

THE JOURNAL FOR SCIENCE, ENGINEERING AND TECHNOLOGY

advances

WALES

The power to deliver

An AI-controlled, driverless delivery vehicle from Aberystwyth is hitting the road.



6 New sustainable way of treating wastewater



9 High-tech method to analyse wheat



Llywodraeth Cymru
Welsh Government

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"Discovery is seeing what everybody else has seen, and thinking what nobody else has thought."

Albert Szent-Gyorgi, Nobel Prize-winning biochemist

Advances Wales highlights groundbreaking scientific research and the development of new, innovative technologies across Wales.

This edition features an AI-controlled vehicle, designed to deliver packages autonomously with no need for a driver (page 18). Wales-based engineers have also developed unique self-weighting technology (page 8) and created a new method for treating contaminated water (page 6-7).

Due to rising resistance to antibiotics and the global health problems that it could cause, novel antibacterial sources are in demand. Researchers at one Welsh university are exploring the potential of Siamese crocodile blood to fight against bacterial infections (page 16). At other universities in Wales, scientists are training viruses to tackle cancer (page 12) and developing a device that allows people to test their own respiratory health at home (page 13). Designers are also starting to 3D-print bespoke masks to improve treatment of a disruptive sleep disorder (page 14).

More new Welsh technologies having an impact in the life science arena include unique light sources for keyhole surgery (page 17) and a digital system that helps nurses to save time (page 20). Meanwhile, a next generation blood pump is on course to enable better management of heart failure (page 10-11). Also featured in this edition are research into the effects of climate change on sea turtles (page 15) and a new high-tech method to analyse wheat (page 9).

Advances Wales is also available online, where you can find previous editions that feature key developments in research and innovation in Wales.

Sophie Davies
Editor

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Advances Wales is a high-quality, quarterly 'transfer of technology' journal produced by Welsh Government to showcase new developments in science, engineering and technology from Wales. Devoted to concise reports and commentary, it provides a broad overview of the current technology research and development scene in Wales. Advances raises the profile of the technologies and expertise available from Wales in order to facilitate collaborative relationships between organisations and individuals interested in new technologies and innovation.

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Advances Wales is designed and published on behalf of Welsh Government by Teamworks Design, 1st Floor, The Bonded Warehouse, Atlantic Wharf, Cardiff CF10 4HF. Opinions expressed in this magazine are not necessarily those of Welsh Government or its employees. Welsh Government is not responsible for third-party sources cited such as web sites or reports. ISSN 0968-7920. Printed in Wales by Harlequin Printing and Packaging, Pontyclun. Crown Copyright.

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Llywodraeth Cymru
Welsh Government

Advances Wales publishes news and features in the following areas

MATERIALS	FOOD	ELECTRONICS	PHYSICS
AGRICULTURE	ENGINEERING	COMMUNICATIONS	CHEMISTRY
ENVIRONMENT	MANUFACTURING	INFORMATION TECHNOLOGY	MEDICINE
ENERGY	EARTH SCIENCES	OPTO-ELECTRONICS	BIOTECHNOLOGY

Long range micro-backpacks for bees

Scientists at Bangor University are developing micro-backpacks for bees to track their movement.

An ecologist and a microsystems engineer are working together on the project, which will allow bees to be followed by small drones as they fly from plant to plant. This will enable scientists to learn more about where the bees collect nectar and find out what might be affecting their numbers.

Bee populations are in decline and their survival is facing several challenges. Certain insecticides affect their ability to navigate, so the ability to track bees over long distances could help scientists understand how these insecticides have an impact on their direction finding. Other applications could include tracking Asian hornets, which are a serious threat to many bee species, with a view to controlling or eradicating them before it is too late.

Existing bee monitoring devices face limits due to their weight, range and how long their power source lasts, but the Bangor University team has set out to resolve these issues using cutting-edge micro-technology. The new tracking device is designed to harness each bee's own electrical energy to power the backpack, meaning there is no need for a battery, and it weighs only a third of the bee's body weight, which is less than a raindrop. This solves the battery longevity and weight problems.

Next steps will be to test the backpacks on some bees in a poly tunnel and to develop a mobile receiver that will track and follow the bees' transmitted signals as they forage.

The Bee Improvement and Bee Breeders Association (BIBBA) is a partner organisation for the project, as it is keen to fund research into honey bee tracking in temperate environments so that the foraging range of bees under differing climatic and environmental conditions can be identified. This would provide them with more robust viability assessments before establishing new apiaries.



www.bangor.ac.uk

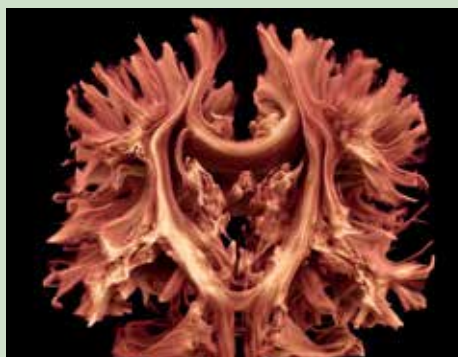
The brain's internal wiring revealed

Detailed scans produced at Cardiff University are helping to unravel the mysteries of the human brain.

BBC Medical Correspondent Fergus Walsh's brain was scanned at Cardiff University Brain Research Imaging Centre (CUBRIC) using Europe's most powerful MRI scanner – the Magnetom Skyra Connectom 3T. The scanner in Cardiff is one of only three in the world.

Engineers from Siemens took the scan data and produced images of the brain by adapting a technique used in the film industry known as cinematic rendering. These images provide a new view of the pathways taken by the white matter, revealing the complex set of connections that underpin brain function.

Another volunteer to be scanned was Sian Rowlands who has multiple sclerosis. Conventional scans clearly show lesions (areas of damage) in the brain of MS patients. However the advanced scan, showing axonal density, helps explain how the lesions affect



motor and cognitive pathways which can trigger her movement problems and extreme fatigue.

Researchers at CUBRIC are looking to provide new insights into the causes of neurological and psychiatric conditions such as dementia, schizophrenia and multiple sclerosis, as well as better understanding the workings of the normal, healthy brain.

"The incredible detail shown in these scans highlights the possibilities available to the talented CUBRIC team, which now has access to the most advanced equipment of its type in the world. The microstructural scanner will be used for research that will potentially have a profound positive impact on the lives of people around the world."

Professor Derek Jones
Director of CUBRIC

The £44 million Centre, which opened in summer 2016, is four times larger than Cardiff University's previous brain research imaging facilities and houses the best neuroimaging equipment in the world.



www.cardiff.ac.uk

VR road safety app in development

The University of South Wales is developing an app to teach road safety to schoolchildren.

Dr Catherine Purcell, who is a specialist in psychology, and games design expert Dr Mike Reddy are working on the project after being awarded £67,500 from the Road Safety Trust.

The funding is being used to develop a virtual reality proof-of-concept app, which will then be tested in Welsh primary schools. Many schools which implement a road safety education programme use books and knowledge-based games to teach essential road safety rules to children. Roadside behavioural training is proven to be more effective than these methods, but schools often do not have the financial resources for this.

The aim of the project is to develop technology that will allow children to learn road-crossing skills in a virtual environment, where there is no danger of injury, providing an efficient, cost-effective way to gain road safety practice.

