anaesthesia.

Visit www.crbard.com/vab-guide to find out more about breast pathology and diagnostics. The website includes a full explanation of the biopsy process, most frequent questions and answers, videos and personal stories of women who have benefitted from it

RADIATION THERAPY

Aiming to destroy the cancer cells

Much misunderstanding remains around radiation therapy which is an important tool in the work of combating cancer

Thomas Hecker/Shutterstock

MARTIN BARROW

Cancer treatment and care has made enormous progress over recent years, with a significant improvement in survival rates and quality of life after cancer. Much of this is down to the evolution of radiation therapy.

Around four in ten of all NHS cancer patients are treated with radiotherapy and last year Simon Stevens, chief executive of NHS England, announced a £130-million upgrade of NHS radiotherapy services.

First used to treat patients in the early-1900s, radiation therapy has changed beyond recognition, in terms of both effectiveness and safety. Yet the mere mention of the word radiotherapy creates panic among patients and their families. Myths and misconceptions about radiation therapy have proven surprising difficult to shift, which instils fear and hesitation when it comes to considering the appropriate treatment options.

Many concerns are rooted in outdated views of how radiation therapy was used 20 or 30 years ago. Although the internet is a useful resource for up-to-date information about radiation therapy, there is also plenty of misinformation, which causes confusion and perpetuates many of the enduring myths. Some cancer patients, for example, mistakenly believe that radiation is painful or that it may make them radioactive.

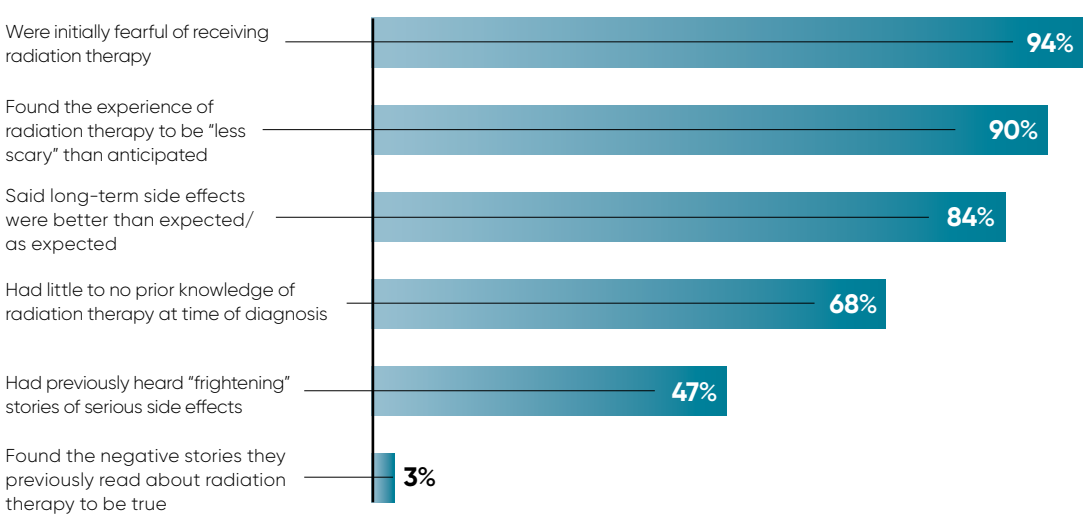
Part of the problem is that radiation therapy is not easy to understand. Whereas surgery and even chemotherapy are procedures that are familiar to patients, radiation therapy is a much more alien concept. In many people's minds it has also become entangled with emerging treatments, including nuclear medicine.

The first step in unravelling the "mystery" of radiation therapy is to explain how it works. The treatment is designed to damage or kill cancer cells, destroying the genetic material that controls how cells grow and divide. Cancer cells, unlike healthy cells, do not heal well once they are damaged. The goal is to deliver non-lethal doses over a number of sessions so that the cancer cells have accumulated enough radiation to destroy them.

> The goal is to deliver non-lethal doses over a number of sessions so that the cancer cells have accumulated enough radiation to destroy them

PERCEPTIONS OF RADIATION THERAPY

SURVEY OF BREAST CANCER PATIENTS WHO HAVE RECEIVED RADIATION THERAPY



American Society for Radiation Oncology 2017

In recent years radiation therapy has evolved to deliver targeted treatments with great precision. In effect, modern radiation therapy is about using the latest technology to avoid hitting healthy cells, protecting vital organs that may be close to treatment areas.

Myths and misconceptions about the safety of radiation therapy have proven surprising difficult to shift

Radiation therapy does not cause nausea or vomiting and does not cause horrible burns. It is typically painless and is similar to having an X-ray. It cannot be felt during the actual treatment. Tools and technologies have been developed to reduce radiation damage to healthy tissue and lower the risk of debilitating side effects in treatments for prostate cancer, for example, protecting the bowels and rectum.

But for many cancer patients external beam radiation treatments usually require little or no recovery time. Fatigue and skin reactions are the most common side effects, and it is not unusual for patients to go about their normal daily routines after each treatment session.

Another widely held misconception is that radiation treatments are given to patients who are dying to obtain some symptom relief. It is true that radiation therapy is an effective way of treating metastasis in the body, for instance for pain relief. But radiation therapy plays an important part in treating a wide variety of cancers, and this includes some early-stage cancers and cancer in younger people.

Risks from radioactivity used in radiation therapy are often a concern for patients. But treatment generally does not leave any radioactive substance in the body. It is safe to be around loved ones, pregnant women and children. No radiation precautions need to be taken.

Similarly, patients worry that radiation therapy causes more cancer to develop. But this risk is small, about one in 1,000. What is important to remember is that the risk of cancer recurrence in the absence of radiation therapy significantly outweighs the risk of a radiation-induced cancer.

So negative stories about radiation therapy are frightening and pervasive, but they generally do not reflect the actual experience. A recent survey of breast cancer patients found that their experiences of radiation therapy confounded their expectations. The survey, presented to the American Society for Radiation Oncology in September, found that three quarters of patients found their experiences with radiation therapy, including overall and specific long-term and short-term side effects, to be less "scary" than anticipated.

Dr Narek Shaverdian, lead author of the study and a radiation oncology resident at the David Geffen School of Medicine at the University of California, Los Angeles (UCLA), says: "Radiation oncologists know first-hand that our patients come in with fears and sometimes misconceptions. Unlike many other treatments and fields of medicine, it is very hard to imagine what radiation therapy is like.

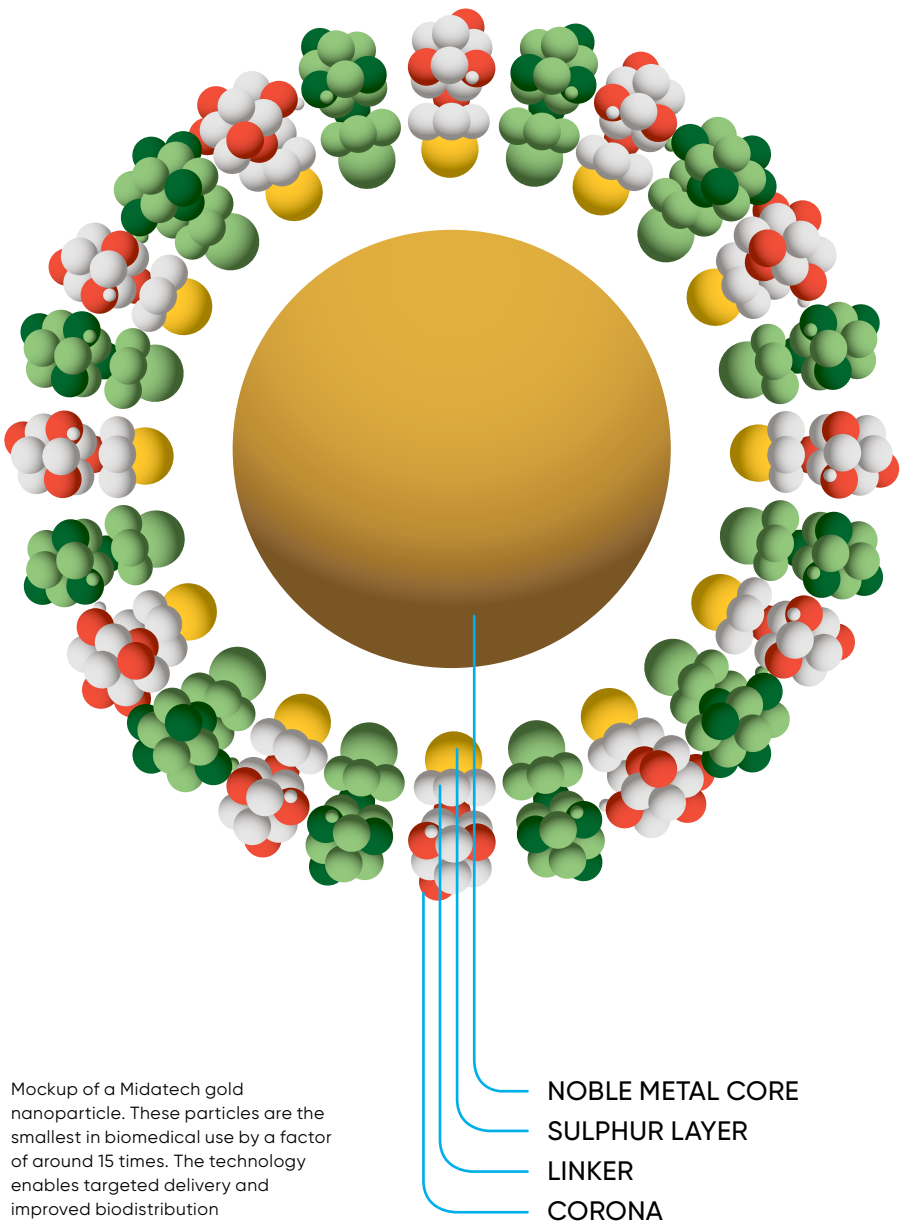
"Still, it is surprising to find that upwards of 90 per cent of women surveyed agree that if future patients knew the reality of the radiation therapy experience, they would be less afraid of treatment."

