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

AF Patient Diary

- Blood Pressure
- Heart Rate
- Automatic
- Health Problems
- AF Medication
- Costs
- Risk Scores
- Lab Results
- Personal Notes

Mobile Health Challenges & Opportunities

❖ Challenges

1. Connectivity Failure
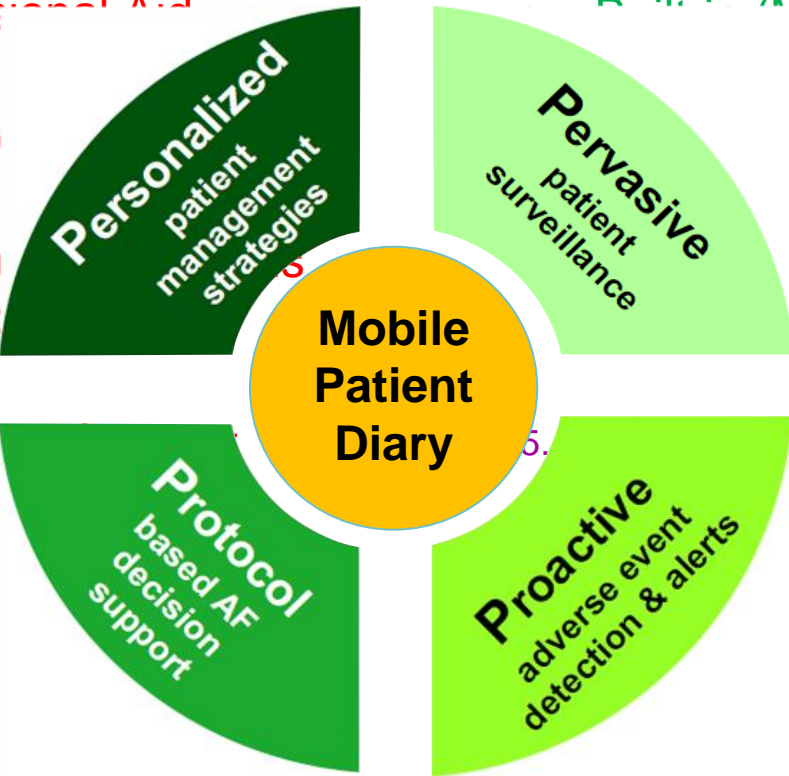2. Latency in Decisional Aid
3. Response Relev...
4. Lack of Evidenc... and Clinical Guid...
5. Maintaining Pati...
6. Intrusiveness
7. Disconnect with ... Processes
8. Privacy, Security

❖ Solutions

1. Light Weight Native Services
2. Built in (Mobile) Decision Support
3. ...wareness
4. ...Health Assessment Tools ...terized Clinical Guidelines
5. ...r Modification Strategies
6. ...zed Notification Schedule
7. ...ractions/Interventions with ...al Clinical Workflow
8. Token System for Data Provenance

