BATTLE THE DEUICES





Implantable Cardioverter Defibrillators (ICDs)



DECIDE

Running blades for amputees





DIDGET glucose monitoring



Resonance Imaging (MRI)

THE GUIDE TO HELP YOU DECIDE

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FOREWORD & INTRODUCTION

Hello and welcome to the **Battle of the Devices** where six health and technology experts will go head-to-head to convince you that their chosen medical device is the most innovative technology in healthcare today.

Each year, millions of people – men, women and children – fall ill but have their lives changed or even saved by medical technology. Today's session will show you a few examples of the incredible range of inventions that have transformed modern medicine. As you will see for yourselves, biomedical technology represents a place where the basic science we learn in school comes together with materials science, engineering, and electronics. Together, highly creative inventors fuse these ideas into almost magical tools. Imagine the following:

- an intelligent pump that can mimic the working of your pancreas;
- a computer game that might improve your health or even save your life;
- beautiful blades inspired by the cheetah's legs that allow amputees not just to walk again, but to run (or even compete in the Paralympics);
- a way of seeing the tissues inside the body live in 3D and in real time;
- life-saving scaffolding the thickness of a strand of spaghetti;
- an implantable device that will keep a damaged heart beating steadily

We've come a long way since the early days of medicine when untested, often poisonous, drugs were common, hygiene was unknown, and surgery was carried out with no anaesthetic using nothing more than saws and blades. While we sometimes take for granted the astonishing medical achievements of the last 200 years, huge challenges remain. We need creative and inquisitive minds to take us forward. That's why you have such a crucial role to play in the evolution of both science and technology. You are the inventors of tomorrow and today you will get to have your say as part of our debate.

Enjoy the session and use this booklet to help you decide which device rocks the world as part of the Schools Science **Battle of the Devices**.

Professor Andrea Sella, Professor of Inorganic Chemistry at University College London & Chair of Battle of the Devices



Stents are tiny medical devices that make a big impact on health, saving hundreds of lives a day.

The cardiovascular system is like a network of flexible pipes allowing blood to flow freely around the body. When those pipes get blocked or narrowed, a stent is needed. A stent is a mesh-like tube, often made of metal, which expands once it is inserted into a heart artery. The stent acts as a scaffold to support a narrowed or blocked artery, keeping it open for blood to flow more freely.

You might have heard of stents in the news recently. Prince Phillip had a stent fitted over Christmas and Tottenham Hotspur manager Harry Redknapp also had a stent operation last year.

Why do we need this innovation?

The heart keeps blood moving around the body, delivering oxygen and nutrients to all parts of the body. It works like a pump. Actually, the heart is two pumps in one. The right side of your heart receives blood from the body and pumps it to the lungs. The left side of the heart does the exact opposite: it receives blood from the lungs and pumps it out to the body.

Right coronary artery Left artery Left anterior descending artery Heart disease is caused by a gradual build-up

of fatty deposits (plaque) in the walls of the coronary arteries, which can then cause them to narrow. Over time, the artery may become so narrow that it can't deliver enough oxygen to the heart, especially when oxygen rich blood is needed quickly by the body, when exerting energy such as running for the bus or climbing the stairs. This can lead to angina – a pain or discomfort in the chest. If a piece of this fatty material breaks away from the artery wall it can cause a clot to form, which will block an artery and starve your heart of blood and oxygen. This is known as a heart attack and can be fatal.

Normal artery



Artery narrowed by atherosclerosis



You can do a lot to control cardiovascular disease, such as taking medication, changing your diet, giving up smoking and exercising.

When these changes aren't enough, a doctor may recommend a stent implant.

Attack of Facts

FACT

Before stents were introduced in the 1980s, patients had to endure invasive heart surgery to open the chest and rib cage.

FACT (

Stents have dramatically reduced the amount of time a patient spends in hospital from 2-3 weeks to 1-2 days and provide immediate relief from pain with little or no recovery time.

FACT

Having a stent does not change a patient's normal life and they should be able to return to work or normal routine a week after the procedure.

FACT

Each year, about 65,000 people in the UK have a metal stent fitted.



IMPLANTABLE CARDIOVERTER DEFIBRILLATORS (ICDS)



An implantable cardioverter defibrillator (ICD) is a device a little bigger than a matchbox and capable of sending an electric current through the heart to prevent sudden death from a heart attack.