The study emphasises the need for clinicians to redouble efforts to address the concerns of cancer patients as they begin treatment. At the very least, patients should be signposted to reliable sources of information about radiation therapy. But NHS trusts can take a more proactive approach, with options including communications training for radiotherapists to informal patient meetings, where newly diagnosed patients can talk to patients who have already undergone radiation therapy.

COMMERCIAL FEATURE

Progress on a 'golden' cancer treatment

Improving outcomes for patients with rare and hard-to-treat cancers is Midatech Pharma's mission. This Oxfordshire-based biotechnology company is at the forefront of developing products that promise improved therapies for patients with devastating cancers



Mockup of a Midatech gold nanoparticle. These particles are the smallest in biomedical use by a factor of around 15 times. The technology enables targeted delivery and improved biodistribution

MIDATECH PHARMA

Cancer life expectancy may have increased rapidly in the last few decades, but not for aggressive diseases such as some liver cancers and brain cancer. This high unmet medical need in seriously ill adults and children is being addressed by Midatech through nanotechnology, the use of materials that are 80,000 times smaller than the width of a human hair. The science is driving forward innovation by enabling doctors to target drugs at cancer cells and then deliver these medicines directly into tumours.

This cutting-edge approach is set to improve how patients tolerate those chemotherapy drugs, which are currently available, but are either highly toxic, difficult to infuse because of their insolubility or have limited efficacy. Employing nanotechnologies in different ways can overcome these challenges: systemic chemotherapy drugs can be targeted directly at a tumour when carried via gold nanoparticles fed into the bloodstream, while a technique called nanotech inclusion enables solubility and, therefore, the direct delivery of drugs via a catheter rather than orally. In both cases, not only are side effects minimised because there is less damage to healthy tissue, but also the efficacy of the treatment is increased as the drug is more accurately targeted at the tumour.

Another advantage of nanotechnology in cancer treatment is that it may enable therapies to move through tissue to reach diseased areas, such as tumour margins, and even cross the blood-brain barrier. In future, doctors may be able to target previously inaccessible tumours, such as highly aggressive and potentially fatal brain tumours.

According to Jim Phillips, chief executive for Midatech Pharma: "What we're doing here in the UK with new technologies is the way forward. At the moment with currently approved cancer treatments, patients at best can hope for just a few extra months of survival with very poor quality of life. We're ensuring cancer treatment is effective by delivering it to the right place at the right time. It's both more effective and less debilitating, and that makes a huge difference, which is our goal."

The key to Midatech's success in the development of potentially life-saving products is gold. As well as being safe because it is non-toxic, this precious metal is the ideal scaffold for the tiny particles used in the targeting and treatment of tumours. The form of gold nanoparticles the company has patented is manufactured in a state-of-the-art facility in Bilbao, Spain, which is believed to be the first plant of its kind licensed in Europe.

Dr Phillips says Midatech's gold nanoparticles are adaptable and highly mobile, a considerable benefit when targeting hard-to-reach parts of the body such as the brain. "Gold nanoparticle technology has been researched in tremendous depth, but no one has yet commercialised the science and got it into the clinic," he says. "What we're talking about are particles less than two nanometres; each one contains 100 gold atoms. The size is crucial because it means the immune system isn't disrupted, the therapies may access the traditionally hard-to-reach areas, and the nanoparticles can be safely excreted via the kidneys and liver."

Regulation and licensing has a key role to play in the advancement of this area of research and development, and in making new treatments that do not come with harmful side effects a reality. Dr Phillips says that progress, for example, in Midatech's child brain tumour research MTX110, which is about to enter phase-one clinical trials for children at sites in the UK, Europe and United States, has been made possible through a compassionate-use programme. Co-ordinated through European Union member states, these schemes help make products in development accessible to patients when satisfactory treatment options are non-existent.

While regulators are generally supportive of novel approaches in the field of orphan cancers, Dr Phillips says there is always room for improvement. "Some regulators are like minded, others are tricky and want you to jump through more hoops, and others blow hot and cold," he adds. "All the approvals [in this area] have been for palliative support because there haven't been the breakthroughs. Regulators are looking for evidence-based research from formal clinical studies, which is a challenge because the number of patients available to take part in trials for rarer cancers is limited.

"Typically, authorisation can take years, but our hope is that the path to this can be accelerated with approvals based on evidence from a single pivotal trial. The existence of special schemes also boosts the chance for patients with life-limiting conditions to get access."

With Britain set to withdraw from the EU in March 2019, Dr Phillips also believes it is vital the UK retains its status as a leading global hub for the life sciences industry. "It's vital for high-tech and innovative industry to have clear access to the European market so that products are approved as before. At the moment this isn't guaranteed because of a lack of clarity over what the UK's position is, which makes planning for the future a challenge. Our ideal as a company is that the UK continues as a member of the European Medicines Agency, and we go to them for product evaluation and authorisation."

He says collaboration is important in the growth of knowledge and competence in what is a fast-developing but relatively nascent technology. Only a handful of centres in the UK and United States currently have the expertise, and Midatech is not at the point yet to deliver products through the NHS, although several are already in late-stage development. Dr Phillips says the ability to treat rare and orphan cancers is a niche but growing skillset and Midatech is "working and collaborating with our experts and partners", including with a number of universities and pharmaceutical companies, both major and speciality ones.