Personalized
patient management strategies

Pervasive
patient surveillance

Protocol
based AF decision support

Proactive
adverse event detection & alerts

Mobile Patient Diary

Mobile Patient Diary Context

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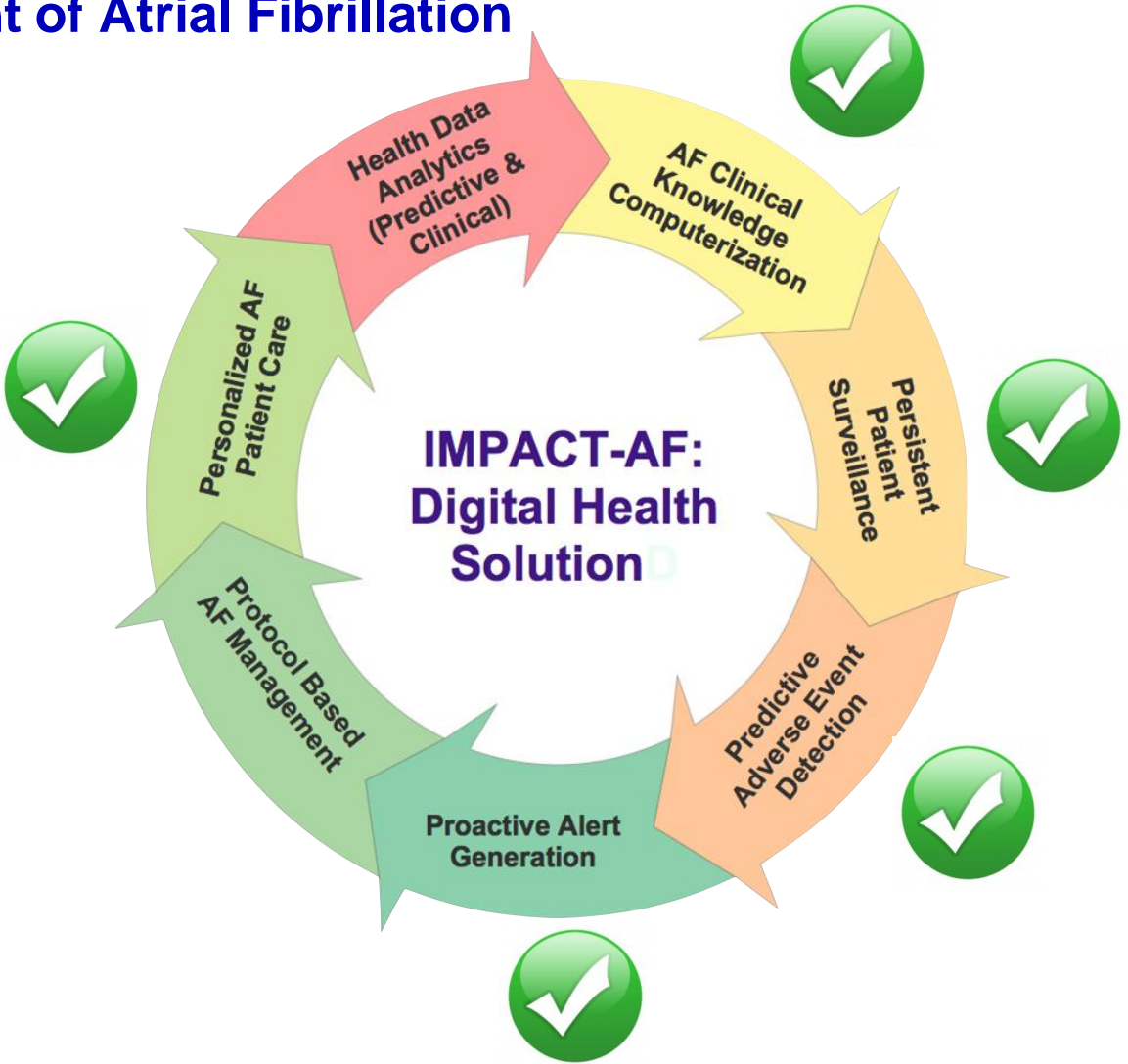
IMPACT-AF Ecosystem

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

- **Engage** AF patients is 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
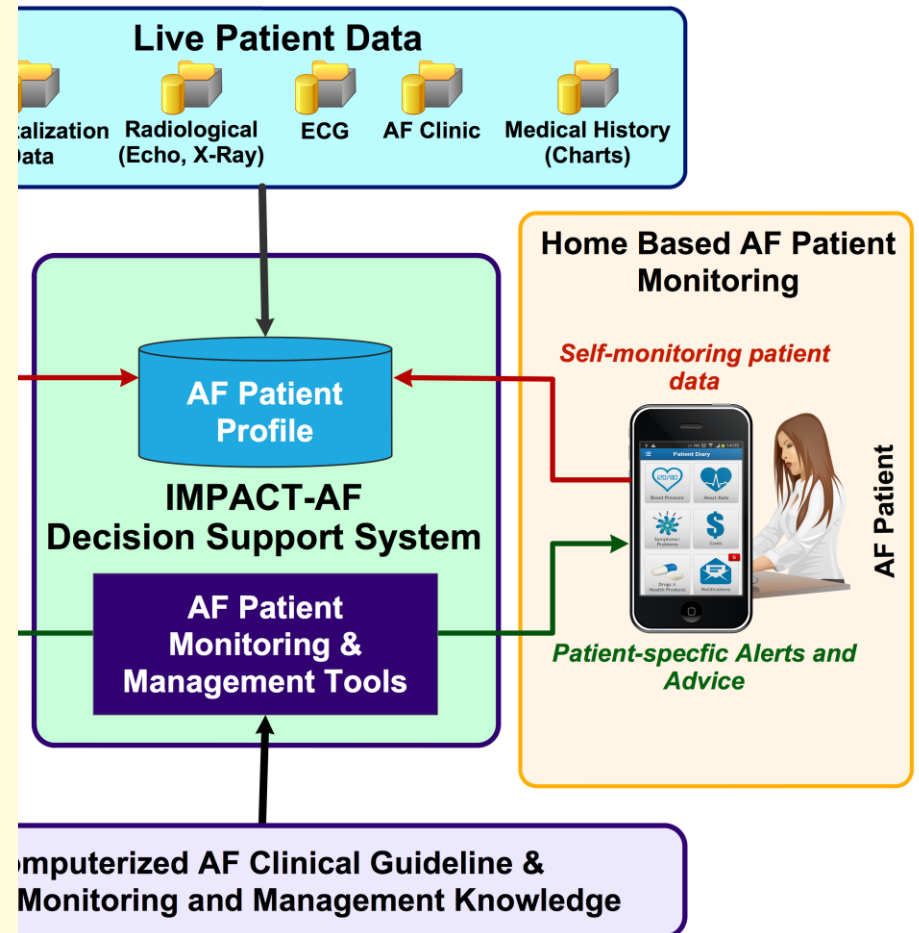
IMPACT-AF Mobile Patient Diary