Some patients refer to them as their own personal paramedic.

The ICD is 'implanted,' or put in your body surgically and has two main parts, a pulse generator and one or more leads. The pulse generator constantly keeps track of your heartbeat. It's like a small computer that runs on a battery. The lead is a wire from the pulse generator to the inside of your heart. It sends signals from your heart to the ICD and then sends an electric current from the pulse generator back to your heart.



Why do we need this innovation?

Normally, your heart has a natural 'pacemaker' and its own electrical system. If your heart is working properly, an electrical current starts in one of the upper chambers of the heart (the atria) and travels through the heart to the bottom chambers (the ventricles). The different chambers need to work together to produce a regular heartbeat. If they are not coordinated, then blood won't circulate properly around your body.

Sometimes, your heartbeat may become irregular. A heartbeat that is not regular is called arrhythmia, and means that your heart chambers are not beating in a coordinated way. Treatment for arrhythmia depends on what kind of arrhythmia you have. Some arrythmias may cause milder symptoms such as dizziness but others can be fatal. You may need an ICD if you have had or are at high risk of having certain lifethreatening arrhythmias.

Attack of Facts

FACT

If an ICD notices a dangerous heart rhythm, it can automatically deliver three lifesaving treatments straight away:

- **PACING** a series of low-voltage electrical impulses at a fast rate to correct the heart rhythm.
- CARDIOVERSION one or more small electric shocks to restore the heart to a normal rhythm.
- DEFIBRILLATION one or more larger electric shocks to restore the heart to a normal rhythm.

FACT

ICDs are miniature, internal versions of the large paddles paramedics use to shock people back to life after a cardiac arrest. After a sudden cardiac arrest, quick treatment is vital, for every minute that passes without defibrillation, the chances of survival decrease by 14%.

FACT

An ICD gives many patients more peace of mind as it will automatically treat their arrhythmia if their heart begins to beat irregularly.



Each year, about 4,500 people in Britain have an ICD fitted.

RUNNING BLADES

London will welcome 1,100 athletes to compete in the 2012 Paralympics in between August and September. Many paralympians with limb loss will be using running blades to help them compete at the highest level.

The running blade is a J-shaped, high performance carbon composite prosthetic sprinting foot, designed to store and release energy in order to mimic the reaction of the functional foot/ankle joint of able-bodied runners.

Why do we need this innovation?

Artificial limbs have come a long way. Older prosthetics were made of wood, metal and leather. They were a actually made to look like a foot, sacrificing performance of the foot over how it looks.





With the help of modern technology people can often lead the kind of

lives they want, achieving things that were almost unimaginable in previous generations. After running on blades for only four years, Oscar Pistorius is a world champion sprinter who has broken his own world records some 30 times. He is the first ever Paralympian to win Gold in each of the 100m, 200m and 400m sprints (Beijing 2008), and his international reputation as the "fastest man on no legs" is gaining momentum with every race.

How it fits



2 Attachment

The connection between the foot and the socket is high enough on the back of the socket to accommodate a long foot.

3 Foot (Carbon composite)

The entire curved component is called the foot. There are spikes in the underside of the tip.

Attack of Facts

FACT

The shape, which somewhat resembles the hind quarter of a cheetah, acts like a spring and shock absorber.

FACT

Running blades are NOT bionic limbs. They do not incorporate sensors, microprocessors, or motors to supply powered movement and responses for the user. Running blades return a high proportion of the energy stored when the foot makes contact with the running surface. Because of the momentum of the runner and the shape of the blade, the energy is returned at a later point in the stride and in the right direction to drive the runner forward.

FACT

Blades are specifically designed for running, allowing amputee athletes to train better and with less risk of injury than if they used prosthetic feet designed for normal daily activities.

FACT

Every medallist in the 100m, 200m and 400m races at the 2004 Paralympic Games in Athens wore a running blade.

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INSULIN PUMPS

Diabetes is a life threatening illness that affects 1.4 million people in the UK, including approximately 2-3 in every 1,000 teenagers.

The best way to manage insulin-dependent diabetes is to imitate how the non-diabetic body regulates glucose through the pancreas. An insulin pump is an insulin delivery device (which looks like a mobile phone) attached to the wearer by a length of clear plastic tubing connected to a cannula inserted under the skin. The pump can be kept in your pocket, clipped to your waistband, or tucked into a sock or bra.