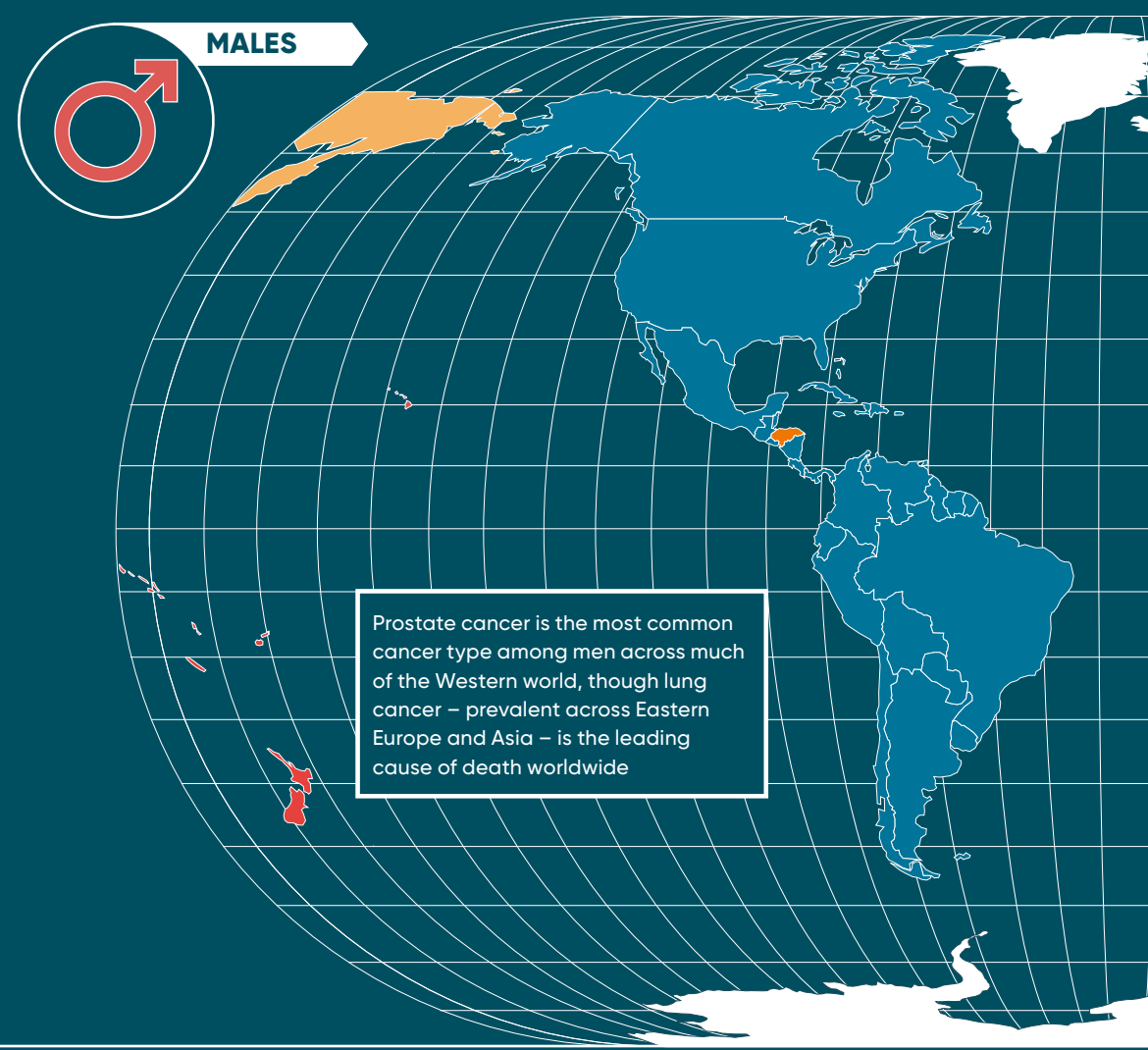
The message from Dr Phillips is simple. He believes that as long as there is the right support from regulators and continued partnership among those with expertise in this area then effective and tolerable first-line treatments will become a reality. For cancer patients whose choices are either limited or non-existent, that would be an outcome worth more than its weight in gold.

A mid-scale 10-litre reactor manufacturing Midatech's gold-core nanoparticles

> "We're ensuring cancer treatment is effective by delivering it to the right place at the right time

MOST **COMMON CANCERS** WORLDWIDE

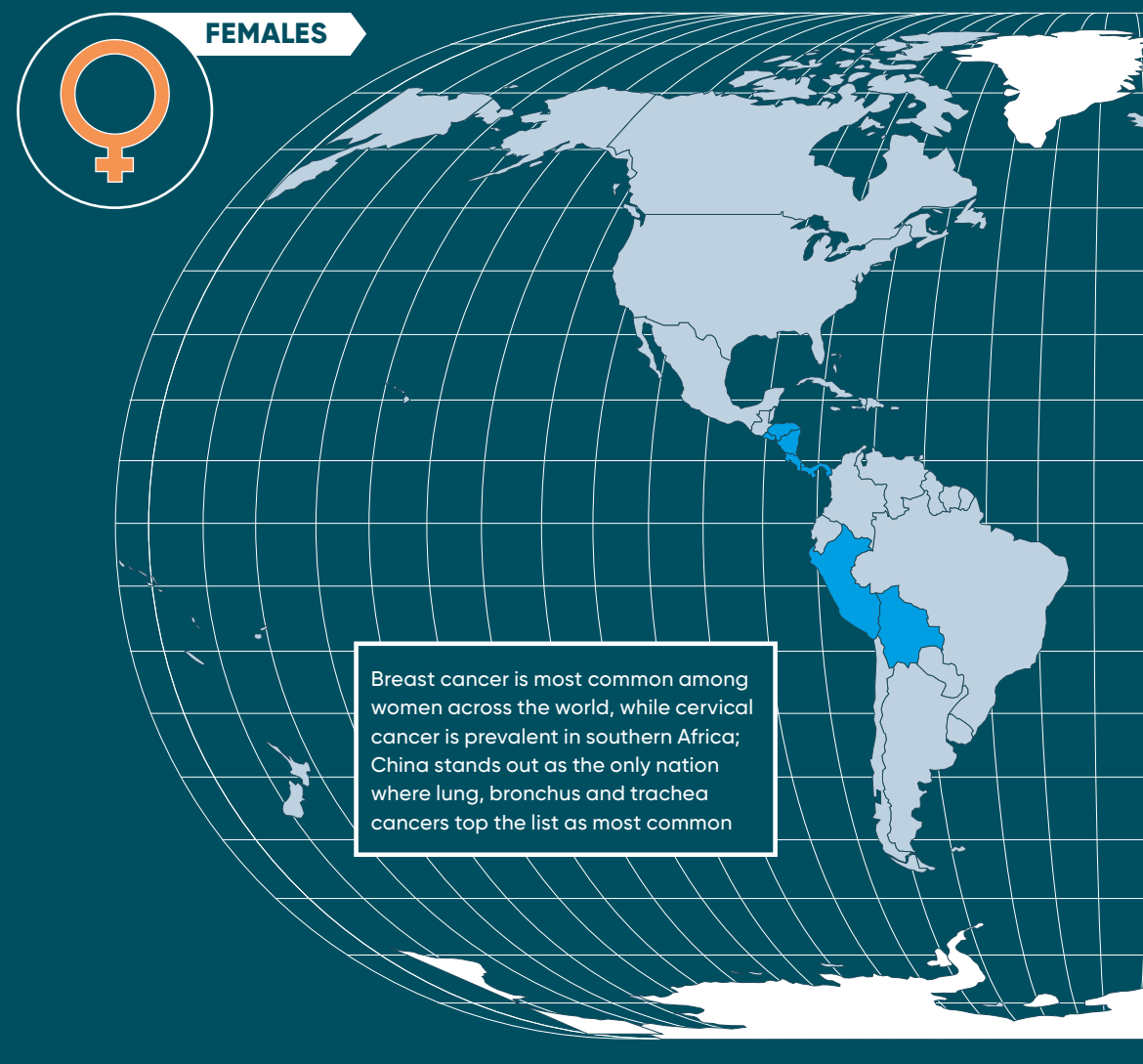
Mapping out the most prevalent types of cancer worldwide shows two distinct patterns: cancers of the prostate and lung are the most common among men across much of the globe, while breast cancer is most prevalent among women. However, there are surprising differences from region to region, especially among low and middle-income countries



MOST COMMON CANCERS WORLDWIDE BY GENDER

BY NUMBER OF CANCER CASES, BASED ON MOST RECENT RESEARCH

- Bladder
- Breast
- Cervix uteri
- Colon and rectum
- Esophagus
- Kaposi sarcoma
- Leukemia
- Liver
- Lung, bronchus and trachea
- Non-Hodgkin lymphoma
- Oral cavity
- Prostate
- Stomach
- Thyroid
- No data



