Mobile Patient Diary with Decision Support for Chronic Disease Self-Management

Raza Abidi
William Van Woensel, Patrice Roy, Samina Abidi, Jafna Cox

NICHE Research Group
Faculties of Computer Science and Medicine
Dalhousie University
Halifax
Mobile Health Apps

- Mobile Health Patient Diary
  - Lifestyle maintenance and modification
  - Patient-centric chronic disease management
  - Patient empowerment for self-management

- State of Practice
  - Collect disease/Patient specific health data
  - Maintain a personal record of a patient’s health parameters
  - Establish interface with health records and devices
  - Establish collaboration channel with healthcare providers
  - Health status determination and reporting
Mobile Health Challenges & Opportunities

**Challenges**

1. Connectivity Failure
2. Latency in Decisional Aid
3. Response Relevance
4. Lack of Evidence-Based Tools and Clinical Guidelines
5. Maintaining Patient Interest
6. Intrusiveness
7. Disconnect with Clinical Processes
8. Privacy, Security

**Solutions**

1. Light Weight Native Services
2. Built-in (Mobile) Decision Support
3. Context Awareness
4. Validated Health Assessment Tools & Computerized Clinical Guidelines
5. Behaviour Modification Strategies
6. Personalized Notification Schedule
7. Align Interactions/Interventions with Institutional Clinical Workflow
8. Token System for Data Provenance

Mobile Patient Diary
Mobile Patient Diary Context

- IMPACT-AF: Integrated Management Program Advancing Community Treatment of Atrial Fibrillation
**IMPACT-AF Ecosystem**

- **IMPACT-AF: Integrated Management Program Advancing Community Treatment of Atrial Fibrillation**

- **Engage** AF patients in self-care
- **Capture** AF related health data
- **Alert** potential adverse AF events
- **Recommend** self-care actions
- **Notify** physicians about adverse events
- **Personalize** reminders for care tasks
- **Record** economic healthcare data
- **Show** lab investigation results
- **Deliver** behaviour modification and AF self-management messages
IMPACT-AF Mobile Patient Diary

- **Mobile Health Innovation**
  - **Mobile Clinical Decision Support System**
    - Identify adverse health events and trends without backend connectivity
  - Customizable notification system
    - Persistent notifications with lifecycles
  - Generic mobile health app architecture
    - Scalable to other chronic diseases
  - Mobile implementation of clinical guidelines
  - Cross-platform mobile app
    - Deployed on Android & iOS
## Architecture

### Login form
- Contact server for authentication
- Offline: store credentials in DB

### Health data entry
- **Data Manager**
  - Store in Local DB
  - Sync with server
  - Offline: auto-sync when online
  - Pass data to CDSS

### CDSS
- Includes *mobile rule engine*
- Execute CPG rules on new data
- Pass health alerts to Notification System
Architecture

- Notification System
  - Issues patient notifications
  - Implements notification lifecycles
Mobile Clinical Decision Support System

- Locally trigger important health alerts
  - No reliance on connectivity or remote server
  - Timely and patient-specific health alerts

- Native light-weight CDSS
  - Detect potential adverse events
  - Ruleset extracted from atrial fibrillation CPG
  - Dataset: contains patient’s latest health data

- Remote heavy-weight CDSS
  - Runs long-term, heavyweight processes
  - Deployed on remote server
  - Communicates results to mobile diary
Customizable Notifications vs. Alert Fatigue

- **Persistent Notifications**
  - Repeat notifications until action is performed
  - Time-delayed strategy to increase obtrusiveness over time

- **Event-based & Evolving Notification Lifecycle**
  - Event-based notification
    - Events (e.g., data entry, sync) influence lifecycle state
  - Evolving notification
    - Interaction (e.g., visual, audio) & frequency evolve over time
Customizable Notifications

- Personalize notification lifecycles
- Limited configuration options
  - To ensure reminders are still clinically relevant
- Display *warnings* as time overlaps with subsequent stages

**Reminders**

Enter your bloodpressure

- *Every* 5

Waiting this long to fill out your data could be risky to your health if your blood pressure or heart rate is uncontrolled. Please enter a more frequent reminder.

Enter your heart rate

1 2 3 4 5 6 7 8 9 . 0 _
Persistent Notifications

Reminder: Enter BP
Slipped your mind? Please enter your bloodpressure.

Urgent: Enter BP
Slipped your mind? It is very important that you enter your bloodpressure.

