REPORT ON MEDICATION RECONCILIATION HACKATHON

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Contents

Executive Summary

Connecticut is currently in planning for Health Information Exchange (HIE) services to connect digital health records for patients across the state. The Health IT Advisory Council[1] prioritized a list of ten high priority use cases for HIE services; medication reconciliation was one of the major objectives. The CT Legislature mandated the formation of the Medication Reconciliation and Polypharmacy (MRP) Work Group to make recommendations by June 2019, under the oversight of the CT Office of Health Strategy (OHS). There were nine objectives (Appendix H) that were defined by the MRP Workgroup, with three (#4-6) being directly relevant to medication reconciliation and management.

UConn Health, as an advisor to OHS on HIE efforts, co-sponsored a Medication Reconciliation Hackathon on Friday, April 5th and Saturday, April 6th, 2019 at the UConn Health Academic Building in Farmington. Objectives included:

- Educate participants about some of the current challenges and newer opportunities in the use of electronic systems for the medication reconciliation,
- Introduce basic technical aspects of Fast Healthcare Interoperability Resources (FHIR) for electronic exchange of healthcare information,
- Identify key "pain points" from various user perspectives and propose viable solutions, and
- Assist in the planning for medication management services for the State's HIE.

Participants included a wide range of clinical (physicians, nurses, pharmacists), technical (engineers, computer scientists, analysts and programmers) and industry subject matter experts as well as students and patient / privacy advocates. Following a half-day of presentations, the participants self-selected into group collaborations to discuss challenges in four areas and develop a specific prototype solution.

The four areas and their key findings were:

1. **Patient / Caregiver Engagement** addressed patient-caregiver perspectives. Their prototype was a patient-centered, interactive medication management application
    - Key Insights:
        - To effectively do medication reconciliation, the indication / reason for each prescription is currently missing and if visible would improve the process.
        - The patient with the app and/or printed list can take an active role in validating what they are really taking and why.
        - The Pharmacist can more effectively counsel patients when the indication for each med is included.
        - When a list exists, a family member or Home Health Aid (or nurse) can search the house to see if it is really being taken.
2. **Extended Care Facilities and Home Health** created a prototype for active collaboration and reconciliation of medications between home health services and the physician office, leveraging real time inspection of actual meds in the home and patient involvement.
    - Key Insights:

The software standard FHIR has several different electronic message types for medication management that were considered for utilization but some inconsistencies between them could cause complications in their desired communication between Home Health Nurse and the patient's clinical provider.

- For example, the "request" domain has an "intent" field, but the "statement" domain does not. The intent field would describe the prescribe's reason or clinical indication for a medication (such as Hypertension).
- The group recommended that all fields should be available across the different domains.
- In their prototype they a two-way interaction between the prescriber and the Home Health Nurse - to acknowledge when a medication is not being taken (and remove from the medication list) or add a medication to the list that the patient was actually taking such as an over-the-counter (OTC) med or one prescribed by a different clinician.

3. **Inpatient Hospital Venue** created a prototype that would compile and summarize a potential list of current medications with an automatically calculated confidence indicator as to whether a patient was actually taking any given medication on the list. Physicians, nurses and pharmacists could leverage this at the time of admission to a hospital. The solution would rate medication data sources for their reliability to help better manage discrepancies that occur.
    - Key Insights:
        - Fast Healthcare Interoperability resources (FHIR) could create a unique physician / clinician view through a dashboard feature within their EHR, for faster and more accurate **medical decision-making** than is available now. The dashboard must:
            - Include a quick summary (snapshot) of current medication information.
            - Leverage machine-learning algorithms to create a confidence level/indicator using many disparate information systems.
            - Allow for a drill down/access to detailed information pertaining to medication, prescriber, refill histories, comments, confidence levels, and past medication history.
            - The group recognized that there was a need to better harmonize the various FHIR resources and their unique attributes.
4. **Ambulatory Primary Care Physician (PCP) Venue** envisioned a digital health service within the HIE that would compile a list of medications from various information sources into a single source-of-truth database which users would access seamlessly within their clinical/pharmacy information systems for medication management.
    - Key Insights:
        - Starting with an end goal of creating a "single source of truth" for medication information, within the state, Connecticut could develop Cloud-based services to compile and transform current medication lists from all systems that hold a patients' medication data.

- Allowing a single place to manage transactions (add, modify, cancel, comment, validate and reconcile) would likely improve safety and efficiency for medication management and reduce medication-related errors.
- The system would facilitate, the "right prescriber" validating and updating the right information regarding a patient's medication list, reducing the risk that specialists and primary care physicians would inadvertently make errors on medications prescribed outside the scope of their usual clinical practice.
- This group also echoed the need for "Indication" on each medication to drive improved care and more Clinical Decision Support (CDS); automatic intelligent filtering and display of medication lists; and Artificial Intelligence (AI) opportunities.
- A long-term solution could be to create this database as an HIE "service"[A] that the EHRs would electronically connect to rather than duplicate medication list management in the EHR. It would be critical to ensure effective integration into the clinical workflow.

Summary

The Medication Reconciliation Hackathon brought together Subject Matter Experts for education and collaboration on improving medication management for the State of Connecticut. There was general agreement that the current medication management process often impedes our ability to determine a current and accurate list of medications for each patient.

Major challenges of the current state include:

- Despite widespread adoption of (attempting to perform) medication reconciliation at each transition of care, a large number of medication-related errors occur.
- Substantial difficulty remains in compiling a patient's medication list from numerous disparate sources, often containing duplicate, missing or inaccurate information.
- Not knowing a clear indication or reason why each medication was prescribed impedes best practice for both pharmacist and physician decision-making and reduces patient understanding and engagement.
- Under-utilization of the available messaging standard, ***CancelRx***, to electronically discontinue a medication puts patients at risk for adverse outcomes and this standard should be more routinely adopted and used by prescribers and pharmacies.
- Physicians often bear the responsibility for reconciling complex medication regimens outside their professional expertise and this can have a significant impact on effective medical decision-making. A robust solution that allows shared reconciliation of medications could potentially improve this.
- We currently a lack an efficient, effective and patient-centric means of incorporating patient-reported medications and a method of sharing that information in a methodical manner when

[A] Current EHRs have built-in processes for managing the patient's medication list. This creates a unique instance of a list of current medications. A "service" would allow the HIE to host the patient's current med list and allow each EHR to interact and update the HIE list, rather than create a standalone list that may no longer be up to date beyond the single EHR encounter.

across disparate clinical and pharmacy information systems. An enhanced solution could have substantial safety benefits.

- The industry recognizes that under-documentation of patients' over-the-counter medications and supplements occurs and could potentially be improved through a patient-facing system.