8.8m
people died from cancer in 2015

2nd
leading cause of death globally

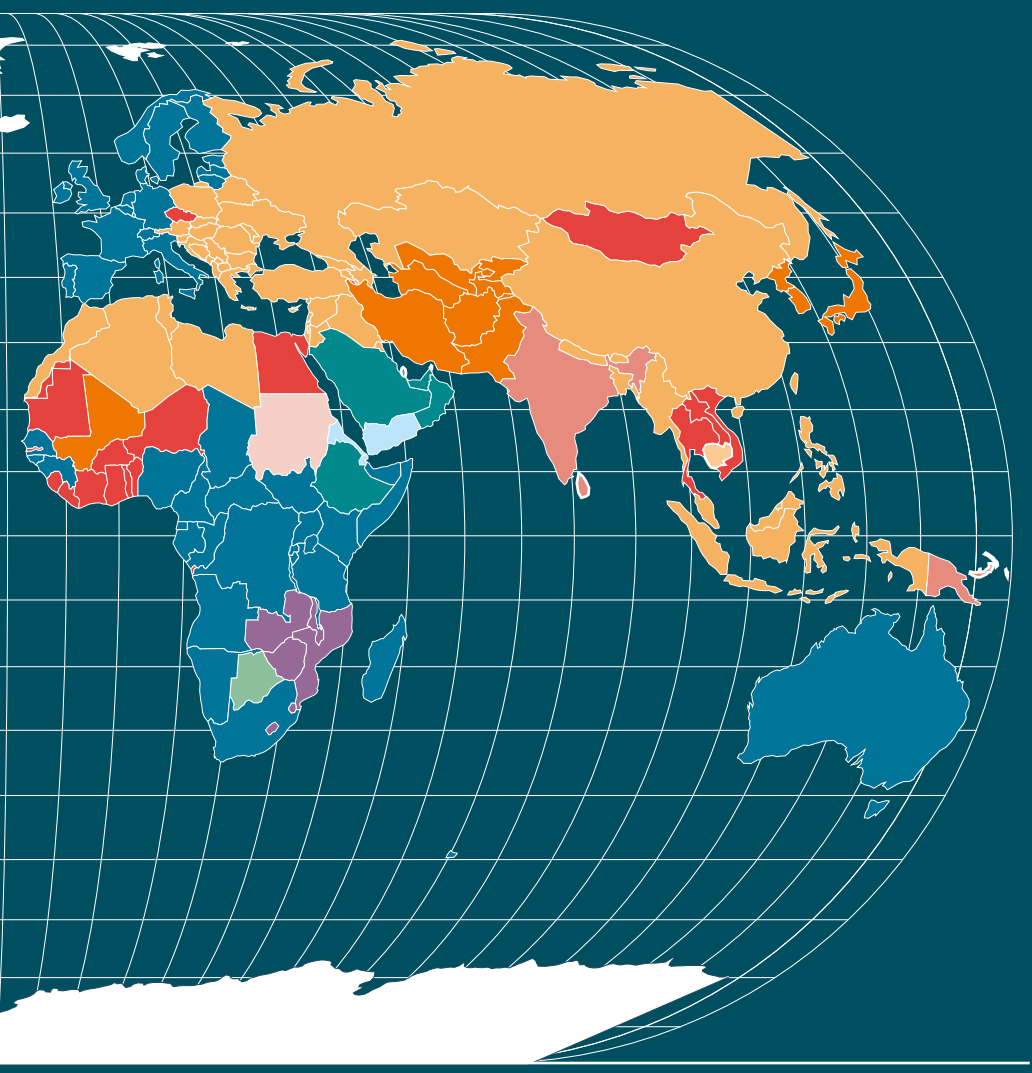
1/6
of all deaths are attributable to cancer

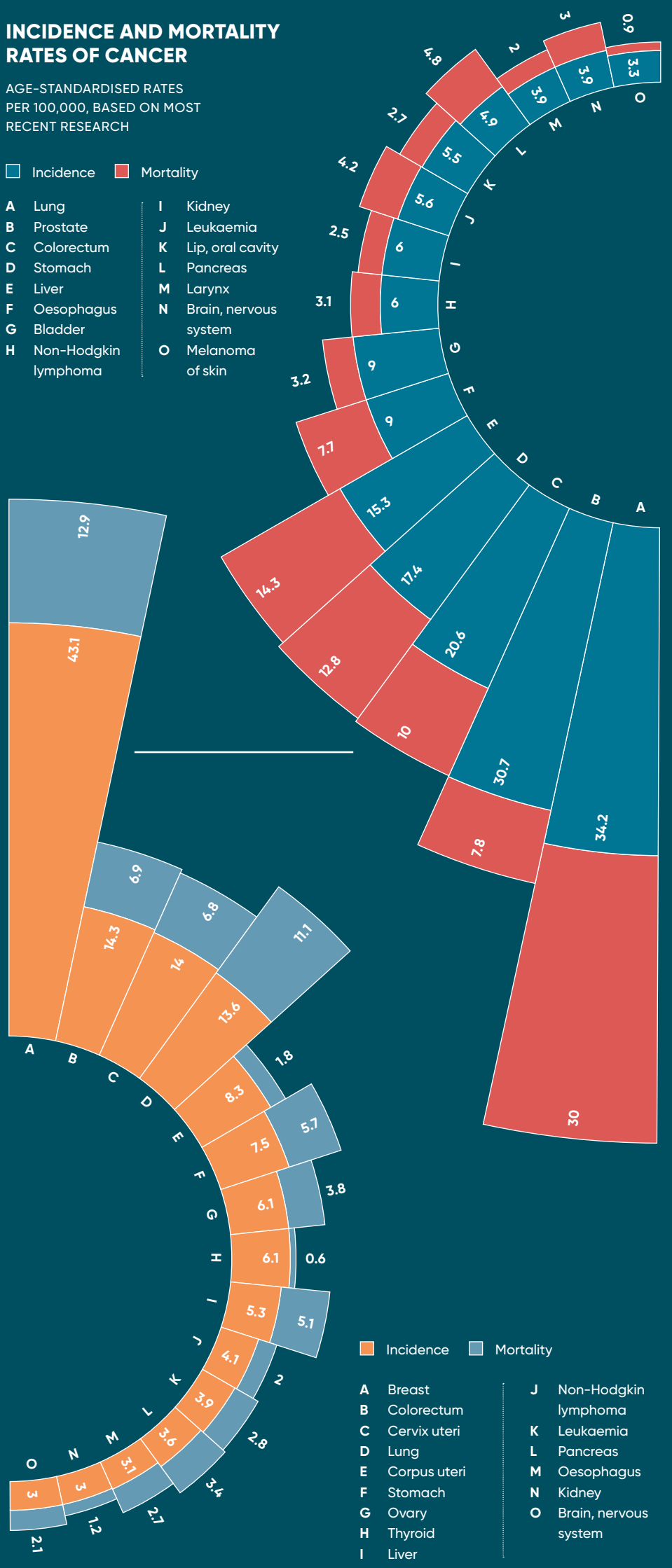
70%
of deaths from cancer occur in low and middle-income countries

