What is nanotechnology? Info A1

Nanotechnology is the ability to create and manipulate materials and build devices which operate at the scale of atoms and molecules. A nano-meter is a thousand millionth of a metre.

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The NanoAthero Project is just the beginning Info A2

The NanoAthero project plans to perform two Phase I clinical trials for imaging 'vulnerable' plaques which could disrupt and lead to heart attacks. If successful these would need more advanced clinical trials in future projects.

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What is Nano? Info A3

Nano-scale particles are small enough to flow in the blood, enter body cells, pass from the blood system to the brain, or pass through the skin. These properties could be very useful medically, but also carry some risks.

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Nanoparticles can be natural or human-made Info A4

Milk is made of solid particles permanently suspended in water, some are nano-sized. Manufactured ice-cream can contain nanoparticles. Merely being small does not mean a nanoparticle must be unsafe.

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What is Atheroslerosis? Info A5

Atherosclerosis is the build up of a waxy deposit (plaque) inside blood vessels which gradually reduces the flow of blood. If a plaque becomes unstable, it is vulnerable to rupturing suddenly, creating a blockage which causes a heart attack or stroke.

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Unstable plaque: heart attacks and strokes Info A6

If the unstable plaque in a blood vessel ruptures, it can cause a blood clot (thrombosis). This can cause a heart attack if it blocks the heart (coronary) arteries, or a stroke if it blocks the neck (carotid) arteries.

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Europe's biggest killer disease Info A7

Atherosclerosis is a major cause of heart attacks and strokes, which are the biggest cause of death in developed countries. It can begin early in life, with no outward symptoms, staying undetected until the heart attack or stroke happens.

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Detecting an 'invisible' disease Info A8

Many people are unknowingly vulnerable to heart attacks or strokes, with an advanced state of atherosclerosis but no outward symptoms. Ways are urgently needed to detect the disease at this stage, and treat people at risk before it's too late.

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Today's limited treatments

Info A9

Fighting atherosclerosis is mostly limited to promoting a more healthy life style, e.g a balanced diet, exercise, stopping smoking. For heart patients already at risk, inserts in blood vessels, like stents, can be used. So can drugs to reduce conditions like hypertension.

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Nanoparticles to treat heart conditions

Info A10

Nanoparticles are becoming more common in cancer therapies, but not yet heart disease. The EC NanoAthero research project aims to create and test nanoparticle systems suitable for predicting and treating advanced atherosclerosis, the major cause of heart disease and strokes.

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NanoAthero project

Info A11

The NanoAthero project is developing nanoparticles from the laboratory through to Phase I clinical trials. Some particles carry compounds which can detect blood clots or vulnerable plaques in patients' artieries. Others are able to deliver therapeutic agents for treatment.

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What are nanoparticles made of?

Info A12

Different materials, according to the use: natural fat cells (lipids), starch polymers, magnetic metal oxides, carbon nanotubes, etc. Each has its pros and cons. All have special surface coatings to target certain cells in the body, and carry payloads of active compounds.

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What's in a Nanoparticle?

Info A13

Nanoparticles for athero-sclerosis have an active molecule inside to image or treat damaged cells. This is protected by an outer shell which stops it being destroyed while circulating in the blood, and has a smart attachment which only releases the active molecule into damaged cells.

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Job specifications for nanoparticles

Info A14

Nanoparticles suitable to treat atherosclerosis need to be stable, reproducible, effective at their task, and have acceptable levels of risk from toxicity and side effects. This all requires extensive laboratory and animal testing (mice, rabbits and pigs).

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Imaging affected parts of the heart

Info A15

There are a range of chemicals called 'contrast agents' which could be placed inside nano-particles to locate areas in the heart affected by atherosclerosis, and be detected in an MRI, CT, gamma or ultrasound scan.

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Nanoparticles to predict heart attacks and strokes

Info A16

Nanoparticles can be used with heart imaging techniques to give advanced warning in a patient of having unstable 'plaque' in arteries which might rupture and cause a heart attack or stroke

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Drugs to treat Atherosclerosis

Info A17

Several drugs can disrupt the complex processes of atherosclerosis, aiming to arrest the disease. The NanoAthero project is testing these in nanoparticles, first in animals and then in clinical trials on affected patients.