The Hackathon demonstrated that current technology standards exists, such as the FHIR RESTful API and other data standards that could improve the acquisition of a more accurate medication list from a number of electronic and human sources. It could also simultaneously facilitate the development of new mobile applications, user interfaces and features such as, specialty applications or features in a patient portal that could empower the patient (or guardian/parent) to report useful information (e.g. side effects, adherence, and undocumented OTC meds, prescriptions and supplements) that are often overlooked today. These should be designed to improve the longitudinal sharing of this information across the various health IT platforms and venues of care.

A centralized medication management service for statewide prescription data could potentially evolve into a single source of truth for medication reconciliation. If successful, this could eventually become a service that replaces the proprietary medication process in each clinical and administrative database.

Access, consent, privacy and security are four critically important areas of specific focus of the MRP Work Group that are under discussion in a separate regulatory subcommittee and a Consent Design group for the HIE.

Acknowledgements

In addition to our sponsors, noted in this report, we would like to give special thanks to the following for our Hackathon event:

- From the Velatura team - Brandon Elliot MD and Courtney Delgoffe (Also on our planning committee); and Lauren Kosowski.
- Also Velatura for setup and population of the FHIR PIT

- UConn AIMS – Lauri Johnson (Event Support), Brittiany Mills (Support)

- UConn School of Engineering – Steve Demurjian Ph.D., Chris Gilman - FHIR API to OPEN EMR

- UConn Center for Quantitative Medicine – Cory Brunson Ph.D. for setting up and maintaining the GITHUB repository.

Background

Connecticut (CT) began planning for a state health information exchange (HIE) in 2017. The Health IT Advisory Council[2] formed a Use Case Design (UCD) group that considered and agreed to 28 Use Cases for HIE Services in CT. They prioritized the top ten most impactful and achievable HIE use cases for CT[3]. The group placed medication reconciliation high on their list and began a planning process to better understand the implications, desired outcomes and approaches to achieving this goal.

The UConn Health Advisors to the project convened a group of medical and health informatics stakeholders and collectively worked on an initial project to better understand and implement a more basic functionality: electronically cancelling a medication prescription. They evaluated a currently available but infrequently used message standard (*CancelRx*) within the electronic prescribing ecosystem and gained valuable insights into how to plan for the more complex task of Medication Reconciliation as a whole. They initiated the ***CancelRx*** project in late 2017. They ran a collaboration of over 50 stakeholders over several months. They provided their recommendations through its Executive Summary[4]

Formation of the CT Office of Health Strategy Medication Reconciliation and Polypharmacy (MRP) Work Group

In May 2018 the State of Connecticut legislatively formed the multi-stakeholder Medication Reconciliation and Polypharmacy (MRP) Work Group under the HIT Advisory Council and the Health Information Technology Officer (HITO) of the Office of Health Strategy (OHS). Members were officially appointed and began meeting in the summer of 2018. This group has been working on recommendations regarding:

- The development of an appropriate MRP use case(s) for the HIE
- Legislative and policy initiatives required to facilitate effective Medication Reconciliation and reduction in polypharmacy
- Defining the technical challenges and solution options and making recommendations for HIE focus and efforts to improve them.
- Engaging patients and caregivers to address concerns regarding Med Rec and Polypharmacy
- Educational program suggestions to improve understanding and uptake of potential solutions

The overall goal remains to improve the quality and costs of care through more effective medication reconciliation (Med Rec) processes and reducing polypharmacy. The MRP Work Group will report their findings and recommendations to the State in June 2019.

Medication Reconciliation Hackathon Rationale

UConn Health, as an advisor to OHS on HIE efforts, co-sponsored this Medication Reconciliation Hackathon to help:

- Educate participants about some of the current challenges and newer opportunities in the use of electronic systems for the medication reconciliation,
- Introduce basic technical aspects of Fast Healthcare Interoperability Resources (FHIR) for electronic exchange of healthcare information,

- Identify key "pain points" from various user perspectives and propose viable solutions, and
- Assist in the planning for medication management services for the State's HIE.

Addressing Med Rec Challenges

We begin each medication reconciliation process from the foundation of the patient's current list of medications. We often find it difficult to establish an individual's true and accurate list of medications. Each caregiver and the patient often record a different list of "current medications". Unfortunately, medication errors due to omission (missing medications) and commission (giving the wrong medication, duplications and mis-dosing) are all too common.

The very tools we designed to help us make clinical care safer and more efficient such as ePrescribing (ordering medications electronically) and our Electronic Health Records (EHR), may have inadvertently led to further complexity as we store information in different formats and locations, often complicating our efforts to access and collate it accurately.

One significant opportunity to improve clinical care and reduce unnecessary harm is our vision to develop and maintain of an up-to-date, accurate and shareable medication list for patients, their families and clinical providers.

Experts and accrediting bodies champion medication reconciliation as a solution to "get everyone on the same page." Despite this effort to obtain a true and accurate list of medications remain elusive due to a multitude of problems.

The 2019 UConn Hackathon event brought together both regional and national experts in the field as well as students from healthcare and computer science engineering. We described the current state of knowledge and practice and offered participants an opportunity join multi-disciplinary teams to brainstorm innovative prototypes/solutions to tackle the shortcomings in the med rec process.

Hackathon stakeholders included:

- Technical experts
- Clinical Informatics experts
- Prescribing Clinicians
- Patient and privacy advocates
- Caregivers (lay persons and family members)
- Pharmacists
- Engineers
- Computer scientists (developers and programmers)
- Analysts
- Students in nursing, medicine, pharmacy and engineering

Our goal was to initiate a medication management collaboration and foundation on which we may build better safety, efficiency and effectiveness for all.

What is Medication Reconciliation?

The MRP Work Group utilized the Joint Commission's (TJC) definition of Med Rec:

> "Medication reconciliation is the process of comparing a patient's medication orders to all of the medications that the patient has been taking. This reconciliation is done to avoid medication errors such as omissions, duplications, dosing errors, or drug interactions. It should be done at every transition of care in which new medications are ordered or existing orders are rewritten. Transitions in care include changes in setting, service, practitioner, or level of care. This process comprises five steps:
>
> 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.[5]"

The Hackathon event provided case studies to mimic some real-world circumstances, including having contradictory information to reconcile from two or more sources of medication lists.

The Current State of Medication Management in the U.S.

Transitions of care represent the most dangerous times for patient care due to communication gaps as one (or more) provider(s) hands off to another provider (or others). Transitions of care can occur in all of the following settings:

- Ambulatory Office visits with Primary Care or Specialty Clinicians
- Emergency Department visits
- Admissions to a hospital or skilled nursing facility,
- Transfer from one level of care to another within the same facility (e.g. critical care to standard inpatient care and vice versa)
- Hospital discharge to home.
    - Where options include independent management, family care, or home health nursing care.