"Road traffic accidents represent the second largest cause of death and disability worldwide for children aged between 5 and 14, so the need to teach children how to safely cross the road is vital. Through previous research I have demonstrated that 'egocentric' software, such as first-person games that directly simulate immersion in an artificial world, have a greater likelihood of teaching children vital information that will help to ensure that they are safe on roads."

Dr Catherine Purcell
Specialist in Psychology

Although virtual reality has existed for decades, it has only recently become high quality enough, and accessible at a reasonable price, to enter the mainstream. The university's road safety project will take the technology beyond 3D video and games for entertainment by looking at how VR



can be used to educate children about a real problem.

Dr Purcell added: "The proposed approach has considerable potential for widespread use and, if successful, additional funding will be sought to develop it further, with a view to sharing it free of charge with schools across the UK."



www.southwales.ac.uk

IN BRIEF

Smart hotel room service launched

Abercynon-based company MyLiveGuard has created a new connected solution that allows people to control their hotel room environment remotely using the TV or their mobile phone. They are now in talks with an international hotel chain and a well-known cruise company regarding the new service which will allow guests to check in, turn on the TV and set the temperature of their rooms, all before they have even arrived. Miles Woodhouse, Managing Director, explained: "Through an app on your phone you can automate and control a number of features in your room, from lighting through to air conditioning and heating. You can even control some coffee makers so there's a fresh cappuccino ready for you on arrival."

Fintech firm goes to Dubai

Financial technology company Delio has won a place on an accelerator programme designed to help businesses expand into Dubai. The programme consists of a 12-week curriculum in which the 11 finalists work closely with financial institutions and other stakeholders to help address the evolving needs of the region's financial services industry. Delio was the only UK company to make it onto the programme, which marks the next step in the firm's international growth strategy. Gareth Lewis, Chief Executive of Delio, commented: "Being the only UK fintech to make it onto the programme is a huge validation of the Delio solution and the role we can play in helping institutions connect private investors with investment opportunities across borders."

Success for first energy-positive classroom

The Active Classroom built by Swansea University's SPECIFIC Innovation and Knowledge Centre (which featured in Advances 80) has won the Construction Excellence Wales Innovation Award. These awards celebrate the best of the construction industry in Wales. The Active Classroom at the Bay Campus generates, stores and releases its own solar energy and provides teaching space and a laboratory for students, as well as a building-scale development facility for SPECIFIC and its industry partners such as BIPVco (whose technology featured in Advances 81). Swansea University are now planning a new project called SUNRISE, which will involve constructing solar energy products in India and then integrating them into five Indian villages, allowing buildings to harness solar power to provide their own energy and run off grid.

Medtech innovation gets green light

Invitron, a Monmouth-based biotech company, is working with Blackwood Embedded Solutions, a Caerphilly-based software and electronics design company, to develop a novel medical Point of Care Test (POCT) device. POCTs are rapid diagnostic tests carried out next to the patient, providing results much faster than conventional laboratory tests. After receiving funding and creating a proof-of-concept device, Invitron has now been awarded further funding to develop a POCT system based on their high-sensitivity chemiluminescence detection technology. Andrew Woodhead, Business Development Director of Invitron, said: "By collaborating with Blackwood Embedded Solutions we will be able to bring this prototype to market within budget and against the agreed timeline. This technology offers a clear market advantage and promises to be a real game changer for the industry and patient care."

Jellyfish collagen manufacturing facility launched

Jellagen has opened a first-of-its-kind facility in Cardiff for the extraction of high-purity collagen from jellyfish harvested off the West Wales coast. The company (who featured in Advances 74) is pioneering the move away from typical sources of collagen, which can carry a risk of disease, and has developed a next-generation collagen with unique functional benefits. Professor Andrew Mearns Spragg, CEO and founder, said: "This is a key milestone in Jellagen's evolution. To be able to manufacture jellyfish collagen in bulk quantities enables us to supply and meet the needs of world leading medical device, biotechnology and pharmaceutical companies." He added: "Being based in Cardiff gives logistical benefits for our business. Not only are we a short drive from key coastal regions for jellyfish harvesting and our depot in Pembroke Dock, but we have good access to support customers in the UK and transport links for global markets."

Sensor to support the vulnerable elderly

Glyndwr University has helped an inventor, who designed a computer monitoring system to support elderly people living alone, to take his new technology to market.

Tim Jones worked with North Wales School of Business and the School of Creative Arts at Glyndwr University to develop the BenignEye technology.

The inspiration came from his late mum, who lived independently until she died from a recurrence of cancer in early 2016. He began to explore ways of recording and observing, for peace of mind, how she moved around the house and used appliances, before later deciding to pursue the idea as a possible business.

BenignEye spends 30 days monitoring how the person moves around the house and what they do, such as looking at how many times they put the kettle on or how long they sit in a chair. Once



it has learned any patterns, it can then alert the person's family by text or email if their routine changes or if they are detected to be less mobile than usual. It can also automatically turn off

appliances which have been left on or raise the alarm if the temperature of the house is too cold in winter.

There are up to 232 different sensors available, including those covering motion, smart plug monitoring and door switches. The system can be fitted with a battery back-up system in case of a power cut, and can notify the operator when friends, family or carers visit the house.

Tim commented: "Mum was my test case and she was happy to help other people in her position, so we were able to get data from around the house. I know there are many people out there like her, who live alone despite their late age and fight for the right to do so. They deserve that right, but you can obviously understand the concerns of people around them – I experienced that myself – so this is a way that can help."



www.glyndwr.ac.uk

Antibiotic resistance collaboration funded

Impspx Diagnostics has won funding to work with partners in Warwick, Ireland and Germany on a project to tackle the global problem of antibiotic resistance. The Abercynon-based company's BreathSpec device (which featured in Advances 75) uses a combination of gas chromatography and ion mobility spectrometry to detect contaminants in the gases produced from waste products in order to analyse samples effectively. Thanks to the funding, BreathSpec will be able to provide a non-invasive method for monitoring the volatile organic compounds present in a person's exhaled breath, and subsequently the blood, which is recognised as a useful clinical test for a more targeted use of existing antibiotics. Santi Dominguez, chief executive of Impspx Diagnostics, commented: "We have a vision of providing primary healthcare with a reliable, fast and simple solution for identifying bacterial or viral infection, optimising patient care and minimising antibiotic consumption."

Awards for Welsh technology innovators

ESTnet's Wales Technology Awards 2017 celebrated the best of the Welsh technology industry. The Tech Start-up Award was won by Penarth-based robo-investing firm Wealthify and the Technology Leader Award went to Cardiff-based IT consultancy and software development firm DevOpsGuys. The prize for Most Innovative Product was shared between Wealthify for their online investment service and Wales Interactive for their live action video game The Bunker. Cardiff University's National Software Academy received the Industry Trailblazer Award for their long-term commitment to changing the way that software engineering is taught, while Bangor's Ysgol Cae Top primary school won the Best Tech Adopter Award due to its use of the eeZeeTrip app to save time and money. Alina Griestaragiene, a Senior Device Engineer at Infineon Technologies in Newport, was crowned Best New Talent.