AF Patient Diary

- Blood Pressure
- Heart Rate
- Automatic
- Health Problems
- AF Medication
- Costs
- Risk Scores
- Lab Results
- Personal Notes

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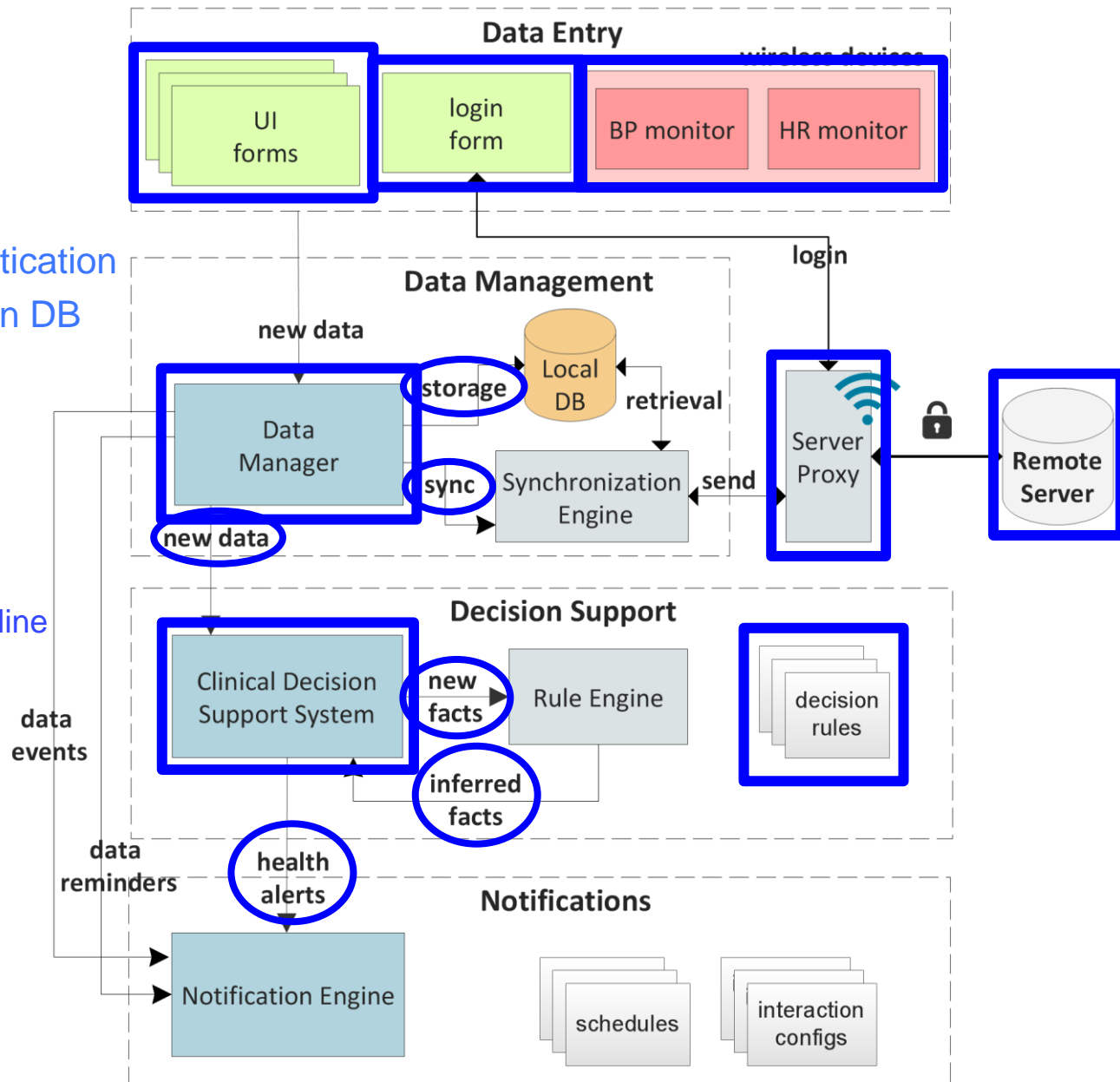
❖ Login form
- Contact server for authentication
- Offline: store credentials in DB