Forty percent of Americans have one or more chronic conditions and take more than one medication.[6] As age increases, the number of chronic conditions and medications increase. According to the CDC, by age 85, most individuals have two or more chronic conditions and take six or more medications.[7]

In the United States, formal medication reconciliation occurs over 1 billion times each year and consumes over 64 million person-hours (> 32,000 FTEs) of physician, pharmacist and nursing time.[8] Despite this expenditure of resources, medication errors account for over 1 million ED visits, 3.5 million physician office visits and over 125,000 hospital admissions annually.[9]

Despite this huge investment of time and resources to perform medication reconciliation, medication management is still difficult as we struggle to:

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

It is essential to consider that the medication list is not static. It is forever in flux based on changes in medications, changes in doses of current medications and the fact that it changes the minute a patient stops taking a medication whether or not they've made their doctor or pharmacist aware.

Vision and Goals of the Med Rec Hackathon

The OHS Medication Reconciliation and Polypharmacy (MRP) Work Group recognizes Connecticut has a unique opportunity to approach medication management at the state level. They created a unique two-day event to:

- Bring together clinical, technical and policy subject matter experts (SMEs) for an opportunity to address the challenges of the current state of medication reconciliation, and
- Envision how technology and innovation could improve the efficiency, effectiveness and safety of medication reconciliation and management for everyone.

They designed the event for both education and collaboration. Workgroups were formed to approach the challenge of medication reconciliation by working together to build a technical solution prototype.

Setting the Stage

The first half-day provided a series of presentations to provide a common knowledge base for everyone:

- Overview of the Hackathon event
- Clinical perspective
- Technical perspective

It was important to provide a clinical perspective on the complexity of medication management today and the many failure points that impact safe and effective care. We discussed the current challenges of:

- Obtaining a true, accurate and complete list of the patient's medications
- The provider reconciling and updating that list to meet the needs of the current treatment plan.

On the technical side, we needed everyone to understand how we electronically share digital information about patients across different electronic health records (EHRs) and other data / information sources. We discussed the technologies behind health care data and information exchange

and the recent advances in new emerging standards to improve interoperability across different technical platforms. The purpose was to level-set across the various SMEs.

The goals of the Hackathon were to create a collaborative event in which the clinical, technical and policy SMEs could develop actual prototypes that would solve specific problems for selected stakeholders. This environment would allow all participants to learn about rapid prototype development and good "user-centered" design. Through collaboration and human factor engineering, we can design solutions within the clinical workflows that will encourage adoption and subsequent transformation of the medication management processes.

The focus on each group's prototype would be to develop a list of needs for their targeted uses, the benefits of new tools, and the features necessary for success.

- Could we teach sound usability principles[10] that would get every participant seeing potential solutions rather than feeling overwhelmed with the frustrations of the current state of medication management?
- Could we create an acceptable user interface that is intuitive, straight-forward and thus efficient?

The planners designed the Hackathon to create an event of synergy, collaboration and hope… for what is possible for improving medication safety throughout our state.

Ultimately, the Hackathon is a starting point for obtaining business requirements for use cases when designing and implementing medication management services for Connecticut's Health Information Exchange (HIE). From a technical standpoint, this work can inform the structure and design of technical infrastructure necessary to electronically reconcile medications. The HIE will provide a conduit for connecting the health information of everyone in the state. Yet the challenge is in how we reconcile all the available data into useful, efficient and easy-to-understand information for informed decision-making. Prescribers and pharmacists have a limited time to work through med rec for each patient so information must be presented for quick understanding and use. While other states focus on the quantity of data, we have an opportunity to focus on the quality of the information for safe and informed decision-making. We need to leverage the best thinking of our multi-disciplinary SMEs to contribute to our success.

Finally, the Hackathon led to the production of a series of Table References (see Appendix C) as well as a glossary of clinical and technical teams (Appendix G) to provide clarity and enhance collaboration and innovation across SMEs.

Clinical Background

The speaker, Dr. Phil Smith explained the goals and processes of medication management and specifically, the mechanics of med rec.

Medication errors are common and many are related to incorrect medication lists. The healthcare team frequently faces challenges getting a correct medication list. Technology helps and hurts. Providers may

find that technology has compiled medication data from many sources including duplications, out-of-date information and even inaccuracies.

Electronic prescribing (ePrescribing), while eliminating illegible, handwritten prescriptions, has introduced unintended errors. For example, there is difficulty with electronically "de-prescribing" medications no longer desired (as in the prior work of the MRP Work Group on the *CancelRx* initiative).

Our speaker has created a framework of over 30 factors that contribute to an inaccurate medication list. He has divided them into five major categories[11]:

1. Patient factors,
2. Disease and/or condition factors,
3. Physician / provider factors,
4. Medication and pharmacy factors, and
5. Socio-economic factors.

Currently there are over 1.1 billion medication reconciliation opportunities annually in the U.S. consuming over 64 million person-hours of provider, pharmacist and nursing resources[12]. The audience provided personal examples that suggest these estimates may be low.

Despite this effort, adverse drug events (ADEs) account for (in U.S.):

- Prolongation of hospital stays (2 million/yr.) adding 1.7 to 4.6 avoidable days,
- Over 3.5 million physician office visits,
- Over 1 million emergency department visits, and
- 125,000 hospital admissions.(CDC Data[13])[14]

Medication adherence[15] is an additional issue, as

- 49% have forgotten to take a prescribed medication
- 31% had failed to fill a prescription
- 29% had stopped a medication prematurely.

Providers recognize that getting a true and accurate list of medications remains a challenge in our current medication reconciliation processes.

Technical Background

The speaker, Dr. Robert Hausam explained that as the electronic health record (EHR) has replaced the paper medical record for most patients, many national efforts have focused on the concept of interoperability, or the sharing of digital healthcare data and information across multiple electronic health records, registries and other data sources.

While standards have existed for decades for exchange of discrete data for financial transactions, clinical data creates some interesting challenges. While some data, such as lab results, can be transmitted as discrete values, much in healthcare exists as narrative, or "unstructured" data. Unstructured data presents challenges for sharing across providers.

Electronic health records (EHRs), often have difficulty sharing data in an interoperable and usable format, not only between two vendor's systems, but often between two organizations using the same vendor product. Even those who use the same EHRs often have different versions and set-ups that present challenges across institutions.

Several strategies have been developed to tackle this challenge. Common standard terminologies have been created such as SNOMED CT, which may be used for coding symptoms, problems, and conditions, ICD-10-CM, which is used for coding diagnoses, and CPT and ICD-10-PCS which are used for coding procedures, operations and types of encounters. These terminologies often play a role in documenting the "indication" or reason for prescribing a specific medication for a patient.