Funding for new home buying platform

Proper, a Cardiff-based property technology start-up, has raised £850,000 to launch its new platform aimed at transforming the home purchasing process. The company's Track My Move platform brings together customers, estate agents and solicitors in one place, making buying and selling homes more transparent. It has aspirations to reduce the standard home purchase transaction time from the current average of 10-12 weeks to just two days. The platform can be accessed from any device, enabling customers to find out how their house purchase or sale is progressing and also streamlining the process for estate agents and solicitors. The firm has signed up a range of estate agents across Wales ahead of its upcoming national roll-out.

Growth for digital dozen firm

Penarth-based software developer OpenGenius is set to create 30 jobs after winning a place on the Innovation Point Digital Dozen Accelerator 2017, a new programme to support Welsh businesses in the technology sector. OpenGenius is the company behind brainstorming and project planning software iMindMap and visual task management app DropTask. The tech accelerator programme is running throughout the second half of 2017, offering finalists the tools, skills and connections needed to grow and secure their next investment round. Chris Griffiths, chief executive of OpenGenius, said: "We feel very lucky to have been accepted onto the programme among some outstanding entrepreneurs. We have an exciting few months ahead of us and we're really looking forward to working with the experienced mentors at the Digital Dozen Accelerator."

Progress for seaweed drug

A drug developed from seaweed that helps fight off infection has won the Medical Innovation Award at Cardiff University's 2017 Innovation and Impact Awards. Researchers discovered that alginates found in seaweed can combat multi-drug resistant infections. Working with biopharmaceutical company AlgiPharma, a team led by Professor David Thomas at Cardiff University's School of Dentistry showed how alginates could disrupt the formation of microbial biofilms. Professor Thomas said: "Our research allowed us to derive material from the natural world with powerful abilities to modify bacterial behaviour, making them more susceptible to antibiotic treatment, and to improve the properties of mucus in patients with lung disease. These findings are being applied to the development of alternative treatment approaches for challenging and hard-to-treat diseases."

New sustainable method for treating wastewater

Elentec has developed new technology to treat contaminated water that is more sustainable and environmentally friendly than conventional chemical treatment methods.

Electrochemical processes are used in industry for a wide range of applications, from making high grade alloys to preventing corrosion of large infrastructures such as pipelines or battery technology. These are applications in which a key feature is the use of electricity as a 'reagent' i.e. electricity can be used to drive and control the process.

The water treatment method known as electrocoagulation (EC) removes contaminants through the addition of a precipitation agent to the contaminated stream. This agent, typically iron or aluminium, binds to contaminants that are dissolved or in suspension and the compounds settle into a sludge. The process is similar to chemical coagulation, which is the industry standard for various waste streams, but differs in the way that the agent is added to the stream. Whereas chemical coagulation does this via chemical dosing, EC does it electrochemically. As a result, the system has a significantly reduced environmental footprint and the need for chemical handling and storage is reduced or even eliminated. These features enable the technology to be safely used in a range of applications and environments.



In EC, conventional water treatment chemicals (iron and aluminium-based chemicals) are replaced with steel or aluminium plate material configured in electrode pack sizes. From using simple plates in boxes a number of years ago, the process has now developed into a full-scale flexible, modular system with fully automated control.

Elentec recently created a mobile system capable of remote operation to treat mine water run-off in Snowdonia as a Small Business Research Initiative (SBRI) project for Natural Resources Wales. Throughout Wales there are currently more than 1300 abandoned mines, which are creating environmental problems and affecting nearby rivers and lakes.

The company's containerised equipment included small footprint separation technology developed especially for the project as well as electrocoagulation. It was able to successfully remove dissolved zinc from an old mine discharging into Snowdonia's Lake Gerionydd using low levels of electricity. This demonstrated that it would be possible to install units in remote sites using energy sources such as mini hydros to power the system.

The system was also designed to operate on a 'plug and play' basis and its electrode chambers weighed less than 25 kg, meaning they could be carried to remote locations by just one person. Work is now underway on a mobile system to treat up to 10 m³ of water per hour for a specific marine application, which will be complete by the end of 2017.



In partnership with Swansea University, the local government for Asturias, Spain, and a German water company, Elentec is working to implement the technology across mine contaminated sites in Europe. They are also collaborating with Harper Adams University, a specialist agricultural university in Shropshire, to develop technology that will treat digestate and recover water and nutrients contained in food and agricultural

waste. This would be a significant step in linking sustainable energy production and agriculture and alleviating the dependence of UK farming on imported fertilisers.

By treating water and waste in a more sustainable way, the technology turns 'contaminants' into 'misplaced resources' that are waiting to be harvested and exploited.

Profile

Product

Water treatment technology

Applications

Treating contaminated water

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Innovative self-weighing technology created

Flintec has collaborated with Cardiff University to develop autonomous electronic load cells.

Load cells are devices that turn force or pressure into an electrical signal. They are used in products where gauging weight is critical, such as in smart bins and agricultural storage silos.

Flintec's CC1 load cells are applied to crude oil pumps, where their main function is to measure the quantity of oil being pumped. This figure is then used in setting the pump speed. Typically the load cells used in oil pumps have permanently attached cables, which can easily be damaged and render the load cells faulty. As oil pumps are mostly located in remote places, the cost of replacing the load cells or cable is high.



In collaboration with Cardiff University's School of Engineering, the company has created autonomous load cells, which are wireless and self-powered. This means they do not require a battery or power cables, so cable related issues can be avoided and maintenance costs are reduced. The new technology combines a low power wireless device, an energy harvester, low power electronics and a strain gauge load cell.

To begin the development process, the vibration energy present in crude oil pumps was measured in California with help from Cardiff University. This allowed a suitable piezo

energy harvester to be chosen. In parallel, Flintec developed low power electronics, bluetooth low energy wireless communications and the load cell which consumes low current.

The piezo energy harvester converts the vibration movement of the pump into electrical energy, which then powers the electronics, wireless device and load cell. Once the electronics are powered, the oil pressure reading from the load cell is taken via a sensor and transmitted wirelessly. The electronics then hibernate and maximise the harvested energy.

Although the new technology is for oil and gas, it can equally be applied to any other field where ambient energy is available. Ambient energy scavenging, also known as energy harvesting or power harvesting, is the process of obtaining usable energy from natural and human-made sources that surround us in an everyday environment. Examples include electromagnetic radiation, solar, thermal and mechanical energy sources.

Modular designs can be developed for use in situations where cables are undesirable. For those using the technology, maintenance costs such as replacing batteries are saved and problems that may arise from potential damage to the cable are eliminated. The system can also serve as a viable alternative for companies that are averse to solar energy solutions due to their higher maintenance requirements, such as regular cleaning and the cost of needing to shut down pumps due to increasing health and safety requirements.

Profile

Product

Autonomous load cells

Applications

Gauging weight

Contact

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High-tech method developed to analyse wheat

Researchers at Aberystwyth University are using CT scanning technology, commonly found in hospitals, to study wheat.

In hospitals, CT scans make use of X-rays and a computer to create detailed images of the inside of the human body. They can produce images of structures including bones and internal organs, and are used to diagnose and monitor many medical conditions.

A pioneering new technique has been developed by Computer Science student Nathan Hughes to extract novel information from 3D images of wheat grain heads. His work will help scientists to develop new strains of wheat with the potential to be more resilient to climate change, better adapt to harsh environments, or have a more optimised grain size and overall yield.

Initially, he developed the technique to measure the effects of different watering and heat regimes on wheat yield.

