A Novel Personal Health System with Integrated Decision Support and Guidance for the Management of Chronic Liver Disease

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Fraunhofer Institute for Biomedical Engineering

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End-Stage Liver Diseases associated with high risk and very poor quality of life, particularly through the complication development. Current monitoring and management models are a poor compromise.

Chronic liver failure: treat "acute on chronic liver" failure, reduce intermittent encephalopathy and ascites, enable long-term therapy in home environment and reduce need for transplantation.
Background and motivation: Decision support in Personal Health Systems for Disease Management

Guide both, patients and doctors, through the healthcare process.

Allow clinical experts to design & adapt formal plans of the disease management process according to the local care model.

Allow to personalise these plans.

Decision Support System

Knowledge Base

Communication link

Data link

EHR

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Background and motivation: Decision support in Personal Health Systems for Disease Management

Support decision making by informing doctors about new findings with suggestions how to handle them.

Reduce the workload of physicians by involving him only if required (triage).

Adapt the patient’s test and measurement schedule dynamically according to his condition.

Manage the patient’s condition by adapting the therapy with or without confirmation of the doctor.

Advise the patient how to cope with a detected health problem.

Support decision making by informing doctors about new findings with suggestions how to handle them.

Reduce the workload of physicians by involving him only if required (triage).

Adapt the patient’s test and measurement schedule dynamically according to his condition.

Manage the patient’s condition by adapting the therapy with or without confirmation of the doctor.

Advise the patient how to cope with a detected health problem.
d-LIVER Approach for Patient Management

Tasks for doctors:
- Warnings
- Prescriptions
- Recommendations
- Ranking according to abstract disease severity parameter

Patient tasks:
- Measurements
- Cognitive tests
- Health Enquiries
- Medication
- Exercising
- Messages
d-LIVER System for Liver Patient Management

Care Flow Engine
- Process and Rules Engine (BPMN 2)
- Knowledge Base (Care Flow Plans)

Message Server
- Tasks & Advice
- Response
- Tasks & Advice
- Response

Health Professional Cockpit
- Patient Health Record
- WAN Receiver

Health Professional Application

PHM GUI, Model & Task Controller
- Device Manager
  - WAN Sender
  - PAN Interface

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Care Flow Engine

- BPMN2.0 process model for encephalopathy management

Process model designed by clinicians

Executable process in the Care Flow Engine
Care Flow Engine

- Knowledge base designed for liver patient management: ascites, encephalopathy, colestatic itch, general monitoring
- Medication management as the focus of decision support: Decision support or active intervention
- Quantification of Disease Severity in the models for patient ranking and need for medical attention (Triage)
- Fully integrated with systems of patients and doctors
Personal Health Manager
**Health Professional Cockpit**

![Image of Health Professional Cockpit interface]