Medications have their own challenges. The FDA registers an NDC (National Drug Code) for each medication, yet those codes can be recycled at times and therefore may not be unique to each medication. RxNorm provides a standard nomenclature for clinical drug names and drug vocabularies. It is often used for clinical decision support (CDS) systems that determine risks for drug-drug, drug-food and drug-allergy interactions.

Many data sources, such as a patient's personal list of medications are typically free-text, and therefore difficult to convert to these standards. It is difficult to not only compile a list, but to determine duplications and omissions. Patients know if they are taking their prescribed medications or not, but only at office visits or if they call their provider is this information obtained. Patient portals will play a greater role in the future to help providers reconcile med lists.

From the standpoint of an HIE, there may be numerous sources of medication lists, some with indications, some without. Medications may be expressed as a trade name or by their generic name. To complicate matters, a patient may not even know the name of the medication or the indication for why the medication is prescribed.

Thus the HIE has the challenge of managing structured and unstructured medication names, indications and instructions as well as different nomenclatures. There may be confusion on whether a drug has been discontinued or merely overlooked. To add to the challenge, most systems have no way to measure the patient's adherence to the medications prescribed.

In addition, there may be over-the-counter (OTC) agents, supplements, illicit or even "borrowed" medications in the mix. Currently, there may or may not be fields to enter this information into a med list. This becomes dangerous because if a prescriber does not have the "full picture" they may prescribe a medication that could have a dangerous interaction with the non-recorded OTC agents, supplements, illicit or "borrowed" medications.

In response to these and other challenges with clinical data exchange and interoperability, a new standard known as Fast Healthcare Interoperability Resources or FHIR (pronounced "fire") is in development and now available. FHIR is an open next generation standards framework from Health Level 7 (HL7) which is focused on implementation and is targeted to individuals and organizations developing software and architecting interoperable solutions that will be using FHIR. FHIR provides a standard healthcare API that allows the communication and exchange of data across multiple healthcare platforms.

The Office of the National Coordinator (ONC) under the U.S. Department of Health and Human Services continues to drive the adoption of digital health records and their interoperability. With this comes a drive to improved sharing of information among providers of healthcare. All of this occurs with the overarching need to address the privacy and security of medical information. The recently announced 21st Century Cures Act NPRMs from ONC and CMS specify the use of FHIR as the API for EHR certification and access to health information by patients, providers and payers.

FHIR is based on modern technology using the common tools which have transformed the information age through the Internet. This includes how devices connect and interact (leveraging RESTful[16] architectures and common Web standards including HTTP, XML, JSON and RDF), allowing developers to use the tools of the World Wide Web to tackle healthcare challenges.

FHIR is web-based and free for use, and allows extensibility (i.e. the ability to address unique, local needs) in addition to the interoperability features. FHIR is now another tool including HL7 version 2 (the legacy HL7 standard, HL7 v3, which has a steep learning curve, and CDA[17] (Clinical Document Architecture) which is a standard for exchange of common clinical documents such as medication and problem lists, allergies, demographics and immunizations.

In other words, healthcare is moving from a model of silo'd data in a propriety EMR to tools that will allow developers to more rapidly develop open source tools that will work across these systems and can be updated with new technology more easily because it is compatible across systems, unlike many vendor tools.

In December 2018, FHIR R4 (4.0.0) was released which includes the first "Normative" (i.e. considered to be stable) content, which should provide a reliable foundation for development. Changes, if any, to Normative content are expected to be infrequent and are subject to strict FHIR Inter-version Compatibility Rules. Previous FHIR releases and parts of the current content are "Trial Use", meaning that they are subject to potentially breaking changes, but significant effort is under way to bring these parts of the specification to Normative status as rapidly as possible. With the increasing acceptance and promotion of FHIR by the major EMR vendors and ONC and the availability now of Normative content, FHIR became the logical choice for use in the Med Rec Hackathon.

The decision to use FHIR enables support for SMART on FHIR application development, CDS Hooks[18] (providing clinical decision support services) and support for the Apple Health Kit. Further information on SMART on FHIR is available at SmartHealthIT.org.

On a final technical note, electronic prescribing in the United States occurs through standards set through National Council for Prescription Drug Programs (NCPDP). *SureScripts*, who also helped sponsor the Hackathon, is one vendor that provides an electronic prescribing communications hub between providers, pharmacies and pharmacy benefit managers. The standards provide that the Diagnostic code (ICD-10-CM) and SNOMED CT (used in Problem Lists and for Conditions) codes can be used for indications during electronic prescribing. Both the SCRIPT v10.6 (current) and v2017071 (effective 1/1/2020) standards include a field for indication.

Two emerging technologies, Blockchain and artificial intelligence (AI) were included in discussion but are not the focus of this white paper. However, both are seen as important areas to address in future discussions at the MRP Work Group level.

Leadership

Tom Agresta, MD, MBI, professor and director of Medical Informatics at the UConn School of Medicine was the leader and executive sponsor of the event. Katherine Hayden, HIE Project Coordinator at the UConn Health Center for Quantitative Medicine implemented the event through logistical support. Faculty for the event are listed in Appendix D.

Planning Committee for event:

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Event

The event occurred from 8 AM – 5 PM on Friday, April 5th and Saturday, April 6, 2019 at the UConn School of Medicine. Public and private funding occurred for the event with sponsors noted in Appendix B.

Participants

113 participants registered for the event. 84 attended the Friday sessions and 47 attended the Saturday sessions. Among the registered attendees included 39 clinical and 40 technical resources. Approximately 100 people viewed the lectures, workshops and/or final presentations remotely using an access link.

Links to lectures, workshops and final presentations are in Appendix E. A full list of attendees is in Appendix F.

Clinical Discussion Breakout Sessions

On Saturday, while the technical participants worked on prototypes, a group of 20 clinical participants discussed medication reconciliation as it was applied to several pre-defined persona. Each persona was presented, with the group identifying the main problems, potential solutions and possible return on investment (ROI) of intervention / innovation. With direction from the event lead, *Velatura* provided the personae for participants to use.

Persona #1: Millie Bryant

Millie Bryant's journey began with problems around obesity, which led to diabetes mellitus type 2 with peripheral neuropathy and increasing issues with mobility, especially with her hips and knees. Now 72 years old, Millie is battling an increasing number of health problems, her son has medical power of attorney but everything regarding her healthcare still feels hard.

Recently, Millie was admitted to the local emergency room with chest pains. Following the onset of atrial fibrillation, Millie was admitted to the Emergency Department due to a heart attack.

Discussion: Millie represents an older patient with multiple chronic conditions with an acute hospitalization for a significant healthcare event. The group discussed the difficulty of managing multiple medications. It recommended that a community health worker be assigned to help the patient with adherence to the medication and plan of care; access to follow up care; and ongoing authorization for visits and support.

