Design of a mobile, safety-critical in-hospital glucose management system

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Motivation

- in-patient glycemic control of acute diseased patients with diabetes is often considered secondary in importance
- in-patient hyperglycaemia important marker of poor clinical outcome and mortality among diabetic patients
- treatment of diabetes and hyperglycaemia results in reduced mortality and morbidity [1]

→ patients suffering from diabetes require continuous glycemic control during in-patient stays including close monitoring of blood glucose and determination of suitable treatment strategies

Current situation at ward

ward physician

night shift

nurse

Patient A
Diabetes type 2

Patient B
No Diabetes

specialist physician
at ward round
General requirements

- Execution of the application via a mobile device to perform activities directly at the **point of care** (patients bed)

- **No data storage on the mobile device.** Wireless communication via web services to an external server, on which the data should be placed

- **Distributed/time-independent access** to data from any place in the hospital

- **Documentation and visualization** of the **most important parameters** relating to diabetes care on the mobile device

- **Automated decision support for insulin dosage** \([2],[3]\)

- **Reminder for open tasks** through an active task management

- Avoidance of manual (and multiple) inputs. A connection to the hospital and laboratory information system is necessary in order to transfer administrative data automatically → **integration of system**

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Methods

- interdisciplinary team (physicians, nurses, technicians, IT-Experts)
- user-centred design approach
- mock-ups and early prototypes as trigger for clinical personnel
- iterative approach
- continuous risk management
- usability testing (Thinking Aloud)
Results

Evolution of Solution – Excel prototype
Results

Evolution of Solution – 1\textsuperscript{st} usability study

Evolution of Solution – Mock-up for mobile application
Results

Evolution of Solution – prototype implementation

Blood Glucose Profile

Administered Insulin

Putting Knowledge to Work
Results

Evolution of Solution – prototype implementation
Results

Evolution of Solution – prototype implementation

Logged in: Physician Plank; Endocrinology

<table>
<thead>
<tr>
<th>Patient List</th>
<th>Open Tasks</th>
<th>Edit recent activities</th>
<th>Logout</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hoell, Bernhard (25)</strong></td>
<td><strong>Glucose Profile</strong></td>
<td><strong>Glucose Table</strong></td>
<td><strong>Therapy</strong></td>
</tr>
<tr>
<td>Room r02, Bed b03</td>
<td>Basal/Bolus Therapy</td>
<td></td>
<td>Yes</td>
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<td>Admission Date: 24.02.2011</td>
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<tr>
<td>Basal/Bolus Regimen</td>
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<tr>
<td>Ordered Bolus Insulin: Actrapid</td>
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<td>Yes</td>
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<tr>
<td>Ordered Basal Insulin: Levemir</td>
<td></td>
<td></td>
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<tr>
<td>Insulin Resistance: usual</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>DSS ✓</td>
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</tbody>
</table>

Blood Glucose Measurement

Insulin Administration

Therapy Adjustment

Current Regimen

Basal/Bolus Therapy

Ordered Insulin

Basal: Levemir; Bolus: Actrapid

Daily Insulin Dose

30 Units

Target Range (blood glucose)

140 - 180mg/dl

Insulin Resistance

usual

Putting Knowledge to Work
Conclusion

- Physicians and nurses have been involved in each design step → end-users have determined main parts of functionality and design
- Use of triggers (mock-ups/prototypes) → end-users got a better idea of design possibilities/functionality → base for decisions and compromises between users → base for further development and/or changes
- Clinicians/nurses and engineers have very different points of view concerning software → Clinicians/nurses: only basic functionality; no manual input; easy but well sophisticated user interface, tailored to current workflow patterns; system integration → Technicians/IT-Experts: focus on gathering as much functionality as possible
- User-centred approach as important precondition to meet the requirements of medical device directive for software (IEC 62366 standard)
Outlook

- on-going: clinical study of decision support for insulin dosage on paper at Medical University of Graz (MUG)
- finishing of implementation work
  - Integration of security WSS, Entity Management
  - Interfaces to HIS/LIS
- 2nd usability study
- clinical study with software solution at department of Endocrinology at MUG
Thank you!

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Homepage: http://www.reactionproject.eu/news.php