Using Raspberry Pi computers and free open source software to drive an irrigation system and a series of weighing scales, it was possible to vary the amount of water given to individual plants and record their weight gain. The wheat grain heads of the plants were then studied using CT scanning technology to identify differences in grain development.

Traditionally at this stage, individual grains would be studied by hand in a painstaking and lengthy process. However, the newly developed technique enabled the research team to analyse 200 wheat grain heads in an hour – approximately 3000 individual grains of wheat. The findings were also compared with traditional grain study techniques and found to

have a 97% agreement rate with manual measuring, whilst being much more consistent.

The work began at Aberystwyth University's National Plant Phenomics Centre, and a genetics grant is now enabling it to continue at the university's Institute of Biological, Environmental and Rural Science. There, the CT scanning technology is being applied to study the relationship between seed shape, size and genetic makeup. This could allow more informed decisions to be made in grass breeding programs.

A type of grass called Brachypodium, which is genetically simple in comparison to wheat, has been used as a model to identify qualities and genes that can then be mapped to wheat. The new method developed for wheat grain analysis has been applied to the model grass with promising results. This aspect of the work is being completed in collaboration with the Sainsbury Laboratory in Norwich.



Profile

Product

CT scanning technology

Applications

Analysing wheat

Contact

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New advanced blood pump to treat heart failure

Calon Cardio is developing the UK's first next generation blood pump for treatment of chronic heart failure.

Chronic heart failure is a serious, often terminal condition that occurs when the heart is unable to pump sufficient blood to meet the demands of the body. It is a growing global health problem, with hundreds of thousands of sufferers in the UK alone.

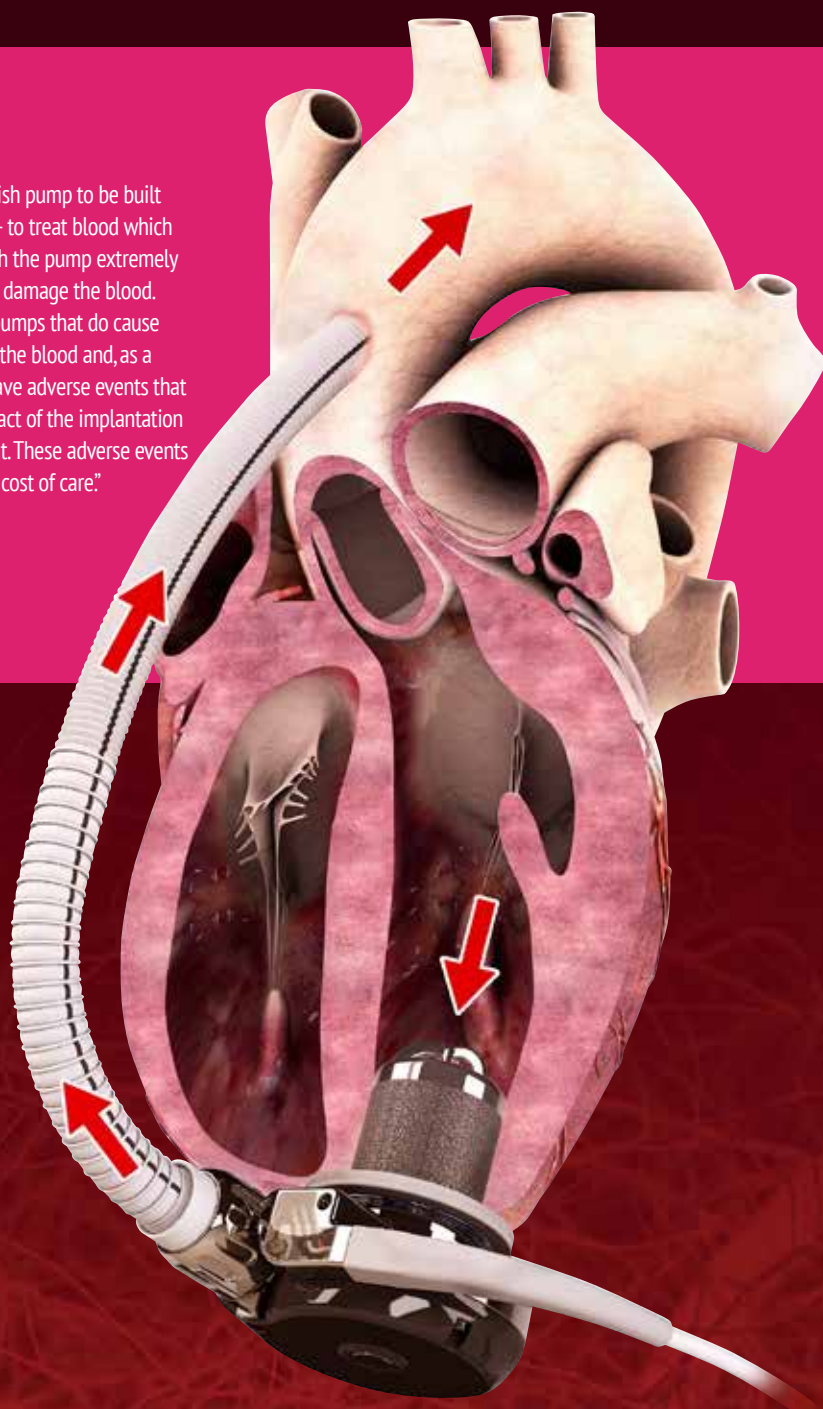
Traditionally medical management and cardiac therapies, such as drugs and pacemakers, have been used to prolong the lives of patients with heart failure. However, these methods are only partially successful and many patients end up progressing to advanced heart failure, which comes with a terminal prognosis and a poor quality of life. Until recently, only heart transplants offered a cure for advanced heart failure, but the very limited supply of donor hearts means that transplants are available only for a lucky few.