Why do we need this innovation?

Diabetes is when your body can't use glucose (sugar) properly. It is all to do with the hormone insulin. Insulin is crucial in helping the body convert glucose from food into energy. When you have diabetes your pancreas does not produce enough insulin and your body can't use the glucose in your blood properly. This means your blood glucose levels get too high and can make you ill.

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- **Type 1** tends to occur in younger people and the basic problem is in the amount of insulin that is made by the pancreas.
- **Type 2** mainly occurs in older people when they make less insulin, and what they do produce, is less effective.

Type 1 diabetes is treated with multiple daily injections of insulin or by using an insulin pump.

However, if you give yourself an injection of too much insulin then the sugar in your blood falls too low and you can become unconscious – this is called a "hypo" (short for hypoglycaemia). Another problem is when diabetics eat too much sugar compared with the insulin they are taking. Then the blood sugar becomes too high, and this also makes the person ill which is known as a "hyper" (short for hyperglycaemia).

Attack of Facts

FACT

Diabetes can cause blindness, kidney failure, heart attacks, strokes, seizures, coma and even death. Insulin pumps help patients gain better control and understanding of their diabetes.

FACT

The pump records ⁴ what happens before hypos and hypers, allowing patients to monitor and manage their diabetes more effectively.

FACT

A constant delivery of insulin is slowly fed through the thin tubing that sits just under the skin, meaning the patient can program how much insulin is delivered every 30 minutes, thus mimicking the working of the body's own pancreas. FACT

Around 1 in 1,000 people with diabetes wear an insulin pump.

DIDGET GLUCOSE MONITORING



Imagine a computer game that could actually save your life. Sounds too good to be true?

Well, DIDGET is a blood glucose monitoring system which reads and records blood sugar concentrations, connects with Nintendo DS® systems and rewards consistent testing by unlocking new mini-games.

Why do we need this innovation?

For people with diabetes, good blood glucose management is essential if they are to keep their condition under control and avoid serious long term health complications. Glucose levels need to be kept as near to normal as possible. This can be achieved by controlling the amount of insulin they use, eating a healthy, balanced diet and taking part in regular exercise.

Testing blood glucose regularly and making a note of the results in a record diary shows how well the patient is managing their diabetes. Poor control can be dangerous and over many years it can lead to blindness, kidney failure, heart attacks, stroke, seizures, coma and even death. DIDGET can measure blood glucose in 5 seconds and automatically stores results to make blood glucose management easier.



When connected to the Game Boy Advance cartridge slot on Nintendo DS and DS Lite systems, DIDGET converts blood glucose test results into reward points. Players can redeem these points to unlock new levels, mini-games, and items in Knock 'Em Downs: World's Fair, a Nintendo DS adventure game bundled with the DIDGET device. DIDGET additionally features an online community with score leaderboards, web games, and player profile pages that can be customised by redeeming DIDGET reward points.

Attack of Facts

FACT

DIDGET is the first and only blood glucose meter intended for young people with diabetes that plugs into Nintendo DS and Nintendo DS Lite gaming devices.

FACT

The product was inspired by a parent of a child with diabetes; he noticed that although his son regularly misplaces his blood glucose meter, he never forgot his Nintendo Game Boy.

FACT

Blood sugar testing is an essential tool for managing diabetes and helps to prevent long-term complications from developing.

FACT

There are now more than 22 million games consoles in Britain, which means about eight in every ten homes has at least one!

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MAGNETIC RESONANCE IMAGING (MRI)

Superman may have had X-ray vision but even he couldn't see as much as we can today by using Magnetic Resonance Imaging or a MRI scan.

MRI is a safe and painless test that uses a strong magnetic field and radio waves to create pictures, of tissues, organs and other structures inside your body, meaning that there is no exposure to x-rays or any other damaging forms of radiation. These images are comparable to an anatomy drawing in a text book.

Why do we need this innovation?

An MRI scan can create clear pictures of most parts of the body. It is useful for all sorts of reasons where other tests (such as X-rays) do not give enough information or are not clear enough, is commonly used to get detailed pictures of the brain and spinal cord, or to detect abnormalities and tumours. Even torn ligaments around joints can be detected by an MRI scan. It is being used more and more following sports injuries, with many Premiership footballers and Olympic athletes undergoing MRI scans before being declared sports fit.