❖ 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
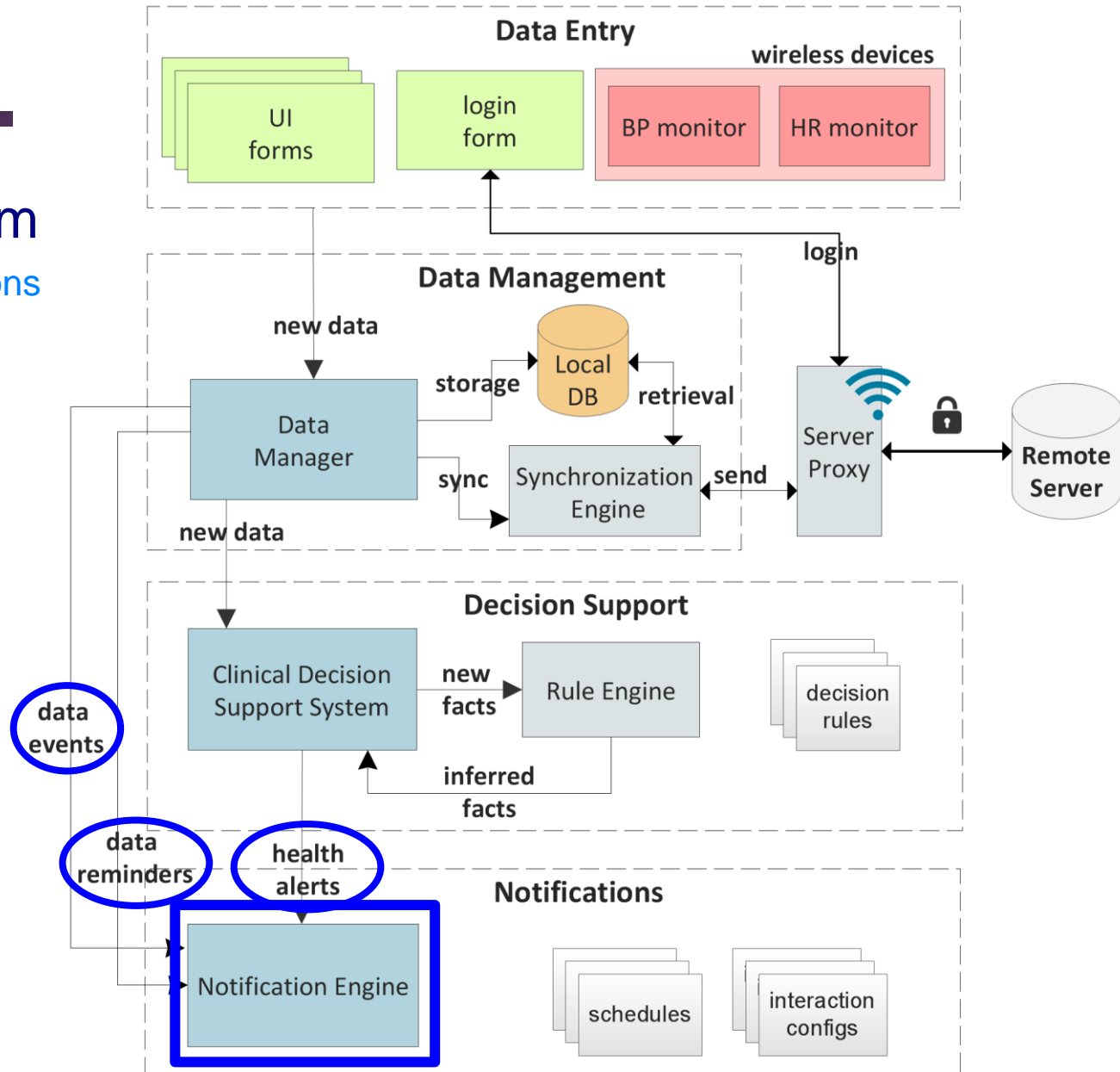
  ❖ No reliance on connectivity or

  ❖ Timely and patient-specific he

❖ Native light-weight CDSS

  ❖ Detect potential adverse even

  ❖ Ruleset extracted from atrial fi

  ❖ Dataset: contains patient's late

❖ Remote heavyweight CDSS

  ❖ Runs long-term, heavyweight

  ❖ Deployed on remote server

  ❖ Communicates results to mobile diary

AF Patient Diary

AF Patient Diary

Health Alert   X

You may have symptoms of stroke.
Please call 911 or your local emergency
number.