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Drugs to treat Stroke Patients

Info A18

In a stroke, 'thrombolytic' drugs can be used to restore the patient's blood flow to limit brain damage. Nanoparticles could make these more effective with less side effects such as the risk of a brain haemorrhage.

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Making drug delivery more specific

Info A19

Therapeutic drugs can be enclosed in nanosized particles which travel through the bloodstream to release the drug in controlled amounts at the places it is needed. This should make drugs much more specific and reduce side-effects.

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Carrying drugs to difficult places

Info A20

Nanoparticles could carry therapeutic drugs to specific locations in the body – into cancer cells to destroy them, or across biological barriers (like between the blood system and the brain) with a vital drug.

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Better use of pharma-ceuticals

Info A21

If encapsulation in nanoparticles enables drugs to target only the intended cells, more powerful drugs could be used which would normally have too many adverse effects on other parts of the body.

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Pre-clinical trials in animals

Info A22

International medical research regulations require that any new drug, including nanoparticle drugs, has been tested in the laboratory and in relevant animals before being tested in humans. This is called 'pre-clinical testing'.

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What animal tests have to be done?

Info A23

Animal testing of nanoparticle systems for efficacy and toxic effects is mainly limited to the few animals known to develop atherosclerosis symptoms – mainly some types of rabbit and a genetically modifed (ApoE) mouse.

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Testing for acute rejection

Info A24

Nanoparticles for use in human trials have to first pass a special test for an immediate violent reaction of the body to foreign material (anaphylaxsis). This is done in pigs, which respond more strongly than humans.

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Going from the Laboratory to the Clinic

Info A25

Once nanoparticles have been evaluated in the laboratory, and tested in animals for efficacy and toxicity, they must then undergo a series of clinical trials in humans, in 3 stages. The whole testing process can take several years.

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Clinical Trials: 3 Main Phases

Info A26

Phase I tests for safety in patients or healthy adult volunteers, depending on the condition.
Phase II tests sick people compared with a placebo. **Phase III** tests more people, for longer times, to assess the final dose and safety aspects.

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What are Phase I Clinical Trials?

Info A27

A small number of people are given a new medicine, to test it for safety and side effects, and estimate doses. There's an unavoidable element of risk if this is its first use in humans but this risk is very low.

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Nano-technologies help Diagnosis

Info A28

Nanomaterials and devices are being used to develop analyses which could enable diagnosis to be made before symptoms appear, or to detect and track diseases with greater speed, precision and reliability.

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Lab-on-a-(Computer)-Chip

Info A29

Nanotechnology may in future enable your family doctor to analyse your genetic data on a computer chip from a blood sample, and immediately prescribe an antibiotic suited to your genetics.

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Implants for chronic patients to monitor the body

Info A30

In future nanoparticles might be developed to implant in the body with a transmitter to monitor the condition of patients with chronic heart conditions. This could enable them to live at home while remaining monitored remotely by healthcare staff.

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Renewing cells lost by diseases

Info A31

In future nanoscale molecules might be used to form scaffolds around which the body's natural stem cells may then grow cells and tissues hoping to replace those lost in degenerative diseases like Parkinson's, or damaged after heart failure.

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Helping our bodies heal themselves

Info A32

A goal of nanomedicine is to understand and then mimic the body's natural self-repair mechanisms. It might enable healing that normally can't happen, e.g. restoring massive tissue loss.

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Regrowing lost tissues

Info A33

In cases of ruptured nerves or major loss of tissue, an ambitious goal is to regrow them on an artifical scaffold. Nanoscale targeting molecules could signal to the body's own stem cells where to begin growth.

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Nanoparticles in clinical treatments

Info A34

Nanoparticles are now used regularly in some cancer treatments to help locate tumour cells and assist the delivery of drugs, with more cancer applications undergoing trials. At present heart disease applications of nanoparticles are at an earlier stage.

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What is a stent?

Info A35

A stent is a tiny wire mesh tube which can be introduced inside a diseased artery to keep it open. A drug-eluting stent slowly releases a drug to prevent fibrous cells building up and blocking the artery again.

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Methods to scan parts of the body

Info A36

Magnetic Resonance Imaging (MRI), computed tomography (CT), fluorescence and ultrasound scanning all build up 3D images by scanning across an organ at different angles. A 'contrast agent' chemical is added to help show up affected tissues from the rest of the organ.

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