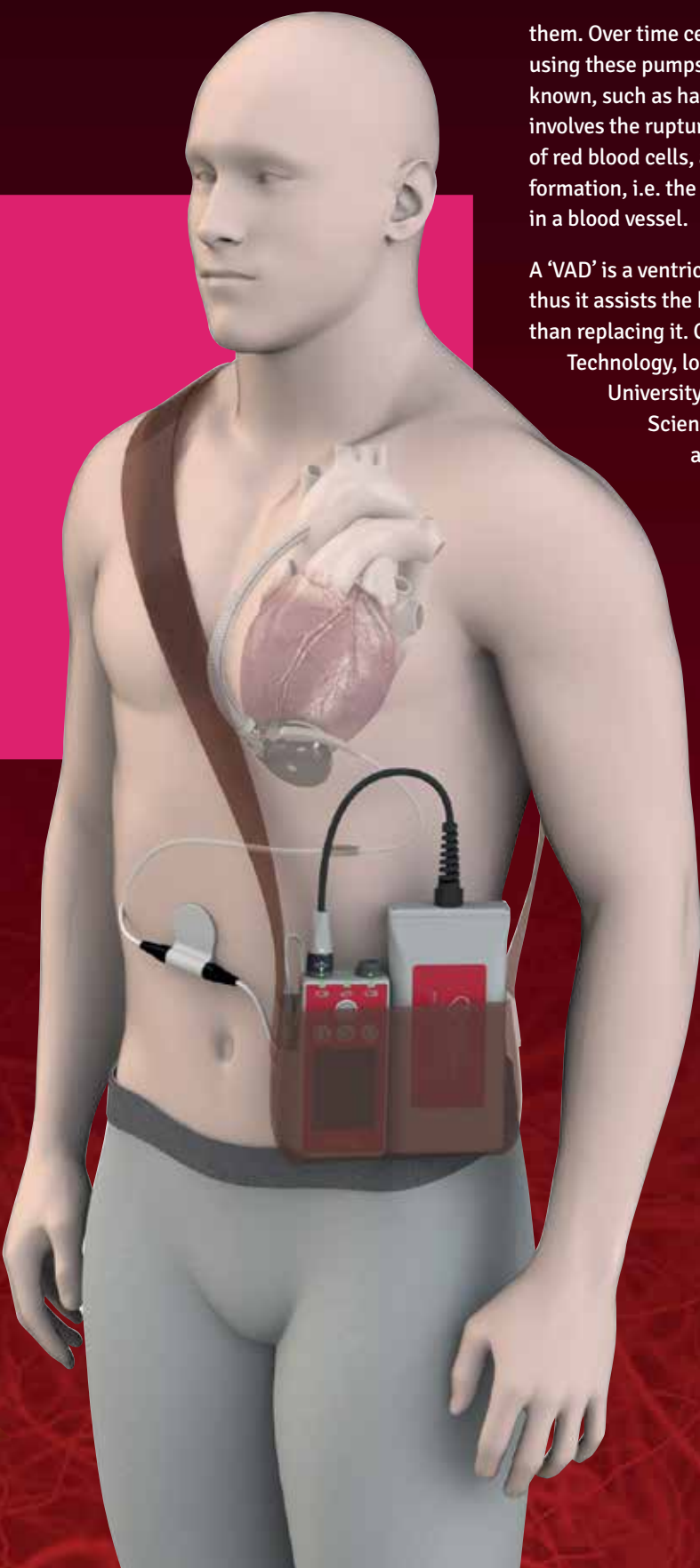
Blood pumps are becoming increasingly recognised as a viable long-term treatment option. However, early generation pumps are expensive, so it is difficult for healthcare systems to implant the numbers needed to fully meet the clinical demand. Another issue is that due to the large size of these pumps, highly invasive surgery is required to implant

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“It is the first British pump to be built for this purpose – to treat blood which is flowing through the pump extremely gently and not to damage the blood. There are other pumps that do cause some damage to the blood and, as a result, patients have adverse events that diminish the impact of the implantation and the treatment. These adverse events also increase the cost of care.”

Stuart McConchie
Chief Executive
Calon Cardio





them. Over time certain side effects of using these pumps have also become known, such as haemolysis, which involves the rupture or destruction of red blood cells, and thrombus formation, i.e. the formation of a clot in a blood vessel.

A 'VAD' is a ventricular assist device, thus it assists the heart rather than replacing it. Calon Cardio-Technology, located at Swansea University's Institute of Life Science, is developing an implantable

micro blood pump called the MiniVAD. In addition to boosting the output of the failing heart, improving quality of life and slowing or halting the progress of heart failure, the new advanced pump is designed to better manage the blood and minimise negative side effects.

After being implanted into the failing heart, the MiniVAD should last around ten years. It is driven by an embedded electric motor and powered by a compact battery pack worn by the user. Its reduced size and weight makes it more affordable than traditional pumps, meaning that it could make VAD treatment more accessible.

If the pump is able to minimise side effects, it will improve patients' quality of life and reduce strain on healthcare providers, as fewer visits to hospital will be required. Clinical trials are due to begin in late 2018, with the aim of a full rollout of the pump two years later.

Profile

Product

Implantable micro blood pump

Applications

Treating chronic heart failure

Contact

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Training a virus to fight ovarian cancer

Scientists at Cardiff University are exploring whether viruses can be genetically modified to tackle ovarian cancer.

Ovarian cancer is the sixth most common cancer among women in the UK, with around 7,400 diagnosed each year. It often goes undetected until it has reached an advanced stage, meaning that 40 per cent of women do not survive longer than five years after diagnosis. In the UK this type of cancer is estimated to cause 4,100 deaths annually.

Dr Alan Parker, a senior lecturer at Cardiff University's School of Medicine, is leading a team to research the potential of using viruses for cancer treatment. They are working to examine and alter the adenovirus serotype 5 (Ad5), which in its original form can cause infection of the airways and is usually spread through coughing and sneezing.

The team of scientists are using a state-of-the-art molecular technology termed 'recombineering' to genetically refine the Ad5 virus, so it can no longer infect cells via its native infectious routes and cause disease. Once refined in this way, it is possible to use the same technology to introduce new cellular specificity, or tropism, into the adenovirus. Using these techniques, the team will determine whether it is possible to genetically modify or train the virus to destroy cancer cells.

Scientists now understand in great detail how the Ad5 virus actually infects cells and causes a cough or a cold. The main limitation to date has been an inability to efficiently manipulate the virus to prevent it from entering the wrong type of cells and causing disease. With their new recombineering platform, the team can now rapidly and seamlessly engineer the virus to selectively infect cancer cells. Once they have solved the riddle of getting the virus specifically into tumour cells, they will be able

”

“A major advantage of using viruses to treat cancer is that if you can get a small amount of virus to the tumour cells, it acts as a factory, making more of itself, bursting or 'lysing' cells when they are full of virus. It spreads to infect surrounding tumour cells, repeating the process and amplifying the therapy at the point of need. Another advantage is that the virus can be further manipulated by inserting additional DNA into the virus genome. This means that in addition to making more of itself and killing cells through lysis, the virus produces vast amounts of proteins that can be therapeutic in cancer – for example antibodies such as herceptin or cetuximab, which are commonly used to treat breast and ovarian cancer.”

Dr Alan Parker
Cardiff University

to introduce additional genetic tricks into the virus genome, allowing the virus to replicate inside the cancer cells.

The use of viruses as agents to treat cancer (known as 'virotherapies') is becoming increasingly common, and recently received a major boost through the FDA and EMA licensing a virotherapy involving a tamed version of the virus that causes cold sores. This virus has demonstrated efficacy against malignant melanoma. It is becoming

increasingly evident that finding better ways to harness the power of virotherapies will be the key to their successful clinical translation into meaningful medicines.

The groundbreaking research at Cardiff University is likely to take around five years to reach a stage where clinical trials will commence. The team are confident that the same technologies can also be applied to treat other forms of cancer including breast, prostate, pancreatic and oesophageal cancers.

