A Mobile Health Application for Medication Reconciliation using RxNorm and FHIR

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Steven A. Demurjian Short Biography

- Full professor, Computer Science & Engineering, Univ. of Connecticut 1987 to present.
- 180 archival publications: 1 book, 2 edited collections, 77 journal articles & book chapters, and 103 refereed conference/workshop articles.
- Research areas:
  - Role-Based, Mandatory, Discretionary, and Lattice-based Access Control Approaches with Security Assurance for UML, XML, Mobile Computing, and Cloud Computing
  - Biomedical Informatics and Software Architectures for Health Information Exchange
  - Adaptive Trust Negotiation for Time-Critical Access to Healthcare Data
- Completed 15 doctoral graduates and 49 masters graduates.

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Why are Medications so Critical?

- Medications are a prescriber's armamentarium and first line treatment for 88% of chronic diseases
- Recent data (2011-2014) from CDC, 40.7% of seniors (65 years or older) and 10.9% of population were taking five (5) or more prescription medications
- For seniors, 40.7% is almost a three-fold increase since 1988-1994 (13.8%)
- Accurate medicationn lists maximize therapeutic impact and prevent medication misadventures that lead to life-threatening patient events
- State of Connecticut passed Special Act 18-6: An Act Requiring the Health Information Technology Officer for a Working Group to Evaluate Issues Concerning Polypharmacy and Medication Reconciliation

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What is Medication Reconciliation?

- Medication reconciliation compares a patient's medication orders to medications that the patient has been taking
- Avoid medication errors such as omissions, duplications, dosing errors, or drug interactions
- Transition of care (changing service, practitioner, or level of care) requires
    1. Develop a list of current medications;
    2. Develop a list of medications to be prescribed;
    3. Compare the medications on the two lists;
    4. Make clinical decisions based on the comparison; and
    5. Communicate the new list to appropriate caregivers and to the patient."

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Medication Reconciliation Challenges

- Transition of care still have large number of medication-related errors occur.
- Difficulty remains to create patient's medication list from numerous disparate sources, often containing duplicate, missing or inaccurate information.
- Lack of knowing reason why each medication was prescribed
- Under-utilization of available messaging standard, CancelRx, to electronically discontinue a medication puts patients at risk for adverse outcomes
- Physicians responsible for reconciling complex medication regimens outside their professional expertise which impacts effective medical decision- making
- No efficient, effective and patient-centric means of incorporating patient-reported medications and a method of effectively sharing that information

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Objectives of our Work

- A mobile health (mHealth) app for medication reconciliation that can:
  - Retrieve medications from multiple electronic health records, personal health records, and other HIT systems
  - Combine and reconcile medication into a medication list that identifies potential conflicts between the same and/or different medication
- Develop an adaptive multi-use algorithm for medication reconciliation for multiple medications pulled from different source
- Provide Fast Healthcare Interoperability Resources FHIR-based software solution for medication reconciliation

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Key Medication Standards

- An NDC (National Drug Code) code is required for each medication under the authority of the Food and Drug Administration (FDA) and are 10-digit/character, 3-segment numeric identifier assigned by FDA to each product
- RxNorm produced and updated weekly by the National Library of Medicine (NLM) is a free drug terminology that provides standard normalized names (active ingredient + strength _ dose form) and unique identifiers for commercially available drugs products
- RxTerms improves drug search capabilities by further normalizing the full drug names found in RxNorm
- RxNav is a browser that ties together multiple medication information sources including RxNorm and RxTerms

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Fast Healthcare Interoperability Resources

- FHIR provides over 125 different resources for: patients, observations, meds, etc.
- Requests for a specific resource are available through a REST API that supports instance level interactions such as: read, vread (version read), update, patch (update a portion of a resource), delete, and history interactions. FHIR
- FHIR resources are organized as *base* resources of patients, practitioners, and family relationships; and organizations, services, appointments, and encounters. *clinical resources* are for a patient's health history, including: diagnostic data, medications, care provision, and request/response communication.
- *HAPI FHIR* is a Java implementation of the FHIR resources including: Patient, FamilyMemberHistory, Condition, Observation, Diagnostic Report, Medication, Immunization, AllergyIntolerance, Coverage, EligibilityRequest, Claim, etc.

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Research topics of interest & ongoing work

- **Research Interests**
  - Health Informatics
  - Secure Health Information Exchange
  - Telehealth, Mobile Health, Remote Patient Monitoring
- **Ongoing Work**
  - Development and Implementation of Connecticut's State Health Information Exchange
  - Evaluation of Telemedicine & Electronic Advance Directive Solutions
  - A Best Possible Medication History for Medication Reconciliation
  - Educational Health IT for Providers: Continuing Medical & Pharmacy

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MedRec Issues

1. Define a true and accurate list of current meds for each individual, in the face of multiple med list sources
2. Ascertain the gaps between what has been prescribed to what is being taken (i.e. adherence)
3. Understand why each med has been prescribed
4. Reconcile this information into a new med list that
   - defines the med management plan
   - can be accurately communicated to patient, care givers, and any members of patient's care team both now and in the future

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MedRec Research Objectives

- Develop adaptive multi-use algorithms for med reconciliation and drug-drug interactions for multiple meds pulled from different EHRs, entered by different individuals over time and reusable in different contexts
- Research and develop a prototype technology mobile health application for med reconciliation which is under development and has limited availability
- Develop and test a FHIR-based extensible software solution for med transferable to multiple settings for use by patients/medical stakeholders via mobile apps, web app, or direct embedding into HIT systems via SMART on FHIR.

