Artificial liver can support the chronically ill

The liver is not just a 'rubbish cleaner', but a central, complex organ that is vital for major parts of the body's biochemistry, and is used by our metabolism and for protein synthesis. Because of this complexity, no one has ever managed to create an artificial, synthetic liver.

Quite simply, it is too difficult to find a good replacement for all the functions performed by the liver.

When the liver fails, a patient's body becomes poisoned. If the liver failure is acute, it may be only a few hours before it develops into a life-threatening condition that affects all the cells in the body. Not even the brain will be able to function optimally.

Many patients suffering from liver failure find that a liver transplant is their only treatment option, but only one in twenty receive this, because of a lack of donors.

The EU has provided funding for the d-LIVER project, in which researchers from several countries will work on a number of measures to help people suffering from liver disease. The patients will be offered technology that can monitor and manage their condition at home.

The project will also construct a system that will help patients within this chronically ill group to undergo artificial liver support treatment when their own livers are compromised or incapable.

Cheaper treatment

Chironically ill patients need intensive monitoring, treatment and also periodic stays in hospital. They often have a poor quality of life, because it is difficult to have this kind of illness and have a job at the same time.

Special skills are required to monitor patients with liver failure, since they have complex clinical symptoms, including abnormal blood parameter values. Their medical monitoring therefore requires them to have access to specialists.

Patient treatment places a high financial burden on society, and this is one of the things that the d-LIVER project aims to improve.

Blood circulated through artificial liver

Instead of an artificial liver within the body, the researchers are now developing an artificial liver unit outside the body. Cells from humans or pigs live and grow in it – and function as real liver cells.

The cells grow in a three-dimensional structure in a reactor that functions like an 'incubator'. It ensures that the conditions are right for the liver cells to function properly. The reactor must be able to control
temperature and to circulate nutrients and oxygen in the right quantities to all the cells.

The artificial liver will be able to act as an 'auxiliary engine' for a patient, during periods when the patient's own liver cannot manage to function adequately. Blood is recirculated from the patient through the artificial liver – a process that takes several hours. In order to avoid the problem of rejected cells, every single patient needs a bio-reactor. This means that meticulous planning and preparations are required for every patient.

"We envisage that it will be possible for this type of artificial liver to be used for patients with extremely poor liver function, preferably before the patients become so ill that their brain function is affected and they cannot manage to look after themselves," says Frode Strisland, scientist at SINTEF.

Patients undergo crisis periods when their liver function is insufficient, resulting in a build-up of waste products in the body. This tends to happen when the patients are suffering from infections or colds – conditions that a healthy liver has plenty of capacity to handle.

For liver patients, treatment with an artificial liver can be live-saving until they have recovered, and their own liver capacity becomes sufficient to keep the body going.

"What is very clear is that the new artificial livers will probably have to be operated and maintained in a hospital environment, although the research project will also look at what would be required in order to be able to offer this kind of treatment in a patient's home," says Strisland.

**Prevention is just as important**

If we can manage to detect when a liver patient is beginning to have problems, it may be possible to prevent these problems in an early phase, by adjusting their medical treatment. This is cheaper and easier for the health services, and much better for the patient, giving them a chance to avoid the worst crises. For this reason, it is important to pick up on the first signs that a liver is not functioning properly.

It is here – in the preventative part of d-LIVER – that the researchers are concentrating their efforts. The idea is to make it possible to supervise patients with liver problems and monitor them at home.

"Monitoring at home should be able to detect patients who are starting to have problems. We think that this may reduce the need for hospital admissions," says Strisland.

Since the balance of the liver is fundamentally linked to infections and a compromised immune system, the researchers will be developing sensors that patients can wear, that will provide information about physical condition and activity. The project will also create a blood analysis instrument that will measure selected blood parameters on a daily basis.

"This will enable these patients to be monitored significantly better than they are now, when many of them might only get to see a doctor every three months," says Strisland.

**Blood test with chip**

The patients will be able to carry-out blood tests daily, using what is known as a 'lab-on-a-chip' blood test. This is a plastic chip with super-thin channels containing chemicals and enzymes in the right mixture to be able to carry out the different analyses automatically when the patient has inserted the chip into the analysis instrument. The analysis instrument will automatically send the measurement data to the hospital, and the patient will be alerted if any measures are required.

The researchers are now in the design phase, and are working on testing out the sensor technology. The d-
LIVER project is coordinated by Newcastle University, and will run until 2015. The technology will be tested by patients with liver failure in Newcastle and Berlin.

You see the dark red liver below the lungs. (Photo: Morguefile) [6]
SINTEF ICT is planning to supervise patients with liver problems and monitor them at home.
Scientist Frode Strisland has liver and heart projected on his body. (Photo: Werner Juvik/SINTEF) [7]
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June 15, 2013 - 06:10
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