Profile

Product

Research into using viruses for cancer treatment

Applications

Fighting ovarian cancer

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Smart device tests lung function at home

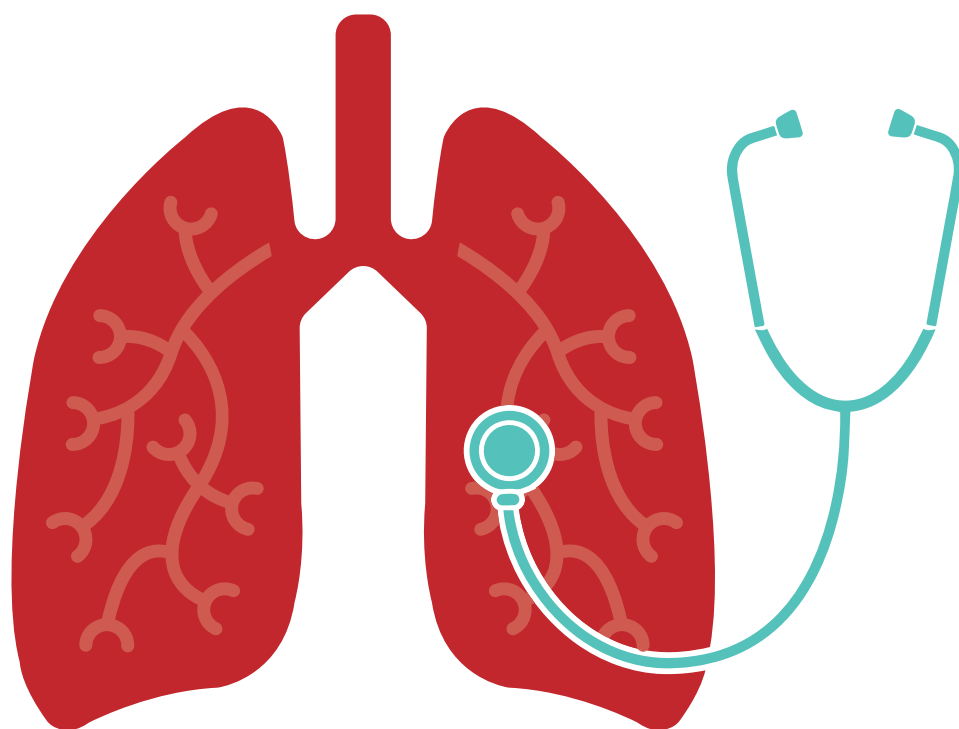
A professor at the University of South Wales is developing new technology that will enable people to test their own respiratory health.

Having good lung function is becoming increasingly important in the minds of the health conscious public. Further prevention of respiratory disease would not only help to improve people's health, but would also significantly reduce strain on the NHS. Lung function is currently tested by healthcare professionals using spirometry and results can take several days to be obtained.

Research carried out by Professor Mark Williams from the University of South Wales has led to the development of a simple breathing test, which people can use at home to provide them with an early indicator that their lung function is deteriorating. He is now in the process of incorporating the new technology into a prototype device suitable for home use and self-assessment.

It is envisaged that the simple hand-held device will become available through pharmacies, across the counter and without the need for a prescription. This will allow anyone concerned about their own breathing to perform a self-check, in a similar way to how some people monitor their blood pressure and blood glucose levels at home. Users of the device could range from smokers, sportspeople, asthmatics and allergy sufferers to people who are 'healthy' but nevertheless concerned about their respiratory health, or people who are worried about exposure to environmental air pollution. The device provides a gentler approach than traditional lung function testing methods, so children and elderly users can easily complete the test.

By giving people the opportunity to monitor their own respiratory health at home, the technology allows potentially serious respiratory conditions to be detected at a much earlier stage. If someone completes the test and discovers there has been a change



in their lung function, the result could give them the confidence to seek the necessary professional advice. Likewise if someone suspects they may have a problem, completes the test and finds no evidence of change in their lung function, they will be reassured and

can avoid an unnecessary GP appointment. The device could also encourage people to stop smoking or avoid adverse air conditions, bringing health benefits in addition to providing long-term cost savings for the NHS.

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“In the UK, lung disease kills one person every five minutes. This Welsh product has huge potential not only in Wales but for the global market, for example, in China and India where air pollution is worse and there are more smokers than here. The expertise is in the device, rather than the healthcare provider.”

Professor Mark Williams
University of South Wales

Profile

Product

Medical device that tests lung function

Applications

Enabling people to test their respiratory health at home

Contact

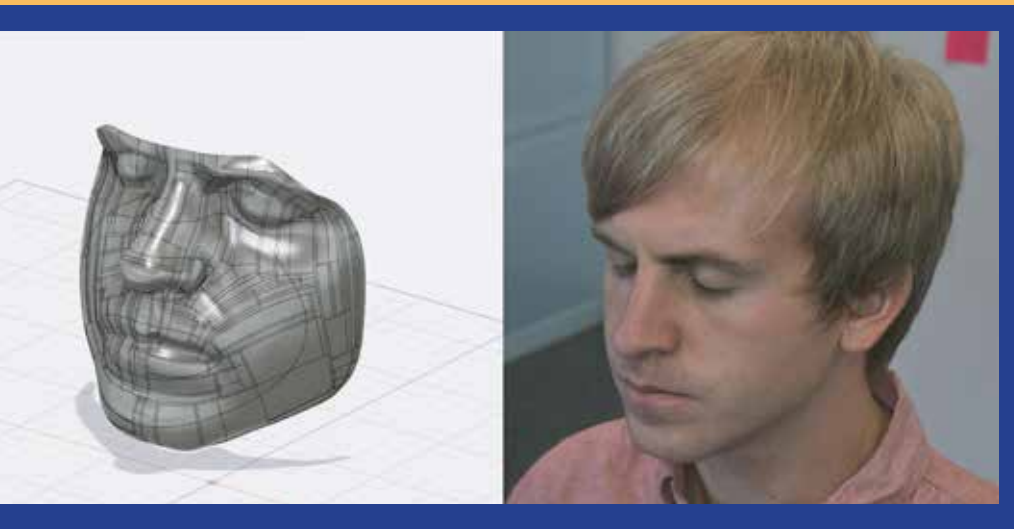
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Bespoke masks for sleep disorder treatment

Designers at University of Wales Trinity Saint David are creating new and improved masks to treat a condition that disrupts sleep.

Obststructive Sleep Apnoea is a sleep disorder affecting over 600,00 people in the UK. It involves the walls of the throat relaxing and collapsing during sleep, causing the airway to become blocked and interrupting normal breathing until the person wakes up. These incidents can happen more than 30 times per hour, significantly disrupting sleep patterns. The condition is linked to an increased risk of stroke, high blood pressure and cardiovascular disease, as well as road traffic accidents due to lack of sleep.



Continuous Positive Airway Pressure (CPAP) is the most common treatment of Obstructive Sleep Apnoea. Pressure is applied to the airway through a mask that the patient wears during sleep to maintain breathing. However despite the improvements to quality of life, 30 per cent of patients choose to not use this form of treatment. Over half of these non-compliant patients cite side effects related to the design of the mask and particularly the human-mask interface. These problems include mask leaks, pressure sores, skin irritation, discomfort due to an ill fit and mask dislodgement during sleep.

A need for better masks, enabling more effective treatment, was identified by Professor Keir Lewis and his team at Prince Philip Hospital, Llanelli. They are now

collaborating with Swansea College of Art at University of Wales Trinity Saint David to turn their research into a physical product.



Designers at the university are developing a new procedure, using low-cost 3D scanning and printing technologies, so that bespoke respiratory masks can be made for sufferers of Obstructive Sleep Apnoea. This is intended to resolve the negative side effects currently associated with CPAP treatment.

To produce a mask that truly fits the patient, 3D scanning is used to capture their face. A 3D digital surface is generated, around which the mask will be formed using 3D computer modelling software. Once this has been created, the mask is 3D printed from biocompatible materials. The procedure will meet the individual needs of the patient and can be modified depending on the severity of their condition.

The use of 3D printing means that the mask will not be restricted to the limitations of traditional manufacturing techniques. Also because the masks will be produced as one-offs, only the amount that is needed will be made, as opposed to mass-producing components. This would reduce the number of wasted materials and unnecessary products on the market.