Automatic

Health Problems

AF Medication
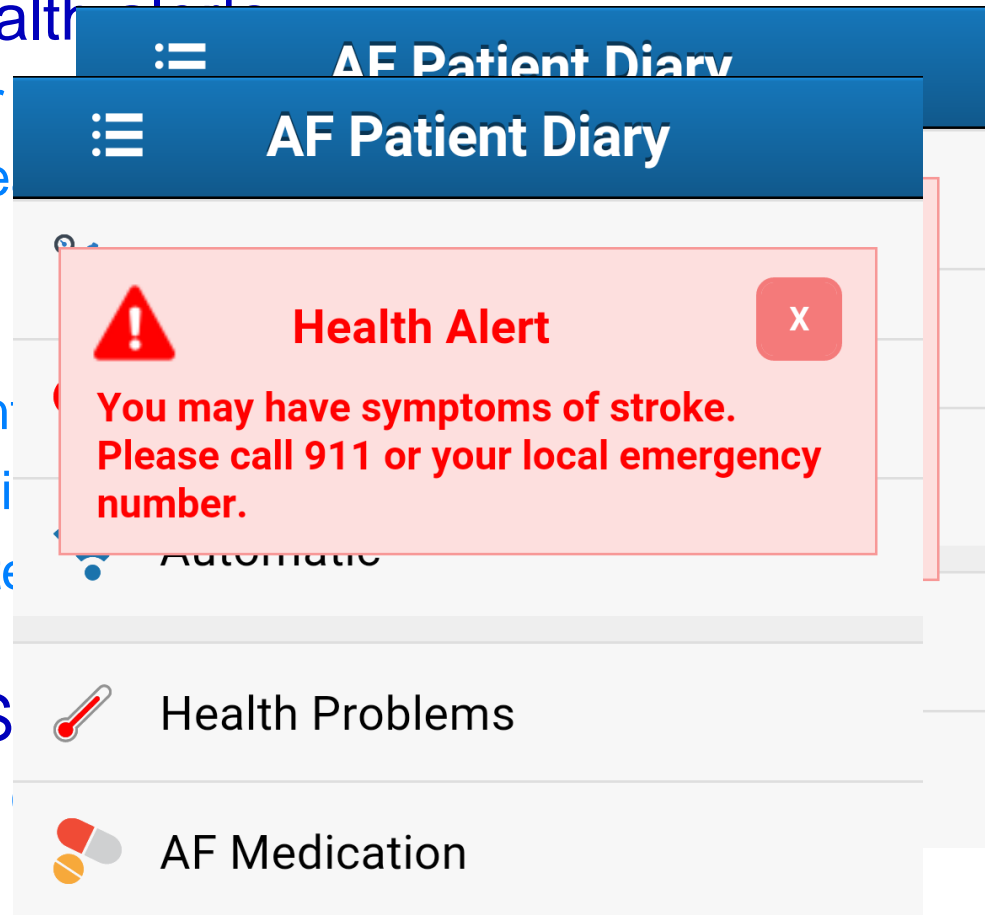
Customizable Notifications vs. Alert Fatigue