The benefits of identifying this patient's needs and creating an effective intervention plan was to decrease risk and costs for further acute care (e.g. ED visits and hospitalizations) episodes. They felt it also important to avoid duplicate dispensed medications and reduce polypharmacy (use of excessive number of medications). This is significant since the patient may be getting some prescriptions filled by a bulk mail pharmacy, which may not get the message that a medication has been discontinued or changed following hospital discharge. (For example, a *CancelRx* communication to the local pharmacy will not simultaneously go to the mail order pharmacy.).

The group felt that the assigned "care manager" could help to accurately identify and engage all members of the patient's care team, including family (i.e. her son). Similar needs occurs with those who are children or under guardianship. One benefit is to avoid miscommunication across providers and reduce confusion for Millie.

The group also discussed the challenges in helping to identify high-modifiable risk factors, such as diet, activity and habits. While some EHRs provide risk stratification tools, often the payers do as well. The tools often have been developed for individual health conditions and may not work well in the face of multiple chronic conditions with conflicting recommendations. There is often confusion on "Who owns the risk?" between payer and providers.

There are apparently early conversations in Connecticut to have pharmacy delivery drivers complete assessments of patient's home during delivery of medications.

This case led to the discussion of several technical considerations:

1. An HIE, pulling medication lists from the EMR of ever physician that Millie sees, as well as her pharmacies, the ED and the hospital may produce a list of potentially hundreds of lines of medication data. How can we use technology to better filter the list? Should the HIE have its own medication database that serves as a source of truth and then provide a "medication service" back to all the EMRs and pharmacies? Could such a database create a "ledger" to show every touch point such as new meds, modifications of existing meds, cancellations and refill data to suggest adherence?
2. How can we better look at reliability of the data and of the patient, when there are so many potential sources of data? How do we best validate the reality of what has been prescribed, and what the patient is actually taking? Can we create a "Confidence Indicator" that helps us determine the accuracy and reliability of each data source contributing to the HIE medication list? Could this help us perform a better medication reconciliation?

Persona #2: George Tullison

George Tullison suffers from Type 2 Diabetes brought about because of obesity. He also has hypertension, Hepatitis C, and a history of alcohol abuse. Recently, George lost his job, which has put his healthcare, home, and life at risk.

George recently had an inpatient visit and was diagnosed with congestive heart failure. Since the diagnosis George has frequently landed in the hospital or ER with complications from his congestive heart failure, diabetes, hepatitis C and hypertension. George's complex care needs make him a high risk for re-hospitalization after discharge.

Discussion: George suffers from chronic congestive heart failure with multiple co-morbidities (i.e. multiple chronic conditions that contribute to more health complications). This case allowed the group to discuss the importance of social determinants (income, housing, support, socioeconomic factors) and health literacy issues that can complicate medication adherence and outcomes. The insight was that medication reconciliation today happens in a vacuum to these factors, yet contribute to the overall patient outcome.

Persona #3: Sarah Thompson

Sarah Thompson suffered a back injury while working, and was prescribed Oxycodone for pain. In hindsight, if she knew where it would lead, she would have never taken the drug.

Sarah quickly became addicted to the drug, but because she had no health insurance through work, she could no longer afford it. A co-worker offered her heroin as an affordable alternative. Sarah said no at first, but the pain persisted and before she knew it she was addicted.

Sarah was charged with DUI and possession of a Level 1 controlled substance after being pulled over by the police while speeding down the interstate. She was given the choice of "getting clean" or going to jail. Sarah spends time in and out of methadone clinics before maintaining her sobriety. Recently, Sarah visits her PCP but doesn't share her history of narcotic dependence for using IV heroin.

Discussion: Sarah falls into the category of opioid dependence and multiple issues that currently compound the difficulties in identifying and addressing it.

From a technological standpoint, the group discussed that even though an HIE may include medications from the Prescription Drug Monitoring Program (PDMP), which includes all controlled substances in the state, methadone clinics do not submit their prescription data to this database. Also, some patients do not consent to all of their providers seeing they are under treatment for mental health disorders.

Also, Connecticut does not have the ability to query the PDMP in the other 49 states. SureScripts only provides a one year rolling view, so past opioid use may not be apparent. There is a current push by several boards of pharmacies to create flags when patient have recent opioid abuse.

The group felt that there is a policy gap with the PDMP and expressed concern that there are unintended consequences of public policy on opioids and controlled substances. It becomes difficult to give safe and effective care when information is not accessible for decision-making.

The group deferred discussion on privacy, consent and security to the MRP Work Group's subcommittee on these topics. Jessie's Law S.581 (passed by U.S. Senate 8/3/2017 and since not addressed by the House) was referenced as it would establish best practices for opioid documentation in the medical record.

The group felt the more could be done through transparent medication histories to allow detection of opioid abuse and opioid diversions.

Persona #4: Christy Munson

Christy Munson has never been the kind of person to give her health a second thought. She is now 38 and has seen her weight rises and lowers each year. In the last year, Christy's weight increased more than usual and for the first time began to impact her emotional well-being as well.

Then other problems began to emerge. She complained to her doctor about fatigue as well as pain in her lower back and hips. After a multitude of tests, Christy felt no better and her doctor was no closer to providing her with a diagnosis or reason for the pain. Christy's doctor even noted at one point that her symptoms could possibly be a manifestation of depression or psychosomatic in nature. This idea really angered Christy.

Christy's pain only seemed to increase. She changed doctors (after the psychosomatic comment) and began to see specialists, most focused on pain. After another round of blood draws and scans, Christy and her specialists could not pinpoint the problem either.

Christy had a recent flare up and her intolerable pain resulted in a visit to the ER where they prescribed her a 30-day opioid prescription.

Discussion: The initial discussion about Christy dealt with the identification or awareness of "poly-providerism" and properly identifying the patient's current care team.

The group's major insight concerning this persona was that in the workflow of medication reconciliation, there are multiple non-medication factors that "inform" medication management and decision-making.

These include:

- Reference labs for the drug or a trigger alert to find the information. For example, the INR is critical for the management of warfarin (Coumadin, a blood thinner). Pharmacists need more than just the medication list. Could the HIE provide CDS rules to mine pertinent labs and problems/diagnoses, allergies. This would be especially helpful for high risk medications or a subset of drugs that have labs associate with them (such as warfarin)?
- But every rule has exceptions. Patients in pain might not get necessary drugs. We need a balance for medication management so system doesn't prohibit patients get the treatment they need
- There is a general lack of information beyond metadata around prescriptions. It is a read only list that doesn't not allow any comments that might be helpful in the future on that medication. For example, pharmacies don't know what other pharmacies have dispensed and should be aware to what else the patient is getting. HIE should permit this. There was apparently a previous law stating pharmacies can't tell you what your meds are for. We have come a long way but having a centralized list of meds that everyone can see
- Need to include indication of a drug. Less than 45% of e-prescriptions have it and it is not always displayed to all providers.