Urgent! Enter BP
Slipped your mind? It is very important that you enter your bloodpressure.

Notifications

Reminders

⚠️ Urgent! Enter BP (June 4)

⚠️ Urgent! Enter BP (June 3)

⚠️ Urgent! Enter BP (June 3)

⚠️ Urgent! Enter BP (June 3)

⚠️ Urgent! Enter BP (June 2)

⚠️ Urgent! Enter BP (June 2)

⏰ Reminder: Enter BP (June 1)

⏰ Reminder: Enter BP (May 31)

Clear All
**IMPACT-AF Mobile Patient Diary**

### Health data entry
- BP, HR
- Symptoms & complications
- Medications

### Economic Analysis
- Visit costs (e.g., clinic, ER)
- Symptom cost (e.g., loss of work)
Health Data Entry

- Self-Recording Method
  - BP, HR, symptoms & complications
  - Medications
    - Local drug & health product database
Health Data Entry Methods

- Device-Based Data Entry
  - Sync with wireless health monitor devices
    - Currently, BP monitor (A&D UA-651BLE)
Economic Data

Visit Costs
- Did you receive any caregiver support for the visit? [Yes]

Caregiver Info
- Name: jess [Yes]
- Occupation: RN [Yes]
- Family member [Yes]
- Miss work time? [Yes]
- Time missed (h): 2 [Yes]

Loss of Work
- Did you receive any caregiver support for the visit? [Yes]

Caregiver Info
- Name: jess [Yes]
- Occupation: RN [Yes]
- Family member [Yes]
- Time spent (h): 6 [Yes]
- Miss work time? [Yes]
- Work time missed (h): 3 [Yes]
# IMPACT-AF Mobile Patient Diary

## AF Patient Diary

<table>
<thead>
<tr>
<th>Section</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk Scores</td>
<td>Risk scores</td>
</tr>
<tr>
<td>Lab Results</td>
<td>Lab results</td>
</tr>
<tr>
<td>Personal Notes</td>
<td></td>
</tr>
<tr>
<td>Notifications (2)</td>
<td>Health alerts</td>
</tr>
<tr>
<td></td>
<td>Reminders</td>
</tr>
</tbody>
</table>

**Lab & calculated data**
- Risk scores
- Lab results

**Notification overview**
- Health alerts
- Reminders
Viewing AF Risk Scores and Lab Results

- Dynamically updated from risk scores based on up-to-date patient data
  - Risk factors (hasBLED, chads2, ..)
  - Lab results (eGFR, ..)
IMPACT-AF: Study Objective

Among community-based patients with AF, does providing an integrated Clinical Decision Support System (CDSS) to providers and patients improve process of care and clinical outcomes, and, decrease healthcare costs and resource utilizations over 12 months, as compared to usual care?

- Cluster randomized (provider level; urban / rural)
- 200 Primary Care Providers
  - Internet Access required; minimum 15 patients with AF
  - 50% Intervention, 50% Usual Care
- 2,000 AF patients
  - Confirmed AF, English speaking, ≥ 18 years of age
  - Only patients of participating primary care providers
- 12 month follow-up
- Comparison with specialist AF Clinic
IMPACT-AF: Study Outcomes

1° study outcome
- CV hospitalization

2° study outcomes
- a. Process of Care
  - Access to specialist consultation, echo, catheter ablations
- b. Clinical
  - Mortality; ED visits; Appropriate anticoagulant therapy
- c. Quality of Life / Cost effectiveness
  - Health Related QoL
  - Costs of CDSS / AF care
Conclusions & Future Work

- **Mobile and Intelligent Patient Diary**
  - Support self-management of chronic illnesses (focus on AF)
  - Incorporates a novel mobile CDSS
    - Native mobile based reasoning and data analytics
  - Personalized notification system to minimize alert fatigue
  - Customizable knowledge model to support other chronic conditions/self-management scenarios

- **Future directions**
  - Context-aware notification system (ambient assisted living)
    - Leverage mobile context to fine-tune notifications
    - Current location, habits, time, …
  - Mobile reasoning that incorporates probabilistic paradigms
  - Extend to include behaviour modification strategies
  - Extend connectivity with “Internet of Things”
  - Extend social health analytics aspects
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Raza Abidi
ssrabidi@dal.ca
www.cs.dal.ca/~sraza

The one constant is change!