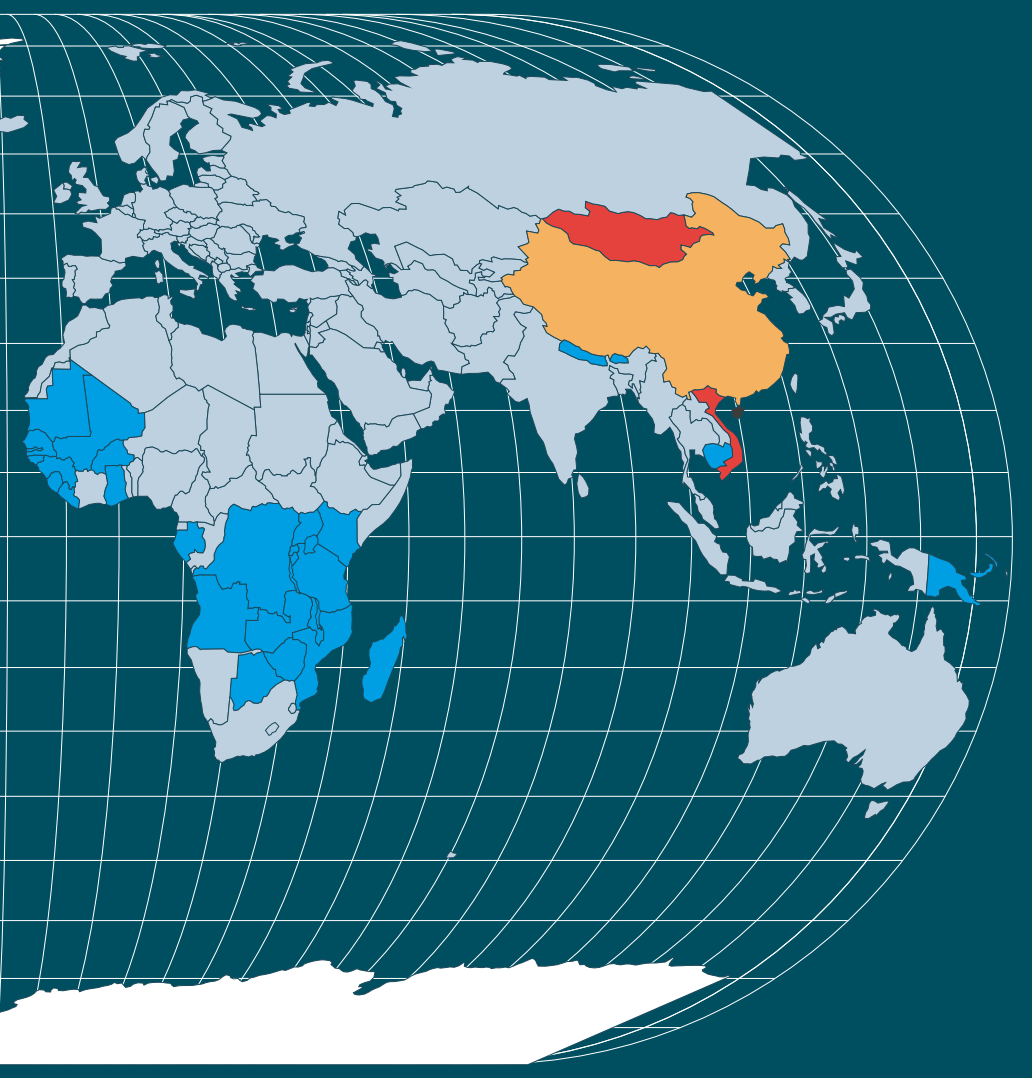
World Health Organization 2017

INCIDENCE AND MORTALITY RATES OF CANCER

AGE-STANDARDISED RATES PER 100,000, BASED ON MOST RECENT RESEARCH







World Health Organization/International Agency for Research on Cancer 2017

CANCER CARE IN AFRICA

Solutions designed to help cure Africa's ills

Provision of cancer treatment in parts of the developing world ranges from patchy to non-existent, but there are rays of hope providing shining examples for others to follow

Before and after: an operating theatre equipped by Medical Aid International in Madagascar in collaboration with NGO Mercy Ships

JOHN ILLMAN

Anyone walking through the cancer wards of public hospitals in Africa would encounter scenes reminiscent of the battle against Aids in the early-2000s, according to *Investing in Health*, a World Bank report.

Hospital beds once filled with Aids patients are now occupied by people with cancer and non-communicable diseases. Many cancer patients travel long distances and make huge financial sacrifices to reach hospitals or clinics, but by the time they arrive their disease is at an advanced stage and survival prospects are slim.

This is widening further the vast gulf between healthcare in developing and Western countries. About one third of the world's population still has no regular access to essential medicines and safe medical care. Many of them live in sub-Saharan Africa, but there are another estimated billion people living in emerging economies marked by wide divisions between rapidly growing middle classes and people living on less than a dollar a day.

What are global healthcare providers doing to close the gap? Government-sponsored programmes have attracted much attention, but the many individual initiatives by people such as Tim Beacon are less well known.

Fifteen years ago he travelled to Uganda after working as an NHS operating department practitioner and studying for a diploma in travel medicine. The trip was the impetus for the foundation of Medical Aid International (MAI), a social enterprise exporter of medical expertise and equipment, everything from sterilising machines to operating tables.

Mr Beacon, who is managing director of the Bedford-based enterprise, explains: "During my trip, an old friend, a missionary consultant surgeon, asked me to assist in an emergency bowel operation on a Ugandan. It was a miracle he survived. The operating table was wobbling and we lacked monitoring equipment for heart rate and blood pressure. We were 'breathing' for him, squeezing air into his lungs via a bag.

"Unbeknown to us, for at least ten or fifteen seconds, his heart stopped. This could have been critical, but he survived somehow. Surgeons, nurses and operating theatre staff working in these primitive environments develop extraordinary skills.

"As I left Uganda I thought this isn't rocket science; there must be something I can do."

Tapping into his NHS and medical equipment contacts, he began seeking donated and reconditioned medical equipment, and established MAI. It now has a staff of four and a £1-million annual turnover. Mr Beacon attributes its success to detailed knowledge and understanding of the demands facing clinics and hospitals in developing countries.

He says: "Many people in the UK donate medical equipment to Africa and the Far East without realising that what works here won't work in a remote tropical climate. It might make them feel good, but it's often useless.

"When we started out, 98 per cent of equipment we exported was recycled; now it's nearer 40 per cent because we bulk buy, and we've started designing and producing some of our own equipment, such as operating tables – we know what is needed."

Easy to transport, the MAI operating table can be taken apart for disaster or outreach work. Critically, it is manually operated, so it doesn't require electricity.

MAI also export a non-electric autoclave for sterilisation of surgical instruments and other items. Wood fired and looking like a domestic stove, the EcoClave reaches a sterilising temperature within 20 minutes, and is significantly cheaper and easier to maintain than electrically powered machines. Irregular electricity supplies and frequent power breakdowns in developing countries make a compelling argument for wood-fuelled autoclaves.

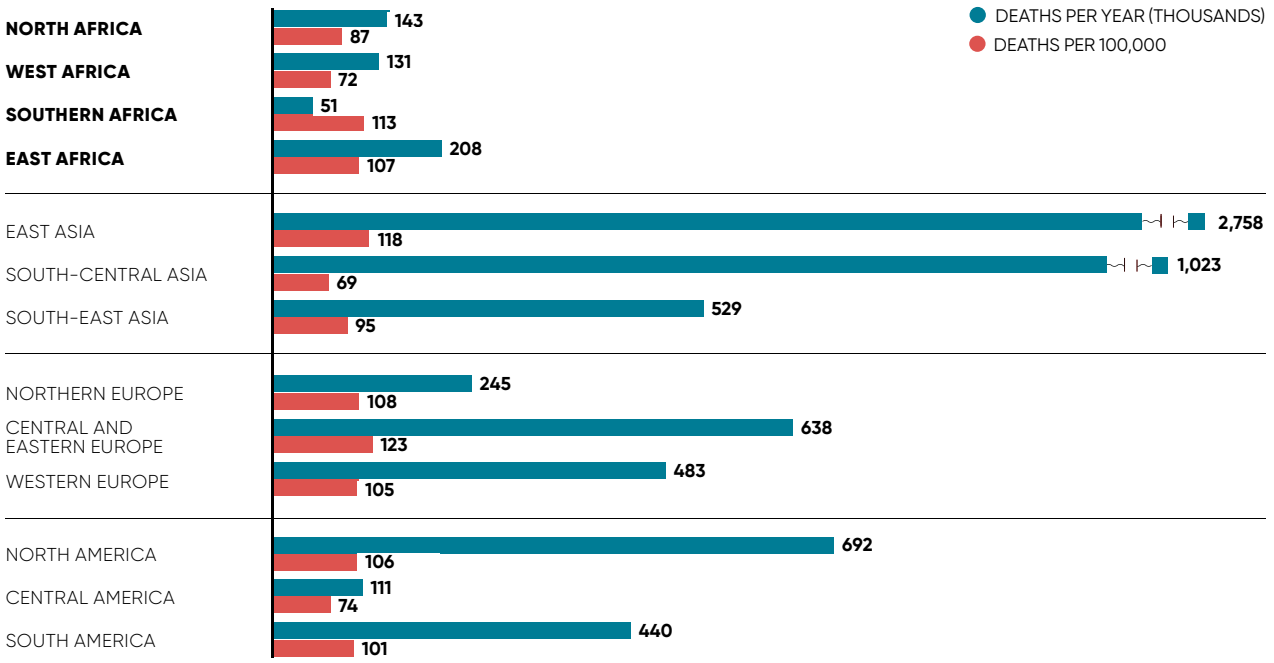
Mr Beacon says: "Urgent cancer surgery is often held up or cancelled because of power failures affecting sterilising equipment. This is devastating for patients and demoralising for doctors trying to work their way through long operating lists."

But even the best sterilisation equipment doesn't work automatically. In a survey at a primary care trauma care course in Uganda, Mr Beacon found that none of the institutions represented were sterilising their equipment to safe standards. This has chilling implications.

In a study reported by the Bulletin of the World Health Organization, healthcare-associated infections var-

CANCER MORTALITY BY REGION

MOST RECENT ESTIMATES OF DEATHS PER YEAR AND DEATHS PER 100,000 POPULATION



World Health Organization/International Agency for Research on Cancer 2017

CASE STUDY

CARINGBRIDGE

When a good friend of Sinia Mehring had a premature baby, she asked her to let all their friends know what was happening. Instead of making dozens of emotional, time-consuming phone calls, she created a website. This was the inspiration for CaringBridge.