The concept for a centralized medication management system within the HIE was again discussed. This would be especially helpful if the provider could prescribe to the "cloud" and let the patient go to any pharmacy and have them be able to receive the authorization to dispense from there. That would

require a rewrite of current dispensing law. However, the benefits would be many. It is convenient for the patient. It allows one list to be the source of truth. The solution would have to be a service in the EHR workflow and not a separate query. It could better manage stale data of old meds that are no longer prescribed but have never been discontinued. *CancelRx* could occur in one location. And it would provide a better opportunity to monitor and manage pain across multiple providers and venues. [B]

Findings of Focus Areas

On the afternoon of Day 1 of the event, participants self-selected themselves into either a technical workgroup or into one of four clinical workgroups. The clinical workgroups were as follows:

1. Patient Care / Caregiver Engagement
2. Nursing Home / Extended Care Facility and Home Health Venues
3. Inpatient / Hospital Venue, Nursing and Pharmacy
4. Ambulatory Primary Care Physician (PCP) Office Venue

Each group's participants, focus, findings and recommendations follow. Source materials, prototypes and recordings are archived on the Hackathon GitHub site. Judging of the teams occurred with four criteria: Problem Definition, Level of Innovation, Team Cohesiveness and Potential Impact to the Health of Connecticut.

[B] One participant noted that first year residents in their state cannot access the PDMP. They must have an attending physician grant access. Though not an issue in Connecticut, it is included to remind the reader of the potential unintended consequences of local / state regulations.

Patient / Caregiver Engagement

Participants: Robert Hausam, Marinka Natale, John DeStefano, Jason Cory Brunson, Sandra Czunas, Sarju Shah, Pat Carroll, Dong-Guk Shin, Rick Munger, Alejandro Gonzalez-Restrepo, Nathaniel Rickles and Riddhi Doshi (facilitator).

Focus: Revolutionizing Med Rec Solution: *MEDME*

Findings and Recommendations:

Problem Statement (patient perspective)

- Not having the patient's current list of medications across multiple physicians, providers and health systems
- Lack of understanding why they are taking a particular medication (i.e. "indication(s)")
- Truth is always changing (i.e. tracking changes)
- No easy way to communicate questions/concerns in a timely manner
    - Side effects
    - Duplicates
    - Etc.
- Difficult to access and interpret information for all populations (including those with vulnerabilities and disparities)
- Challenges as we incorporate and adopt tools and technology into healthcare delivery.

Problem Statement (health professional perspective)

- Some health professionals cannot access the indication (e.g. context and need) for each medication for a variety of reasons. For example, not all clinical (EHRs) and pharmacy information systems consistently enable, require or display indication fields.
- Even when prescriber includes an initial indication for a medication, downstream care providers may be unable to view the relevant indication or diagnosis.
- Data needs to be pulled from multiple providers and sources without gaps.
- Limited information on over-the-counter (OTC) drug, supplements and herbals that patients are taking.
- Prescriber does not have easy access to formulary or cost.
- Pharmacist uninformed to reason for many prescriptions (i.e. diagnosis / indication).

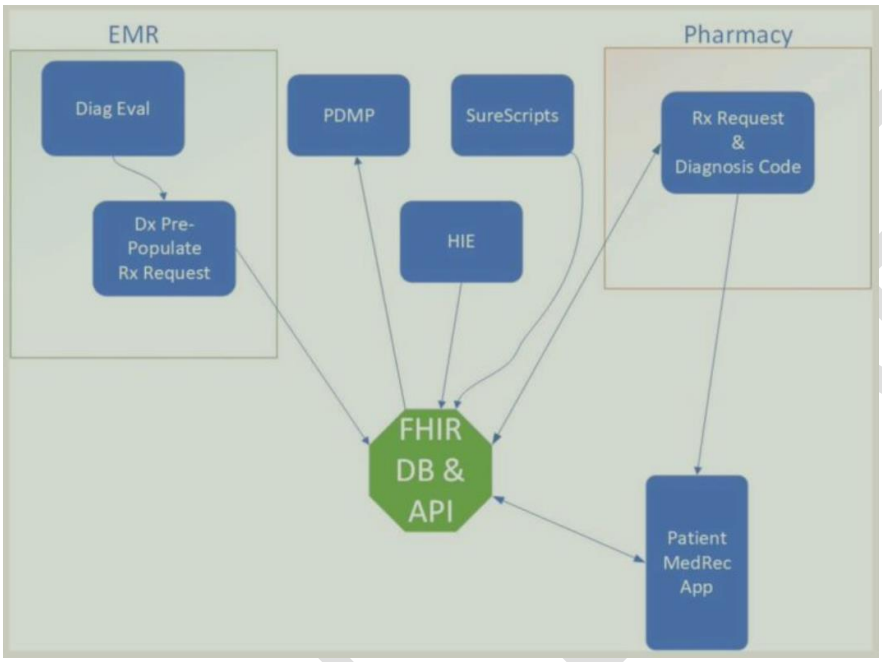
Major Features of their Solution

- Linked to an integrated database.
- Enable database access to multiple parties.
- Leverage workflow that already exists.
    - Provider includes an indication / relevant diagnosis to the initial electronic prescription from the electronic health record.

  - Allow easy linking from within the EHR between diagnoses and ePrescribing to ease physician's/prescriber's data entry burden.
- Allow patient to provide feedback on any medication.

The team presented the following details on their proposed solution.

Proposed Solution Schema:



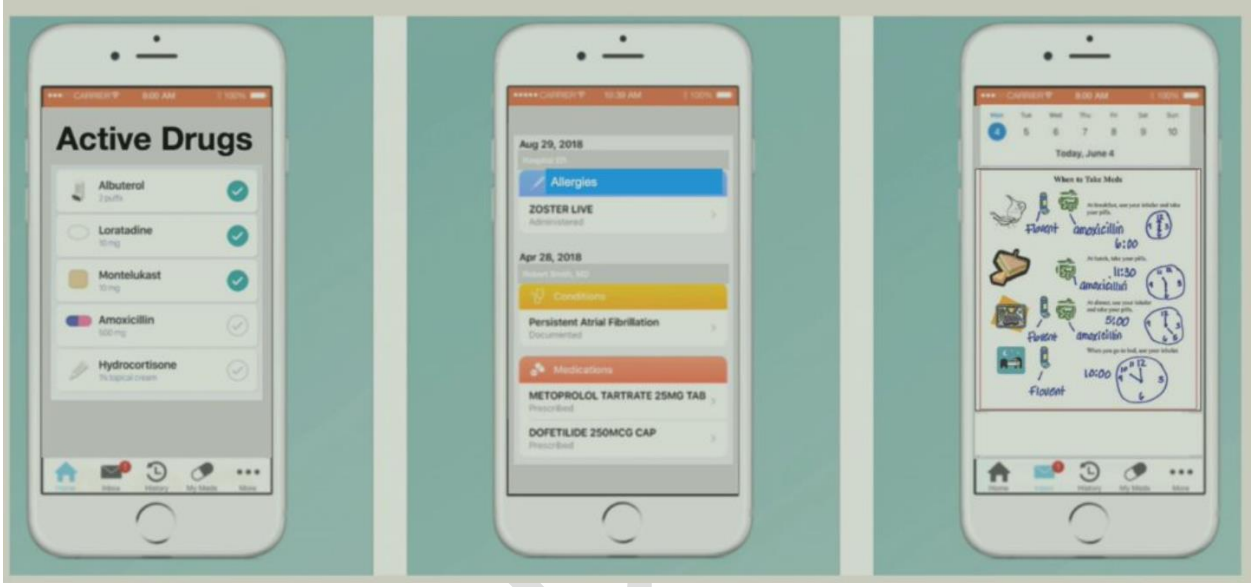
Proposed data schema for integrating multiple patient data sources. The diagram demonstrates communication across multiple systems, including a patient-facing application.