<table>
<thead>
<tr>
<th>G.P. Details</th>
<th>Consultant Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr Lan Wthhe 02134 4567890 The Surgery <a href="mailto:lan.wthhe@gpsurgery.com">lan.wthhe@gpsurgery.com</a> 18 Main Street Liverton L12 4ET</td>
<td>Dr Brian Brown 02134 4567890 The Hospital <a href="mailto:brian.brown@hospital.com">brian.brown@hospital.com</a> 90 Main Street Liverton L12 7EX d-LIVER treating doctor: Dr Craig Evans</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Documents and notes</th>
<th>Prognostic scores</th>
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</thead>
<tbody>
<tr>
<td>02/02/2013 Clinic letter Gastro</td>
<td>MELD</td>
</tr>
<tr>
<td>21/02/2013 Clinical note</td>
<td>EASILab</td>
</tr>
<tr>
<td>02/01/2013 Letter to patient</td>
<td>UKELD</td>
</tr>
<tr>
<td>18/11/2013 Clinic letter Hepatology</td>
<td>EASILab</td>
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<tr>
<td>03/10/2013 GP referral letter</td>
<td>Child Pugh B (5)</td>
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<table>
<thead>
<tr>
<th>Most recent blood results</th>
<th>Most recent vital signs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ref range</strong></td>
<td><strong>Weight</strong> 03/03/13 75.3 kg</td>
</tr>
<tr>
<td><strong>Lab</strong></td>
<td><strong>Temp</strong> 03/03/13 38.2</td>
</tr>
<tr>
<td><strong>Bili</strong></td>
<td><strong>BP</strong> 03/03/13 145/92 mmHg</td>
</tr>
<tr>
<td><strong>PT</strong></td>
<td><strong>cO2/WD</strong> Min: 112/71 mmHg</td>
</tr>
<tr>
<td><strong>Albumin</strong></td>
<td><strong>HR</strong> 03/03/13 Max: 94 bpm</td>
</tr>
<tr>
<td><strong>Creatinine</strong></td>
<td><strong>Min: 52 bpm</strong></td>
</tr>
<tr>
<td><strong>Sodium</strong></td>
<td><strong>Ammonia</strong> 50 µmol/L</td>
</tr>
<tr>
<td><strong>Potassium</strong></td>
<td><strong>Bile acids</strong> -</td>
</tr>
<tr>
<td><strong>Glucose</strong></td>
<td><strong>-</strong></td>
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Lactulose Management by d-LIVER System for Liver Patients with Encephalopathy

1) Health Professional Cockpit - Treatment planning for encephalopathy management

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Lactulose Management by d-LIVER System for Liver Patients with Encephalopathy

1) Health Professional Cockpit - Treatment planning for encephalopathy management

<table>
<thead>
<tr>
<th>Active Disease Management Scenarios</th>
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</thead>
<tbody>
<tr>
<td><strong>Encephalopathy</strong></td>
</tr>
<tr>
<td>Lactulose dose:</td>
</tr>
<tr>
<td>30.0</td>
</tr>
<tr>
<td>Single Dosage Lactulose (ml)</td>
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<tr>
<td>120.0</td>
</tr>
<tr>
<td>Max Lactulose (ml)</td>
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<tr>
<td>60.0</td>
</tr>
<tr>
<td>Current Lactulose (ml)</td>
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<tr>
<td>Cognitive Test</td>
</tr>
<tr>
<td>30.0</td>
</tr>
<tr>
<td>Max Accomplishing Time (s)</td>
</tr>
<tr>
<td>26.0</td>
</tr>
<tr>
<td>Current Accomplishing Time (s)</td>
</tr>
</tbody>
</table>
Lactulose Management by d-LIVER System for Liver Patients with Encephalopathy

2) Personal Health Manager - Patient is asked to carry out a cognitive test and to answer a question about his bowel frequency during the last 24 hours.

3) A medication message is received about a new dosage together with the intake schema.

Attention! Your medication has changed! Please take your Lactulose as follows:
- Daily dosage 60
- 30 at breakfast
- 30 at lunch
Lactulose Management by d-LIVER System for Liver Patients with Encephalopathy

4) Health Professional Cockpit - Doctor is informed in a prescription task about new dose

Prescriptions

Encephalopathy
29/08/2014 18:04

Observations:
Stool frequency = 5, cognitive threshold time = 30 sec, cognitive response time = 26 sec and old Lactulose dosage = 90mg

Findings:
Stool frequency >3/day, cognitive function unchanged. Lactulose reduced.

Recommendation:
The new Lactulose dosage is 60mg.

Severity Level: 0

Medication

60 mL Lactulose (ml)

Submit
Care Flow Engine & Rehabilitation Exercising

Upper Limb Exercises

Angle
Left Shoulder Angle 89
Right Shoulder Angle 99

Done

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Conclusions and Discussion

- A personal health system with integrated decision support and guidance for the management of patients with chronic liver diseases has been achieved.
- Focus on medication management with dose adaptation.
- Clinical trial with encephalopathy patients under preparation.
- Potential to be used as a generic approach for chronic disease management scenarios.
- Intensive risk management for patent safety required.
Acknowledgements

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www.d-liver.eu

Thank you for your attention!

Questions?

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