Ten of thousands of cancer patients and carers are among the half a million people in more than 200 countries who have set up free CaringBridge websites to update friends and family about their diagnosis and treatment, sometimes just as it seems that the questions and phone calls won't stop.

Visitors who are provided with an individual's personal website address or url and password can read updates and post messages.

More than 2,500 volunteers help to run the service. caringbridge.org also provides invaluable tips and encouragement. For example, Peter Bailey of St Paul, Minnesota became a care-giver when his wife Tanya was diagnosed with throat cancer in 2016.

He came to regard care-giving as a continuum and, with Tanya's full support, he did what many people like him are advised to do, but don't. He took care of himself first.

He says: "It might seem selfish to be a care-giver taking care of yourself. But it was like what the flight attendants say: 'Put your oxygen mask on first'. Then I was able to be a really supportive care-giver."

caringbridge.org explains how to a start a website and how to access the extensive resources section.

ied between 2.5 per cent and 14.8 per cent in Algeria, Burkina Faso, Senegal and Tanzania. Incidence in surgical wards ranged from 5.7 per cent to 45.8 per cent in Ethiopia and Nigeria.

MAI also exports whole facilities. For example, it has just provided a Dar es Salaam city hospital in Tanzania with a complete paediatric surgical unit for £150,000. It includes two operating theatres, a sterilisation department, a recovery unit, 30 beds and nursing equipment. The bill would have topped £750,000, Mr Beacon estimates, if all the equipment had been new.

The Dar es Salaam unit serves a wide area with patients travelling long distances for treatment. One mother recently travelled 1,000 kilometres with her sick two-month-old baby who had a teratoma, a congenital tumour. Teratomas in newborns are generally benign and do not spread, but they can become malignant. The cancerous tumour was completely excised.

A fully functioning operating theatre, running off solar power, in a remote hospital in the Democratic Republic of Congo is seen as a template for as many as 50 other Congo locations to bring medical care closer to those in need.

Hospitals in developing countries are not usually associated with state-of-the-art technology, but digital X-rays are generating huge excitement. They bypass the need for chemical processing and, in the long term, save money.

> Urgent cancer surgery is often held up or cancelled because of power failures affecting sterilising equipment

Mr Beacon says: "Spending money on this kind of thing is how you can really make a big difference. With digital X-ray you can very easily change the contrast of the picture, zoom in or measure angles.

"The image can be immediately seen on other networked computers and users can log in from anywhere in the world. This makes it possible for a doctor in a remote hospital to seek a second opinion from a specialist centre – it's revolutionary. The image costs nothing and can be printed for the patient's notes."

MAI is having a significant impact, but a relatively small social enterprise company can have only a limited impact. The Access to Medicines Foundation, which is committed to encouraging the pharmaceutical industry to help more people in developing countries, estimates that two billion people in the world lack access to medicines. However, MAI shows what one individual with a vision can do.

COMMERCIAL FEATURE

Deciding on chemotherapy

A test is available which can spare some women with breast cancer the ordeal of chemotherapy

Genomic Health
LIFE. CHANGING.

Breast cancer is the most common cancer in the UK, but survival rates are improving and have doubled in the last 40 years. An estimated 691,000 women are alive in the UK after a diagnosis of breast cancer and this is expected to rise to 840,000 by 2020.

The advent of personalised medicine offers hope of increasing survival rates even further, while improving quality of life for those living with cancer.

Genomic Health, the world's leading provider of genomic-based diagnostic tests, has harnessed the potential of molecular technology to provide doctors with information about who will, and who will not, benefit from chemotherapy.

Although chemotherapy is an important and potentially life-saving cancer treatment, it is toxic to normal cells as well as cancer cells. Patients commonly experience painful and arduous side effects. Treatment with chemotherapy can cause lethargy, nausea, hair loss and it can leave patients with an increased vulnerability to infections. Chemotherapy can also take an emotional, psychological and economic toll that sometimes lasts long beyond the course of treatment.

Personalised medicine, and Genomic Health products in particular, can help to identify those patients who will benefit from chemotherapy. This means that those who do not need it can be spared this treatment. Improved targeting also offers clear benefits to the NHS by directing finite resources to those who need them.

Genomic Health's Oncotype DX Breast Recurrence Score® test for early-stage breast cancer patients has been available in the UK and Ireland since 2006, and in 2013 the National Institute for Health and Care Excellence (NICE) published guidance advising that the Oncotype DX test is clinically and cost-effective for use in the NHS. It is now established as the most commonly used genomic test in breast cancer and is a routine part of the diagnostic process for patients diagnosed with early-stage breast cancer.

> With genomic testing, we can now confidently reassure many of these women that chemotherapy is not required

The Oncotype DX Breast Recurrence Score test works by examining the activity of 21 genes within the tissue of cancer tumours. Data about this activity yield the Recurrence Score® result, on a scale between 0 and 100, assessing the likelihood of chemotherapy benefit and ten-year risk of distant recurrence to inform adjuvant treatment decisions in women with early-stage invasive breast cancer.

Clinical data has shown that the Oncotype DX test can serve to guide treatment decisions after breast cancer surgery. A growing body of evidence supports the benefit of applying the test to patients with breast cancer which has spread to the lymph nodes, as well as to those where it has not spread.

The test's accuracy and effectiveness has been confirmed in multiple large, independently run international studies taking in more than 63,000 patients. For example, the TAILORx study, involving 1,626 patients, found that 99.3 per cent of patients with a low Oncotype DX Recurrence Score result were relapse-free after five years of treatment with hormone therapy alone, confirming that the decision to avoid chemotherapy was appropriate.

Dr Mark Verrill, head of the Department of Medical Oncology at the Newcastle upon Tyne Hospitals NHS Foundation Trust, and deputy lead clinician for breast cancer in the North of England Cancer Network, says: "Being diagnosed with cancer is a distressing experience and patients have so many questions.

"One of their main concerns is the impact of chemotherapy on their lives. When you are able to tell them that they don't need to have chemotherapy, the sense of relief is immense."

Dr Verrill says the Genomic Health platform is an example of the positive impact of personalised medicine for patients and healthcare systems. "In the days before Oncotype DX, many women with a moderate risk of breast cancer recurrence underwent chemotherapy, with all its unpleasant side effects, because of anxiety around that risk," he says. "With genomic testing, we can now confidently reassure many of these women that chemotherapy is not required and that anti-oestrogen drugs like tamoxifen are all that is needed to reduce the chance of the cancer returning."

For more information please visit www.genomichealth.co.uk

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OVARIAN CANCER


Christopher Sardegna/Unsplash

Specialists on the brink of a major breakthrough

Greater awareness of symptoms and earlier diagnosis, coupled with new drugs, are giving hope to women struck down by ovarian cancer

NIGEL HAWKES

Like a thief, ovarian cancer can steal a woman's health when she is unawares. A healthy lifestyle provides little protection and the symptoms can easily be confused with those of other conditions, by patients and GPs alike.

So more than a quarter of patients are unaware they even have the cancer until they are taken to an emergency department desperately ill, by which time it may be too late for treatment to do much good. For those detected earlier, the prospects are much better as a third of women will survive for at least ten years if their disease is diagnosed in its early stages.

The best chance of improving overall survival, therefore, lies in improving awareness and early diagnosis, and developing new drugs to treat the later stages of the disease. There are signs of progress in both, but especially in treatment. "It's very exciting for me to be working in this field," says Dr Susana Banerjee, consultant medical oncologist at the Royal Marsden Hospital in London, where the recent advances have been pioneered.

This is a big change from the mood of "nihilism" that Annwen Jones experienced when she launched the charity Target Ovarian Cancer in 2008. "People said that the symptoms were so vague you couldn't diagnose it earlier and there wasn't much that could be done," she says.

"We commissioned a study to track awareness levels among women and GPs, and the experiences of women, and we repeat it every three years. We were convinced by the research that this is a disease that could be diagnosed earlier if women were aware of the symptoms and if GPs were more aware, too."

There are around 7,400 new cases of ovarian cancer every year, half in women over 65, and the numbers have remained stable since the early-1990s. There are no strong risk factors except age and family history, neither of which can be controlled. Women who have children and breast-feed them have significantly lower risks than those who remain childless. Use of the contraceptive pill also provides some protection.