Definitions and Descriptions of above diagram:

- **Diag/Eval**: During evaluation, physician provides a diagnosis / indication for each new medication as a byproduct of documenting the encounter.
  - **Dx Pre-Populate Rx Request**: Integration allows documentation and electronic prescribing to share the diagnosis or indication rather than requiring dual entry.
- **PDMP** is the existing database for controlled substances within the state. (PDMP = Prescription Drug Monitoring Program)
- **SureScripts:** SureScripts provides the network and management of electronic prescribing communications between providers (through apps and EHRs) and dispensing pharmacies, as well as with pharmacy benefit managers (PBMs). SureScripts compiles an electronic medication history from these various sources.
- **HIE:** Refers to the Health Information Exchange for the State of Connecticut.
- **FHIR DB & API:** Refers to a central database connecting and compiling medication lists for each patient using FHIR (see Technology Background).
- **Patient MedRec App:** Refers to a web-based application that would allow patients to view, manage and comment on their current list of medications.
- **Rx Request & Diagnosis Code:** As a pharmacy receives a new prescription request, the indication or diagnosis code would be associated to that new prescription.

Discussion: The central database would coordinate communications across the multiple data sources and provide transparency for all users on both indications for each medication as well as patient's comments. The database could be a FHIR server with an interface or a FHIR interface. Would need to be a record locator involved to match the patient to the pertinent records using a master data management solution or other tool for patient matching

User Interface for the Patient Application:



The above mock up demonstrates how a patient-facing application can provide an active list of medications and their indications / diagnoses as well as allergies. The application would include reminders of when to take medications. The patient could also comment on each medication. The screen above on the right indicates an example of a graphical user interface to help minimize healthcare literacy challenges.

The mock up below demonstrates a Patient Summary with Reason for each med (first column), details of each med (e.g. instructions), (second column) and status (Active, On Hold, or Discontinued), (third column):

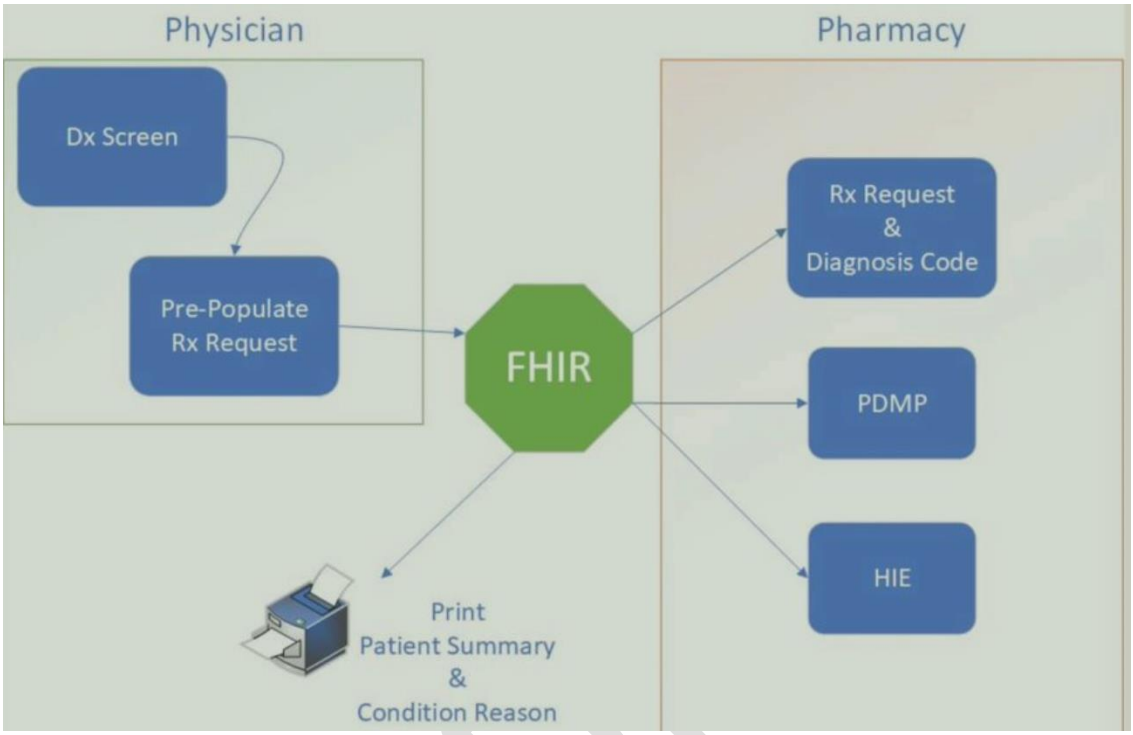
Medication	Taken for
Carvedilol 6.25mg 2x/day	High blood pressure and keep heart rate down
Lisinopril 20mg daily	High blood pressure
Amlodipine 10mg daily	High blood pressure
Atorvastatin (Lipitor) 80mg daily	High cholesterol
Spironolactone 25mg daily in morning	Heart failure; water pill
Furosemide (Lasix) 40mg daily in morning	Heart failure; water pill
Metformin 500mg 2x/day	Diabetes
Insulin GLARGINE (Lantus) 40 units BEDTIME	Diabetes
Insulin LISPRO (Humalog) 10 units BEFORE EACH MEAL	Diabetes
Acetaminophen (Tylenol) 500mg 4x/day AS NEEDED	For arthritis pain; no more than 4 pills/day
Spiriva Handihaler 18mcg 2 puffs of one capsule daily	Daily for lung disease NOT for short of breath
Advair Discus 250/50 one puff 2x/day	Daily for lung disease NOT for short of breath
Albuterol inhaler 2 puffs every 4 to 6 hours AS NEEDED	Use FOR short of breath for lung disease (COPD)

(COPD) Blood pressure | Cholesterol | Heart failure | Diabetes | Pain | Lung Disease

Every stakeholder from patient, physician, pharmacist and beyond would benefit from seeing clear reasons for each medication. This would facilitate medical decision-making and safer medication management as everyone is "on the same page" regarding the list of medications.