What does an MRI scan involve?

The MRI scanner is like a tunnel about 1.5 metres long surrounded by a large circular magnet. You lie on a couch which then slides into the scanner. A 'receiving device', like an aerial, is placed behind, or around, the part of the body being examined. This detects the tiny radio signals emitted from your body. When each 'picture' is being taken you need to keep still for a few minutes, otherwise the scan picture may be blurred.

The scan itself is painless and can take 15-60 minutes in total, although no individual scan is longer than 10 minutes. It may be a little uncomfortable lying still on the couch for this time. In some cases, an injection of a special contrast dye is given into the bloodstream via a vein on the arm. This helps to give clearer pictures of certain tissues or organs being examined.



Attack of Facts

FACT

MRI scanning allows the doctor to view what is going on inside the body without the use of x-rays. MRI allows them to discover understand what's not working without the need for exploratory surgery: therefore reducing the need for unnecessary operations.



The technology is constantly evolving and the next generation scanners will dramatically reduce the time a patient spends in the scanner. It will be easier to image the whole body rather than just small areas of it.

FACT

MRI scans are better than X-rays at showing soft soft tissue or inflammation, for detailing blood vessels and creating crosssectional pictures in any plane or direction. The scanners can also tell us about the body's function not just anatomy.



The scientific principles behind MRI were discovered in 1946, but it was not until the 1970s that the technology became available to use these principles. The first commercial MRI scanner was installed in Manchester in 1983.

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SCORE THE FACTS

To help you decide which device rocks the world, score the devices 0-10 in the three categories below, thinking about the following when making your decision:

Innovation Factor – which device really has the wow factor and is something you might expect to see on Dr Who or Star Trek? How has the device evolved over time to make it faster, smaller or more effective for patients?

Impact Factor – is this device a matter of life or death? How many patients have benefitted from the device? **Quality of Life Factor** – what can the patient do now that they couldn't before the device was fitted? How has their life been improved for the better?









Innovation factor

Quality of life factor

Impact factor





ABOUT SCIENCE4U.INFO

ABOUT MEDTRONIC UK

What is science4u?

The science4u website **www.science4u.info** has been created for the annual Schools Science Conference project.

Objectives of the Schools Science Conference and the website are to:

- Inspire students to study science
- Demonstrate the importance of science in health and everyday life
- Showcase some of the myriad careers open to those who study science.

Science in Health and Life is a series of annual conferences, presented by professional scientists and healthcare professionals to

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showcase a wide range of exciting and rewarding careers open to those who study science. Up to 250 secondary school and further education college students (years 9-11) attend with their teachers (40-60). Some 80-100 professional scientists from the NHS and other public sectors, industry and commerce provide the backbone of the conference and hands-on interactive displays. The conference targets students from schools that historically have suboptimal educational outcomes. Last year, 25 different ethnicities were represented, 37% of attending students spoke English as a second language, 21% of the attending students were entitled to receive free school meals, 25% of the attending schools had less than 40% of students obtain 5 A-C GCSE passes.

Medtronic is the world's largest medical device company. We are a US company that shares its birthday with the formation of the NHS. Our founder, Earl Bakken, invented the world's first battery operated pacemaker in a garage in Minnesota. Today, we research, develop and sell therapies that range from pacemakers to insulin pumps to surgical equipment to neurostimulators. In the UK we have about 420 employees working in a range of sales, technical and support roles serving customers and patients in pretty much every hospital in the country.

Our medical technologies help make it possible for millions of people to resume everyday activities, return to work, and live better and longer lives.

FURTHER SOURCES OF INFORMATION

Arrhythmia Alliance - The Heart Rhythm Charity www.arrhythmiaalliance.org.uk

Ashley Jolly Sudden Adult Death Trust (SADS UK) www.sadsuk.org.uk

The British Heart Foundation www.bhf.org.uk

Diabetes UK www.diabetes.org.uk

The Limbless Association www.limbless-association.org

NHS Choices MRI pages www.nhs.uk/conditions/MRI-scan/Pages/Introduction.aspx

Medtronic www.medtronic.co.uk