❖ 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

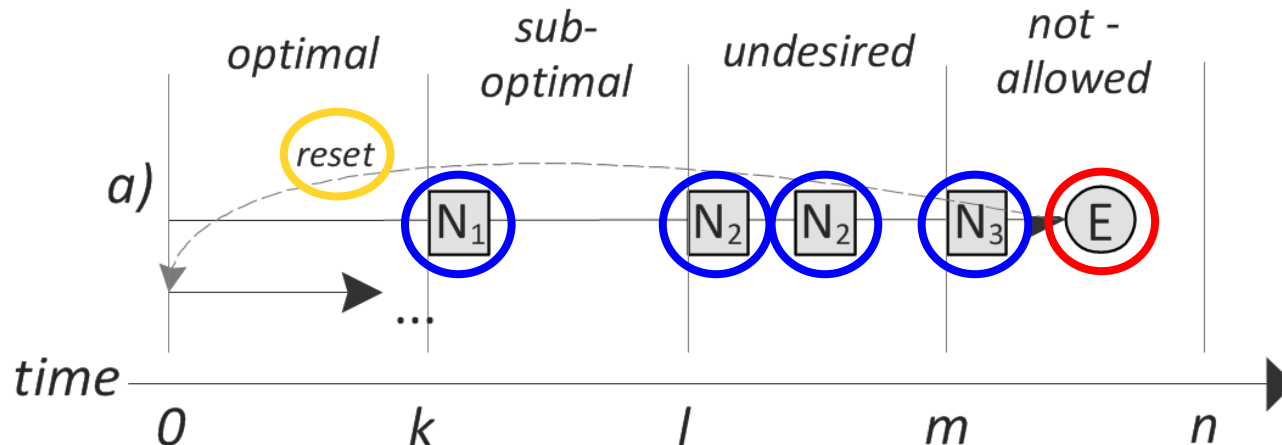 ❖ Evolving notification

    ❖ Interaction (e.g., visual, audio) & frequency evolve over time

Customizable Notific

- ❖ Personalize notification life
  - ❖ Limited configuration options
    - ❖ To ensure reminders are still *cl*
  - ❖ Display *warnings* as time ove

Reminders

Enter your bloodpressure
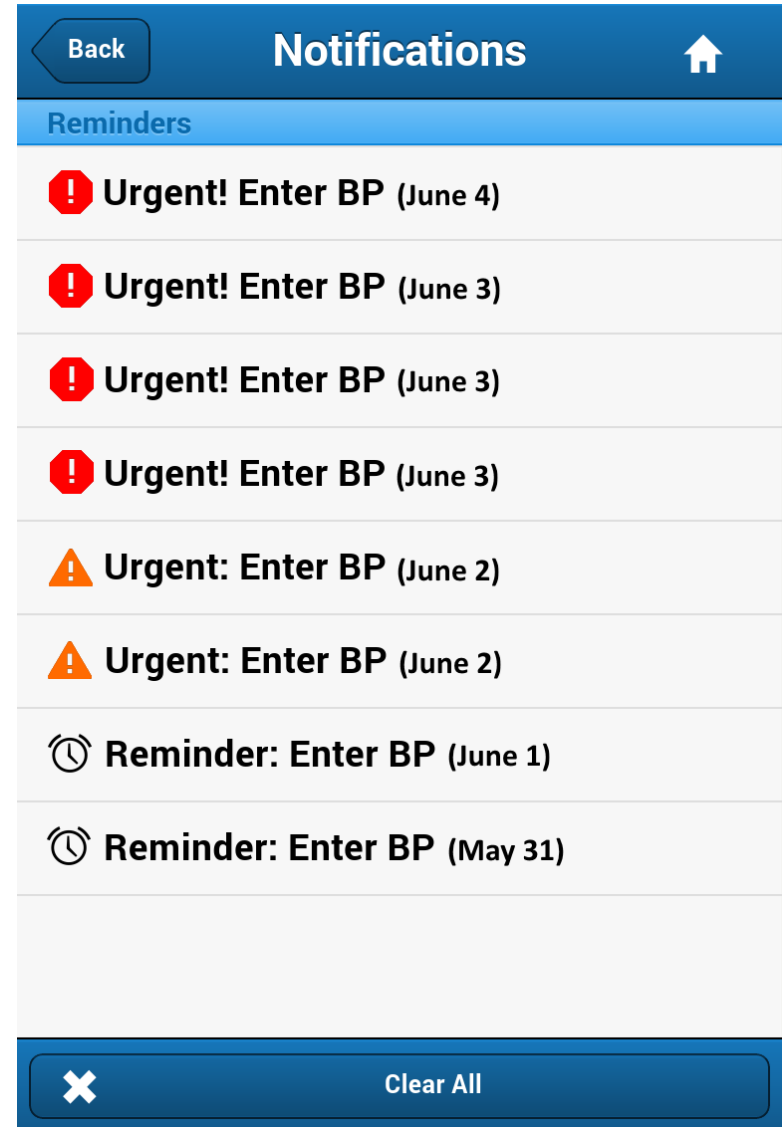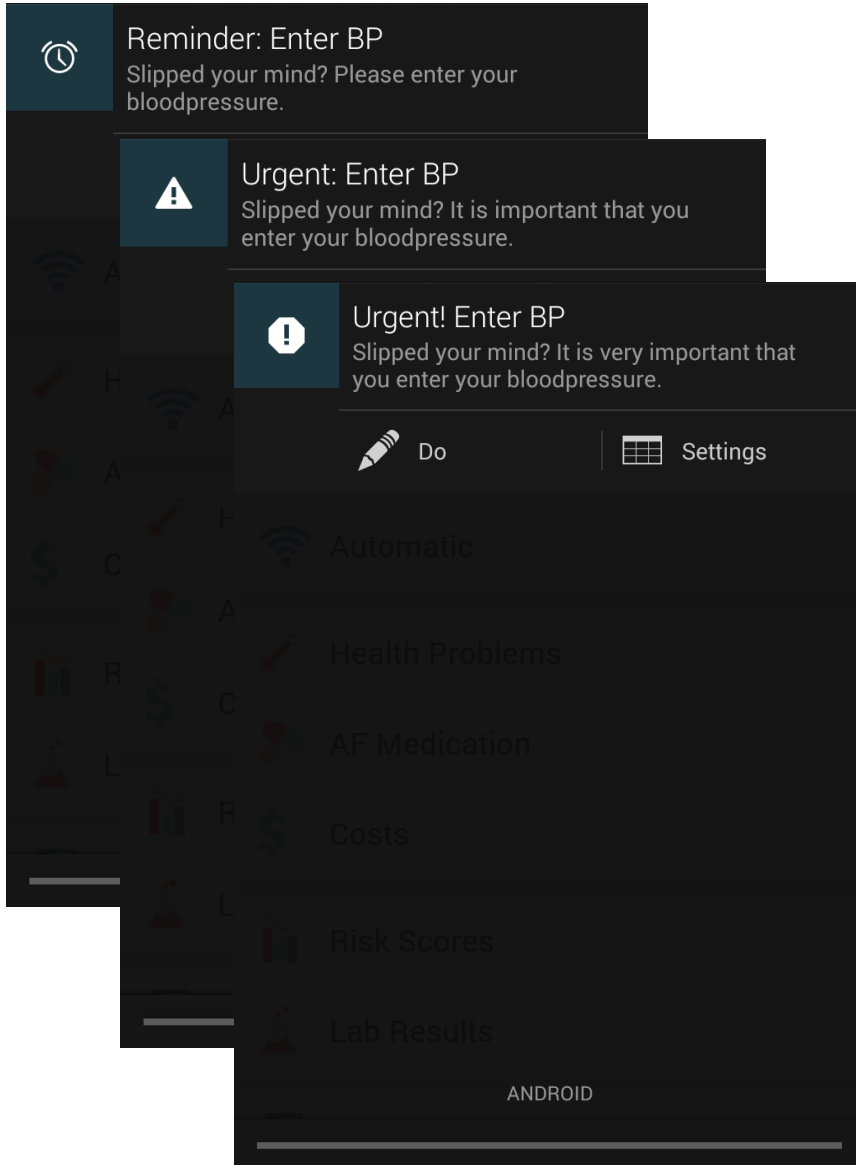
| Every | 5 | ⊗ |

