

New Technologies to Improve Lifestyle of Liver-sick Patients

S. Dasen, M. Bertschi, V. Neuman

The liver is a complex organ with various vital functions in synthesis, detoxification and regulation; its failure is life-threatening and the only curative treatment is transplantation. Whilst awaiting transplantation, or after liver resection, patients need to be supported with detoxification systems which, being currently mainly based on filtration, do not support metabolic liver functions. This can only be provided by living cells. Thus, development of bio-artificial liver support systems with associated remote monitoring to assist in the treatment and management of liver patients in care settings extending from the hospital to the home is essential.

As of today, liver transplantation is still the only curative treatment for liver failure due to end-stage diseases. Donor organ shortage, high cost and the need for immune suppressive medications are still the major limitations in the field of liver transplantation.

There is a clear, unmet need for a bio-artificial liver (BAL) in combination with liver patient management and support systems with associated monitoring and control for the remote management of patients with chronic liver disease outside the hospital. The EU FP7 project named D-LIVER^[1] originates from clinical needs and applies a scenario driven development methodology (Figure 1). The overall goal of the project is to provide safe and cost-effective systems for continuous, context-aware, multi-parametric monitoring of both patient and BAL system parameters in order to (i) enhance the quality of medical treatment and management; (ii) improve the quality of life for patients and (iii) reduce the incidence and duration of hospitalization and consequently reduce the health economic burden of chronic liver disease. D-LIVER will facilitate treatment whilst enabling patients to spend more time at home under constant, albeit remote, medical supervision.

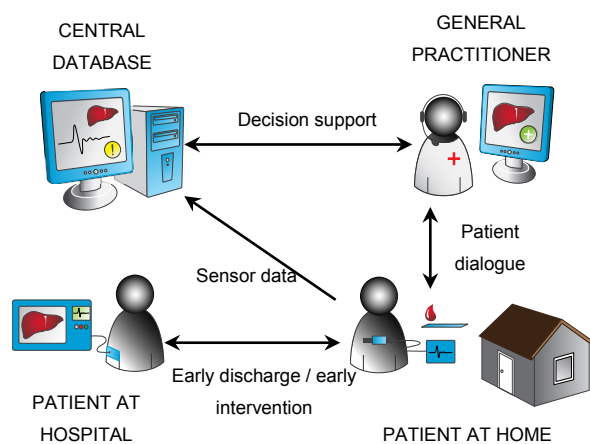


Figure 1: D-LIVER scenario^[2]

Early identification of liver patient condition exacerbation is essential in order to allow moderate and timely intervention. It is therefore valuable to be able to track the patient's "vital signs" during extended periods of time. For liver patients, heart rate, temperature and blood pressure are considered the clinically most interesting monitoring parameters. Elevated heart rate over extended periods of time indicates that the physiology is stressed, and temperature measurements can indicate thermal stress or early stages of infections. Finally, blood pressure monitoring can identify potential complications – for example, as a result of low blood pressure arising from bleeding, sepsis or splanchnic dilation, following hypertension and following changes caused by limited liver function.

Therefore, a wearable, multi-parameter physiological sensor system for monitoring liver patients on a sustained basis will be developed for the patient home-monitoring. CSEM is responsible for the development of this wearable sensor.

A blood biochemistry instrument (Figure 2) will also be developed by CSEM for the monitoring of patients at home. The patient has to put a drop of blood on a microfluidic cartridge once or twice a day. This cartridge is then inserted into the instrument and several parameters are measured from the blood drop. Electrochemical sensors based on enzymes will be used for the measurement of bile acids, creatinine and bilirubin, whilst impedance will be used for the measurement of albumin and clotting time.



Figure 2: Example of blood biochemistry instrument developed at CSEM

The BAL is a cell-based liver support system with an integrated multi-parametric sensor platform enabling monitoring and control of cell culture conditions. It will be developed to bridge the liver function of patients experiencing acute liver failure in hospital or other clinical environments. Either human or porcine hepatocytes (liver cells) will be cultivated in a three-dimensional environment formed by three interwoven yet independent capillary bundles inside the BAL.

The D-LIVER project is supported by the 7th Framework Programme of the European Union under grant agreement no. 287596. CSEM would like to thank the SFOT for their financial support and all the partners of the consortium for their constructive collaboration.

^[1] <http://d-liver.eu>

^[2] Figures from SINTEF, partner of the D-LIVER consortium