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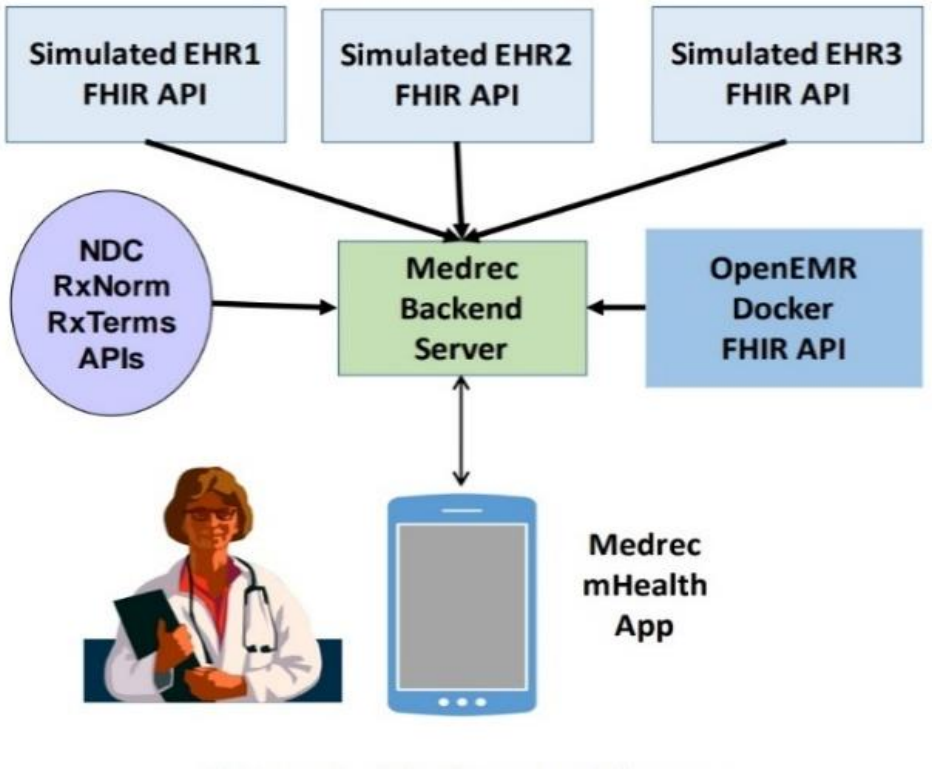
MedRec Architecture

- OpenEMR is gold standard with exact correct meds without any duplications or problems
- 3 HIT systems are perturbed versions of gold standard with missing meds, different meds, errors in dosage, old meds etc.
- Left middle different APIs related to medications, names, formats, dosage, etc.
- MedRec backend has all logic for the med reconciliation algorithm to pull from HITs
- Communication and interactions to and from HITs via the MedRec FHIR interface



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MedRec App Screens

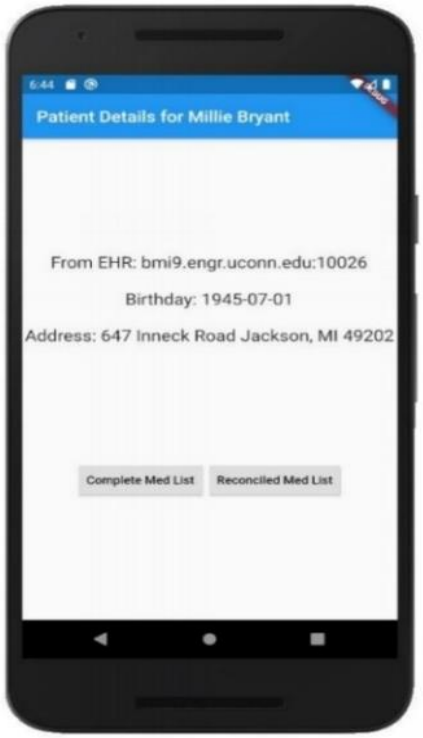

Figure 3. Screen for patient.

Figure 4. Meds from EHRs.

Figure 5. Warfarin Reconciled.

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Conclusions

- Explored the medication reconciliation in detail by reviewing:
  - Critical issues and importance of reconciliation;
  - Four different personas of patients that have medication reconciliation needs
  - Related research from medication reconciliation and computer science perspectives
- MedRec overall architecture and infrastructure, discussing
- MedRec FHIR API for aggregating and reconciling medications
- Illustrating the MedRec mHealth app
- Reviewing our medication reconciliation algorithm

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Ongoing and Planned Research

- Focusing on a number of directions:
  - Evolve and improve the MedRec mHealth app by leveraging user-centered design and development
  - Arrive at best possible medication list across all these multiple settings.
  - Interact with potential stakeholders for input and suggestions
    - medical students, clinicians, pharmacists, visiting nurses, home health care aides, patients, and other family members.
  - Improvements to the algorithm for medication reconciliation o identify drug-drug interactions which can have serious consequences if not found.

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