Around a fifth of cases have familial links, with inherited breast cancer genes BRCA1 and 2 accounting for the great majority of these. But for the rest the genetic changes that give rise to the disease are not inherited but random, striking unpredictably.

Symptoms include feeling bloated for three weeks or more, feeling full quickly or losing appetite, urinary urgency, suffering fatigue, unexplained weight loss and pelvic or stomach pains. But there are common explanations for most of these symptoms and, since a GP is unlikely to see more than one new case of ovarian cancer every five years, it is not surprising that opportunities for diagnosis are often missed.

Could more be done? Ms Jones believes so and is pressing for a national awareness campaign.

"We do local campaigns, but you need much more than that," she says. "We really need to see ovarian cancer included in the Public Health England (PHE) Be Clear on Cancer campaign. Earlier this year, PHE ran a pilot study in the Midlands looking at awareness of abdominal symptoms, which can be linked to various cancers. We expected it to be expanded this autumn, but it seems to have ground to a halt."

The treatment for ovarian cancer is surgery followed by chemotherapy. "For some patients, this is a cure," says Dr Banerjee. "But for too many, the disease comes back."

Better chemotherapy drugs such as bevacizumab (Avastin) have helped to improve outcomes. Used in combination with other drugs, it has helped to sustain a slow but steady increase in survival. But the real excitement comes from trials of a new class of drugs, the PARP inhibitors.

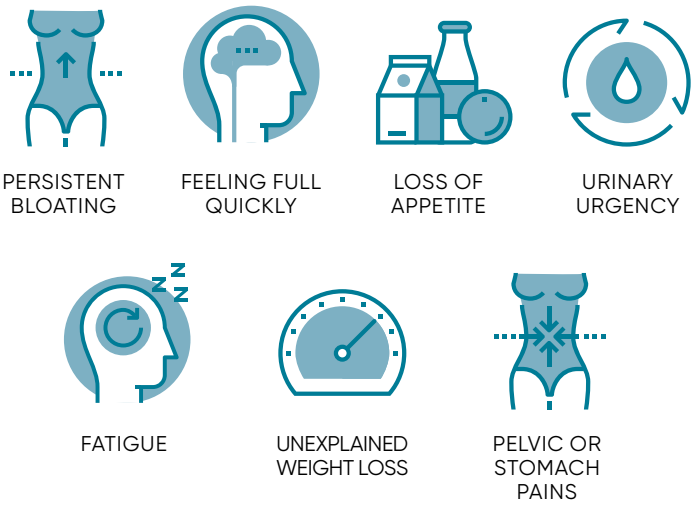
They work by blocking the action of an enzyme, poly-ADP ribose polymerase, which is used to repair damage to DNA when cells divide, a mechanism discovered by the Institute of Cancer Research at the Royal Marsden 12 years ago. Since cancer cells divide more often than normal ones, they are more sensitive to the effects of this damage than are healthy cells, so slowing the repair mechanism selectively attacks the cancer cells.

The first PARP inhibitor, olaparib (Lynparza), has been available in the UK for two years for women who have suffered two recurrences of the disease, while the latest, niraparib (Zejula), has just gained licensing approval from the European Medicines Agency and has yet to be certified as cost effective in the UK by the National Institute for Health and Care Excellence, known as NICE. Zejula is especially exciting because there is evidence that it works in women whose cancer is not caused by BRCA mutations, that is, the great majority.

"The trials show that Zejula reduces the risk of recurrence by 73 per cent in women with BRCS mutations," says Dr Banerjee. "In practical terms that means 21 months instead of 5.5 months, on average. In women without BRCA mutations, the increase is from four to nine months."

These are the largest benefits ever seen in survival in recurrent ovarian cancer. According to lead author of the trial, Dr Mansoor Raza Mirza, chief oncologist at Copenhagen University Hospital, these are "landmark results which could change the way we treat this disease". Dr Banerjee hopes even better news lies ahead. "We hope we'll be able to show this is effective earlier in the disease and will increase survival," she says. "A trial to test this is complete and we're waiting for the results."

SYMPTOMS OF OVARIAN CANCER



140k
deaths from ovarian cancer each year

World Ovarian Cancer Day

> This is a disease that could be diagnosed earlier if women were aware of the symptoms and if GPs were more aware, too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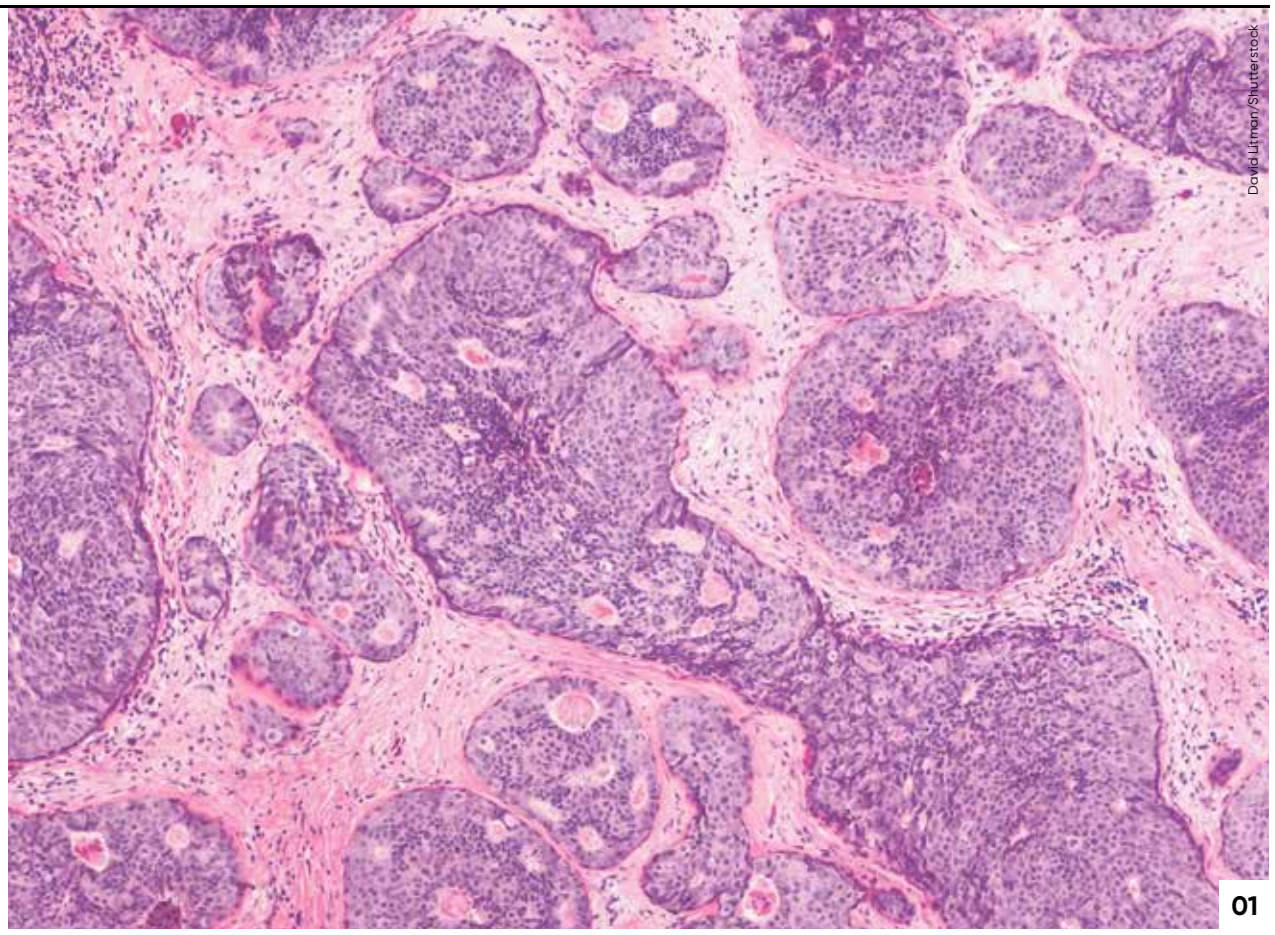
ARTIFICIAL INTELLIGENCE

New line of defence in cancer battle

Enlisting artificial intelligence to fight cancer raises the hope of winning the prolonged war against this despised disease


David Litman/Shutterstock

01

HEIDI VELLA

Cancer is an umbrella term for thousands of different types of conditions, yet treatment offered today is often generic and does not consider the need for differing therapies for different people," says Professor Toby Walsh, a leading expert in artificial intelligence (AI).