*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.*

(days)

Enter your heartrate

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 important that you enter your bloodpressure.

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

✏ Do   ⊞ Settings

Automatic

Health Problems

AF Medication

Costs

Risk Scores

Lab Results

ANDROID

Back   **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

AF Patient Diary

- Blood Pressure
- Heart Rate
- Automatic
- Health Problems
- AF Medication
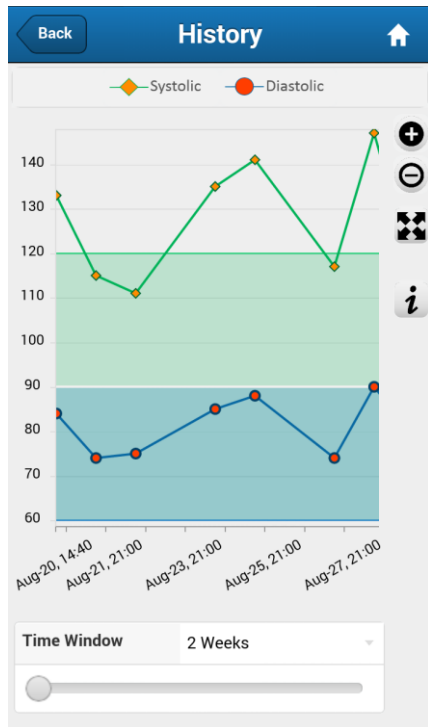- Costs
- Risk Scores

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
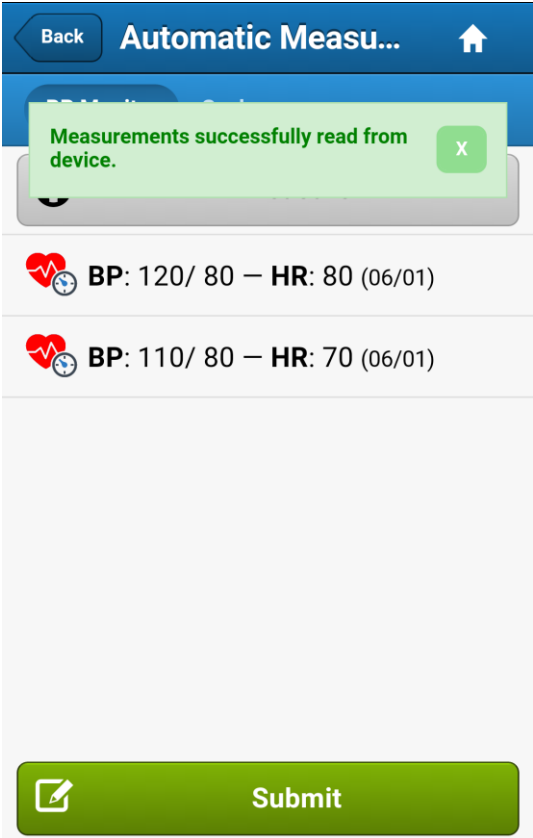 - ❖ Local drug & health product database