It is estimated that CPAP treatment over a 14-year period can reduce a patient's risk of having a stroke by 49 per cent, suffering from cardiovascular disease by 46 per cent, and having a road traffic accident by 31 per cent. Overall probability of survival also increases by 25 per cent, so the introduction of more effective masks would have extensive patient benefits and reduce costs for the NHS.

Profile

Product

Bespoke 3D-printed sleep masks

Applications

Treating Obstructive Sleep Apnoea

Contact

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Sea turtles in danger due to climate change

New research from Swansea University suggests that warming temperatures could be driving sea turtles towards extinction.

A sea turtle's sex is determined by the temperature at which the embryo was incubated. This is known as Temperature-Dependent Sex Determination or TSD. The pivotal temperature for TSD is approximately 29°C as it produces both males and females in equal proportions, whereas above this point mainly females are produced and below this point more males are born.

Research has established that since temperatures are rising due to climate change, sea turtle populations will likely be more female-biased in the future. While it is known that males can mate with more than one female during the breeding season, if there are too few males, population viability could become threatened.

The new study, led by Dr Jacques-Olivier Laloë of the Swansea Lab for Animal Movement, explored another important effect of rising temperatures – in-nest survival rates. Sea turtle eggs only develop successfully in a relatively narrow thermal range of approximately 25-35°C. If incubation temperatures are too low the embryo does not develop, but if they are too high then development fails. This means that if incubation temperatures increase in the future as a result of climate change, more sea turtle nests will fail.

Researchers recorded sand temperatures at a loggerhead sea turtle nesting site in Cape Verde over a period of six years. They also noted the survival rates of over 3,000 nests in order to study the relationship between

incubation temperature and hatchling survival. Using local climate projections, they examined how turtle numbers are likely to change throughout the century at this particular nesting site.

The results showed that beyond a critical incubation temperature, the natural growth rate of the sea turtle population decreases due to an increase of in-nest mortality. Temperatures are too high and the developing embryos do not survive. This threatens the long-term survival of the sea turtle population.

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“In recent years, more and more sea turtle nests in important nesting sites like Florida are reported to have lower survival rates than in the past. This shows that we should really keep a close eye on incubation temperatures and the in-nest survival rates of sea turtles if we want to successfully protect them. If need be, conservation measures could be put in place around the world to protect the incubating turtle eggs. Such measures could involve artificially shading turtle nests or moving eggs to a protected and temperature-controlled hatchery.”

Dr Jacques-Olivier Laloë
Swansea Lab for Animal Movement

It is expected that the number of sea turtle nests in Cape Verde will increase by approximately 30 per cent over the next 80 years, due to more females being produced because of TSD and therefore more eggs being laid. However if temperatures continue to rise, the number could start decreasing afterwards as fewer embryos will survive. The study identifies temperature-linked hatchling mortality as an important threat to sea turtles and highlights concerns for species that use TSD in a warming world.

Profile

Product

Research into the effects of rising temperatures on sea turtles

Applications

Understanding threats to the survival of sea turtles

Contact

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Crocodile blood fights bacterial infections

Scientists at Cardiff Metropolitan University are exploring the use of crocodile blood as an antibacterial source.

A significant proportion of global infectious diseases are bacterial infections, and their associated morbidity and mortality rates are a serious public health concern. Due to the rise of resistance to antibiotics, bacterial infections are set to become even deadlier, so scientists are now broadening the search for new antibacterial substances and exploiting novel sources wherever possible.

The Siamese crocodile is a small, freshwater creature, which in the wild experiences many traumatic wounds that you would expect to be rife with infection. However this is not the case, as their immune system is very potent and allows them to recover quickly from

injuries that would kill other animals. Siamese crocodile haemoglobin is the most abundant component in its blood and has been long associated with a wide range of biological activity, including antimicrobial, antioxidant and anti-inflammatory activity.

Cardiff Metropolitan University's study, in collaboration with Khon Kaen University in Thailand, investigated the antibacterial activity of haemoglobin from Siamese crocodile blood. It was found that small fragments of haemoglobin could successfully kill multi-drug resistant bacteria such as *Pseudomonas aeruginosa* and *Klebsiella pneumoniae*. These bacteria can cause pneumonia and urinary tract infections in people who are already unwell. They can also be particularly harmful for cystic fibrosis sufferers, who have compromised immune systems and are prone to getting lung infections.

The findings explained that fragments of haemoglobin cause bacterial cells to become stressed and 'leaky'. The haemoglobin fragments clump together in the bacterial cell membrane, which essentially stops the membrane functioning as a barrier. Bacteria need an intact membrane to survive, so the membrane leakiness eventually causes bacteria to die. This is the case for many bacteria, meaning that the haemoglobin fragments could be useful against a variety of different deadly superbugs.

The scientists who undertook the study have identified which fragments of haemoglobin work best, and based on their findings, hope to develop them into a novel antibacterial treatment. The Siamese crocodile is widely farmed in Thailand and its blood is currently a waste product. With larger future studies drawing from this exploratory work, it may be possible to instead use the blood in the fight against bacterial infections and antibiotic resistance.



Profile

Product

Siamese crocodile blood

Applications

Exploring its potential as an antibacterial source

Contact

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Shining a light on keyhole surgery

Cymtec has designed three novel multiwavelength LED light sources to replace and improve on the traditional bulb technology used in keyhole surgery.

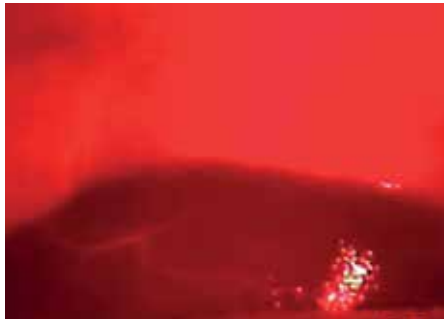
Many different procedures are now carried out using keyhole or minimally invasive surgery, which is a method of operating without needing to make a large incision in the body. In this modern form of surgery, high quality of light is essential, and healthcare providers also value low running costs of the light source and minimal downtime, for instance due to changing a bulb.

Cymtec's three new light sources are designed to improve both efficiency and quality of light, thereby increasing the chances of surgical success and reducing costs for healthcare providers. Each system incorporates the company's patented LED multiplexing technology.

One new system comprises ultraviolet (UV), red (R), green (G) and blue (B) LED light. It allows the surgeon to choose UV as well as colour balancing white light via adjustable RGB channel settings. This LED light source has been designed initially for use in the detection and removal of bladder cancer tissue.

UV light is essential for visualising cells stained with the chemical marker Hexvix. This is selectively absorbed by cancer cells and emits in the red wavelength when excited by UV. The surgeon is guided to the cancerous tissue, reducing the risk of both leaving cancerous cells inside and unnecessarily removing healthy tissue. The new system will soon undergo human clinical trials with the surgical team at St Mary's Hospital London. For the white light component of the system, a study has shown that the RGB output from the new device offers a significant improvement on the bulb technology currently used.

Another of the new sources consists of infrared, red, green and blue LED light. Similar to the



first design, the surgeon has the ability to colour balance white light, but they also have the option to choose infrared instead of UV. This system has been initially designed for use with the chemical marker Indocyanine Green (ICG), which is frequently used in medical diagnostics and has many applications, including but not limited to the detection and removal of cancerous breast tissue. ICG is notably cheaper than Hexvix and therefore more frequently used and accepted as the marker of choice.