"However, with AI, all of us can have access to the best experts on the planet to get the best diagnosis and treatment."

Major technology companies such as Alphabet's Verily and Google's DeepMind, alongside a slew of start-ups, are using cognitive computing to fight cancer by building tools that essentially sort and accumulate medical knowledge and data on a scale that is impossible for humans alone to achieve.

Using machines to encapsulate the knowledge of physicians and experts, and to interpret data better than the specialists, can create a new understanding of cancer to provide better diagnosis and treatment outcomes.

For example, opportunities provided by genome sequencing can be unlocked with AI. The cost of sequencing someone's genome, which is the unique arrangement of their DNA, is falling and can now be done in 24 hours for $1,000.

Analysing a patients' DNA enables doctors to understand the type of cancer they have and, importantly, to act on the molecular code of the disease for more accurate treatment.

But there is no standardised approach to handling the high-volume, high-quality data produced from genome sequencing. It can differ from one hospital to another.

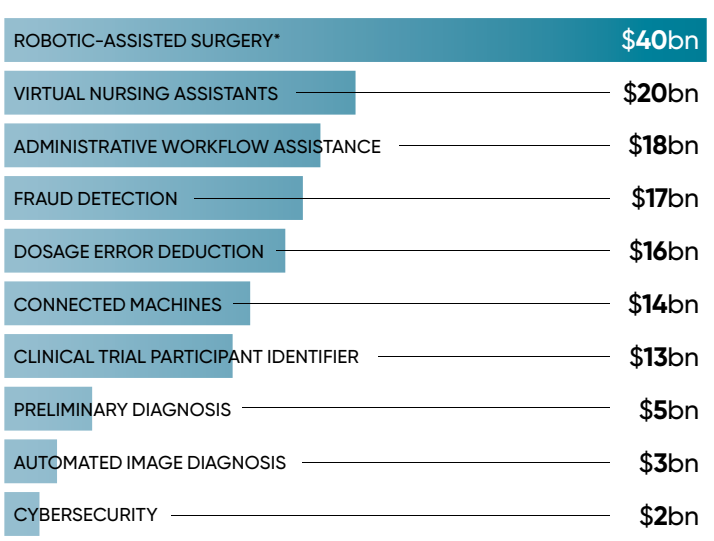
Swiss startup SOPHiA Genetics has developed AI that takes raw genome data and studies it to decipher the molecular profile of a person's cancer to find more suitable and personalised treatment options.

"This technology allows doctors to understand what is driving the cancer and to tackle it with the medicine which best treats the cause of the molecular event that is no longer working," says the company's chief executive Jurgi Camblong. The more data analysed by the AI, the more it learns and the more powerful it becomes.

By 2020 the company, which currently has partnerships with five UK healthcare institutions, including Oxford University Hospital, wants to start collecting data on treatment outcomes, so it can identify how a specific strain of cancer responds to different treatments to determine which is most successful.

TOP TEN APPLICATIONS FOR ARTIFICIAL INTELLIGENCE IN HEALTHCARE

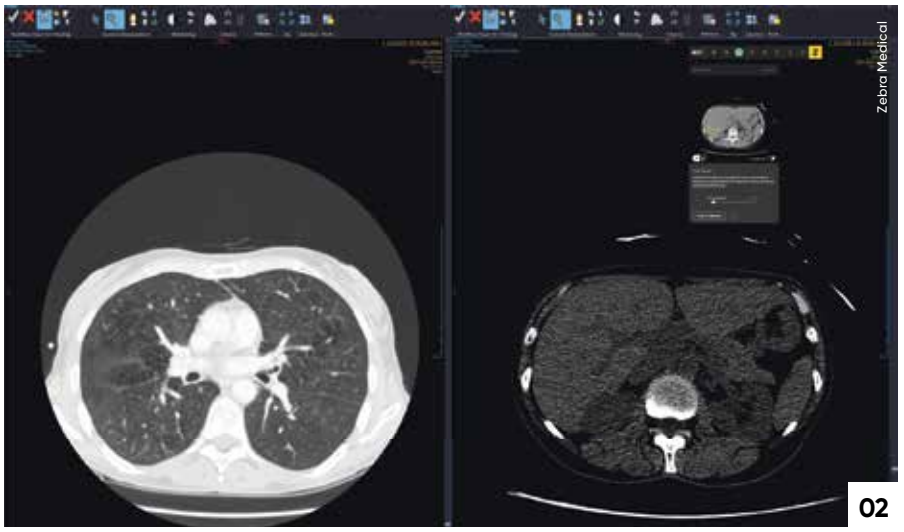
ESTIMATED POTENTIAL ANNUAL BENEFITS FOR EACH APPLICATION BY 2026



*Orthopaedic surgery specific

Accenture 2017

> Using machines to encapsulate the knowledge of physicians and experts, and to interpret data better than the specialists, can create a new understanding of cancer to provide better diagnosis and treatment outcomes


Zebra Medical

02

US-based Guardant Health has also used AI and DNA sequencing to commercialise the first comprehensive genomic liquid biopsy.

The blood test, developed by borrowing concepts from algorithms and digital communication, can unravel genetic sequences of a patient's cancer to categorise its sub-type without the need for a physical biopsy. By repeated tests, the cancer, which is continually evolving and changing, can be easily monitored so treatment can be adapted accordingly.

Furthermore, by combining machine-learning and advances in object detection in computers, algorithms can now routinely diagnose medical images, faster and more accurately than a radiologist, which could reduce waiting times and provide cheaper and earlier diagnosis.

For the last two years, the Royal College of Radiologists has highlighted a desperate shortage of imaging doctors, making delayed scan results routine for NHS patients.

"Two billion people are joining the middle classes worldwide and will at some point need a medical scan, but there are not enough doctors to diagnose those scans; therefore we need to get help from our friends, the computers," says Eyal Gura, co-founder and chairman of Zebra Medical Vision.

The company trains algorithms using medical images, diagnosis information and patient outcomes to detect specific diseases in scans. The algorithms are made available on a desktop AI assistant for radiographers to make a diagnosis from a scan quickly and easily.

Zebra's algorithm trained to detect breast cancer can identify the disease at a higher accuracy rate (92 per cent) than a radiologist using computer-aided detection software (82 per cent).

To keep costs low, the company, which is currently working with the NHS in Oxford to test the technology, launched AI1, a new suite that offers all its current and future algorithms to healthcare providers globally for only $1 per scan.

Google's DeepMind is doing something similar, training AI on a million anonymised eye scans from patients at various stages of age-related macular degeneration at Moorfields Eye Hospital, London.

But obtaining good-quality data in healthcare can be a problem. In November, the House of Lords heard from Julian Huppert, chair of the independent review panel for DeepMind Health, how data-sharing in the NHS presents huge challenges, and needs to become more digital and centralised as currently different trusts use varying systems that do not work together. This is perhaps why the NHS has been slow to take up AI technology.

Professor Walsh, author of *Android Dreams: The Past, Present and Future of Artificial Intelligence*, says the NHS is currently "not being proactive about using the technology in a proper way". He refers to data breaches that occurred when London's Royal Free Hospital handed over personal data of 1.6 million patients to DeepMind.

Incorporating the use of AI into the healthcare system must be done properly. Protocols, procedures and even adequate competition must be established, so large technology conglomerates do not monopolise patient data.

But it's clear we are barely scratching the surface of what can be achieved with cognitive computing in healthcare. There is no doubt that AI has the potential to transform cancer patient care, with the ultimate goal of using computers to take first-world healthcare into the third world at an affordable price.

01 Automated image diagnosis is expected to be one of the leading uses of artificial intelligence in healthcare; this image shows a ductal carcinoma in situ in a breast cancer biospy

02 Zebra Medical trains algorithms using medical images, diagnosis information and patient outcomes to detect specific diseases in scans; this image is a scan of a liver

CAMBRIDGE
CANCER GENOMICS

Tumours change over time... so too should cancer therapy.

Cambridge Cancer Genomics is developing tools to enable clinicians and scientists to understand therapeutic response in real-time. Through the use of artificial intelligence, we can predict a tumour's evolutionary trajectory and what this may mean for cancer treatment.

To find out more, join our global clinical partnerships or our growing R&D team, get in touch. Together we can change the way cancer is treated.

@CCGenomics info@ccg.ai www.ccg.ai