Health Data Entry Methods

❖ Device-Based Data Entry

  ❖ Sync with wireless health monitor devices

    ❖ Currently, BP monitor (A&D UA-651BLE)

AF Related Health Economic Data Capture

Economic Data

IMPACT-AF Mobile Patient Diary

AF Patient Diary

- Risk Scores
- Lab Results
- Personal Notes
- Notifications (**2**)
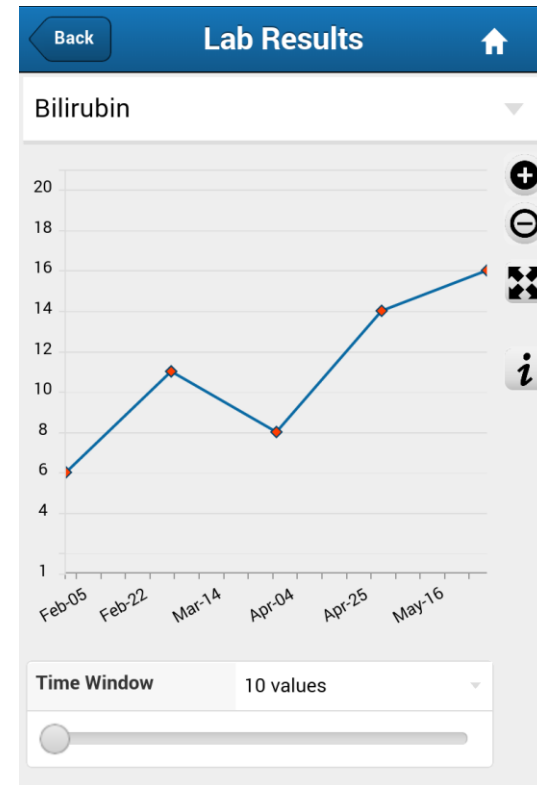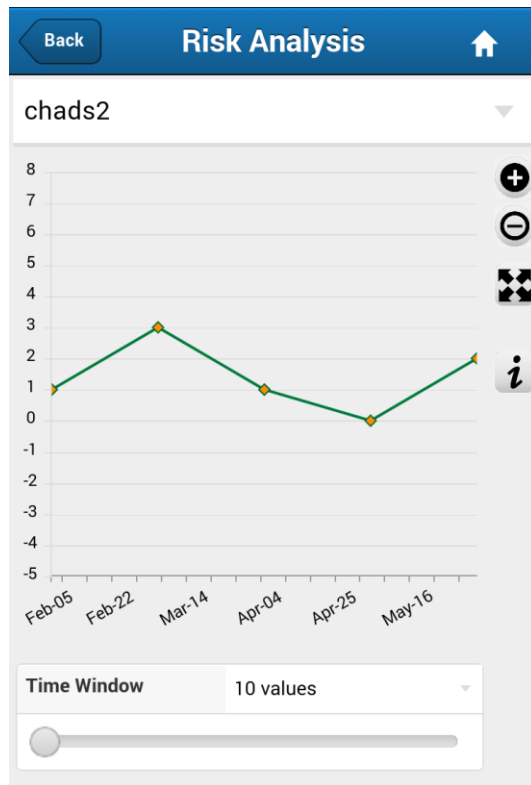- Resources

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 uptodate 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, $\geq$ 18 years of age
  - ❖ Only patients of participating primary care providers
- ❖ 12 month follow-up
- ❖ Comparison with specialist AF Clinic

IMPACT-AF: Study Outcomes

❖ 1^0 study outcome

   ❖ CV hospitalization

❖ 2^0 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

Acknowledgements

This project is funded by an investigator driven research grant sponsored by
Bayer Healthcare

The authors thank the entire IMPACT-AF team and collaborators for their contributions and support

Thank You

Raza Abidi

ssrabidi@dal.ca

www.cs.dal.ca/~sraza

The one constant is change!