This light source is undergoing in-vitro trials at Imperial College London and St Mary's Hospital London with in-vivo trials planned for 2018.

Surgeons currently rely on skill and experience alone to decipher healthy tissue from diseased, so the company's two new light sources offer an additional tool to improve on surgical success rates and reduce the need for follow-up procedures.

Finally, the company has developed a system that offers surgeons white light, utilising light emitting phosphor technology. Designed for endoscopic procedures where high illumination is vital, it makes use of Cymtec's patented double pumped phosphor technology, whereby phosphor material is optically pumped from both sides by LEDs within the phosphor's blue excitation wavelength band. The result is an increased luminous output without altering the optical path or increasing the light area, therefore producing a greater intensity of light.

A true white light is fundamental for surgery and this system provides a broadband white light which gives the surgeon the ability to adjust light intensity. While the design does not involve infrared or UV, it can be implemented in a wider range of diagnostic surgeries, such as early stage or exploratory endoscopic procedures. With just two LED sources, this system will consume less power, produce less heat and be cheaper and physically smaller. The white light design is currently in its development phase and has already generated global interest.

Profile

Product

Multiwave LED light sources

Applications

Providing light for keyhole surgery

Contact

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Driverless delivery vehicle hitting the road

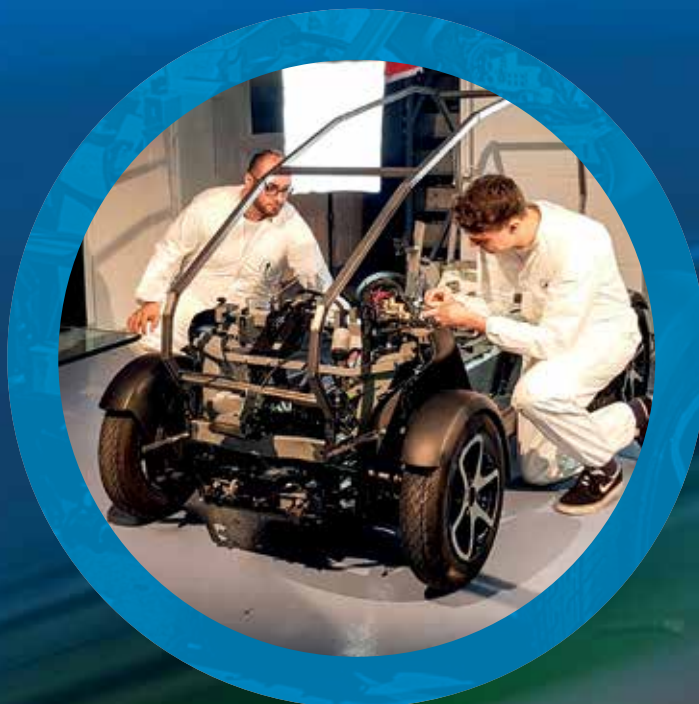
Academy of Robotics, a company based at Aberystwyth University, is developing a driverless, AI-controlled delivery vehicle.

When a parcel is travelling to its recipient, a significant proportion of the delivery cost occurs in the last few miles. By automating the delivery process with a vehicle that requires no driver or operator, this cost can be removed.

Kar-Go has been designed to deliver multiple packages to addresses in residential areas, all completely autonomously. Its creator, William Sachiti, began the project after studying artificial intelligence and robotics at Aberystwyth University.

Inside the vehicle's body is a system of compartments which contain packages belonging to different customers. As the vehicle arrives at each delivery address, AI software automatically selects the package belonging to the corresponding customer. The package is then released through an opening in the rear of the vehicle. More than a dozen deliveries are possible in a single trip.

Using sensors and robotics combined with driverless vehicle technology, the vehicle is able to travel around residential areas. To navigate a route, it employs Simultaneous Localisation And Mapping (SLAM) algorithms, which fuse data from multiple sensors and an offline map into current location estimates and map updates. Through detection and tracking of moving objects (DATMO), it can detect and manoeuvre around hazards such as other vehicles and pedestrians. Sensors within the car include lidar and stereo vision, GPS and IMU, and it also makes use of visual object recognition and machine vision including



Profile

Product

AI-controlled, driverless vehicle

Applications

Delivering packages autonomously

Contact

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neural networks. The AI system is capable of learning its surroundings, which means it can drive through unmarked roads to reach almost any address.

Large companies working on similar projects are concentrating on driverless vehicles that can navigate main roads. Academy of Robotics, on the other hand, has developed a system that can operate in more remote areas. Wales has been described as the

perfect test ground for it, as there are so many narrow, winding roads.

In the earliest months of its use, Kar-Go will only be able to run on residential roads, but the plan is to ultimately make it usable on all road types. Once this happens, it is estimated that the vehicle could enable cost savings of up to 90% in the last leg of deliveries, where vans are still the most common method of transportation.

Academy of Robotics has partnered with car manufacturer Pilgrim MotorSports to make the vehicles in the UK, starting from raw metal to fully functional autonomous vehicle. So far a working prototype exists and street-legal versions are now being created with Pilgrim. In a crowdfunding round for Kar-Go's development, the target was reached and exceeded.



Digital system saves time for nurses

Elidir Health has created a digital tool to reduce the time that nurses spend chasing patients' laboratory test results.



If nurses wish to check whether their patients' test results are available, current practice is to repeatedly log onto a portal in order to view the status of their request or to call the pathology department. A Betsi Cadwaladr University Health Board study at Wrexham Maelor Hospital found that nurses in a typical paediatric ward spend an average of 28 minutes per shift chasing test results in this way. In the case of adult wards, the figure is estimated to be even higher. This is naturally frustrating for nurses and takes away vital time that they could be spending face-to-face with patients.

The contents of the test results themselves are not automatically released, safeguarding patient privacy. Users must complete a further verification step by logging into the clinical portal to retrieve the results.

The digital company's general aim was to produce a solution for healthcare professionals which would allow them to provide safe, quality care in a more timely manner. To ensure that it was efficient and easy to use, the people most likely to use the tool were involved in the design and development process. This meant that it could be truly 'by nurses for nurses', rather than having a system created by software developers with little knowledge of the clinical environment.

Elidir Health has designed CHAI Ping to notify nurses when patient test results are ready for collection in real-time. A permanently connected interface lists the patients on each ward and sends an alert when results are available. The system integrates with the hospital's patient administration system and clinical portals and works alongside existing IT systems, with no disruption to the established infrastructure.

CHAI Ping has its roots in the company's first CHAI (Connected Healthcare Administrative Interface) tool, which was developed to help nurses save time on administrative tasks. In contrast to the traditional paper-based system, it gives nurses access to patient information digitally as and when required, whether they are on or off the ward. The initial goal was for nurses to find 10 per cent more time for direct patient care. This was exceeded, as evaluations found

that the new system was capable of giving nurses 23 per cent more time to spend with patients.

Elidir Health is currently working on a personalised version of CHAI Ping so that doctors and nurses can monitor the results of only their own patients, rather than monitoring every patient on a particular ward. To improve assurance that results have been noted, the system will also soon keep records on notifications, dismissals and actions taken.

Profile

Product

Digital tool for nurses

Applications

Reduces the time spent chasing test results

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