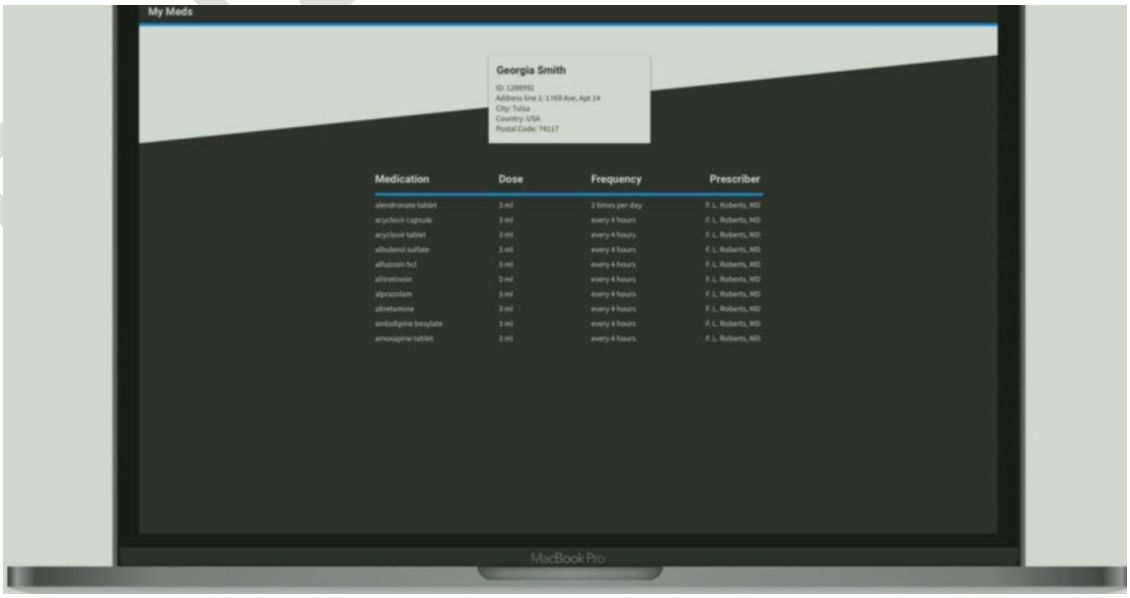
Data Flow: In order to produce a working prototype at the Hackathon, the group used FHIR to communicate between the physician EMR and the pharmacy information systems. The group indicated the importance of leveraging multiple sources of patient medication lists with agreement on indications. They included the ability to print a patient summary which included indications on the medications.

Data Flow example:



Within the two-day Hackathon, the Patient/ Caregiver Engagement group was able to successfully pull information from multiple sources and display them in a list as shown in the following two screen shots (below). All while showing the information within two different workflows.

Hackathon Prototype:



Medication	Dose	Status	Prescriber	EHR
Advair Discus 250/50	one puff twice daily as directed	completed	Bailey Wilkinson	PO1
Coreg 6.25 mg	one tablet twice daily as directed	active	Bailey Wilkinson	PO1
Glucophage 500mg	one tablet twice daily as directed	active	Bailey Wilkinson	PO1
Lantus 40 units	40 units at bedtime as directed	active	Bailey Wilkinson	PO1
Lipitor 80mg	one tablet daily as directed	active	Bailey Wilkinson	PO1
Norvasc 10 mg	one tablet daily as directed	active	Bailey Wilkinson	PO1
Proventil HFA 90mcg	two puffs every four to six hours as needed	active	Bailey Wilkinson	PO1
Zestril 20 mg	one tablet daily as directed	active	Bailey Wilkinson	PO1
Aldactone 25mg	one tablet daily as directed	active	Bailey Wilkinson	PO1
Humalog 10units	10 units prior to meals as directed	active	Bailey Wilkinson	PO1
Advair Discus 250/50	one puff twice daily as directed	completed	Bailey Wilkinson	PO2

Feasibility of Prototype:

The group validated that the data pull can be successful. They felt future efforts would address further integration of more complete information on each medication into the appropriate workflow of each user to enhance adoption.

The group summarized their Usability Principles:

- Use the language of the users.
- Match "system and the world" by avoiding local or proprietary notations.
- Users are in control of their medication list.
- Prototype application can access this database and interact and update in real time
- Prototype is using FHIR standards, FHIR server, and FHIR interface – pulling information from two FHIR servers and creating unified view
- User interface
    - Captures active drugs and allergies summary
    - Includes patient summary (reason, medication, details, status, reason)

Key insights of this group:

- To effectively do medication reconciliation, the indication / reason for each prescription is currently missing and if visible would improve the process.
- The patient with the app and/or printed list can take an active role in validating what they are really taking and why.
- Pharmacist benefits when the indication for each med is included.
- When a list exists, a home health person can search the house to see if it is really being taken.

Extended Care Facilities and Home Health

Participants: Jake Star, Vimal Bhat, Jennifer Boehne, Christopher Merrick, John Schnyder, Joe Anderson, Brady Hecht and Sean Jeffery (facilitator).

Focus: The process for a home care nurse to create a true and accurate medication list as a patient returns home from a post-hospital discharge. Any discrepancies identified need to be communicated with the appropriate prescriber, who then needs to acknowledge receipt of the discrepancies and follow up with the patient.

Findings and Recommendations:

The following represents the process that a home care nurse typical follows on the first home visit.

1. Home care nurses currently receive paper records from the hospital following discharge.
2. They take these paper records and their laptop to the patient's home.
3. Reconciliation occurs in the home and consists of using these lists along with medications in the home that the patient has confirmed they are currently taking.
4. Nurse creates a new medication list using these various sources.
5. Then nurse creates a list of discrepancies and sends them to the appropriate physician(s) via fax.
6. The physician(s) needs to respond back that they received the discrepancy list and this provides an audit trail.
7. **Issues:**
    a. The paper records sent with the patient at discharge are one snap shot in time and don't provide any historical information on the medications the patient was on prior to discharge.
    b. Home health nurses may find medications (OTC, vitamins, supplements, etc.) in the home that are not on the paper records (See photo below.).
    c. The patient may not have picked up Discharge Medications. Therefore these new medications may be absent during the reconciliation process.

Example of how during a home visit, a healthcare professional can discover prescriptions, over the counter medications and supplements that have never been reconciled.

Photo Credit: Sean Jeffery, PharmD

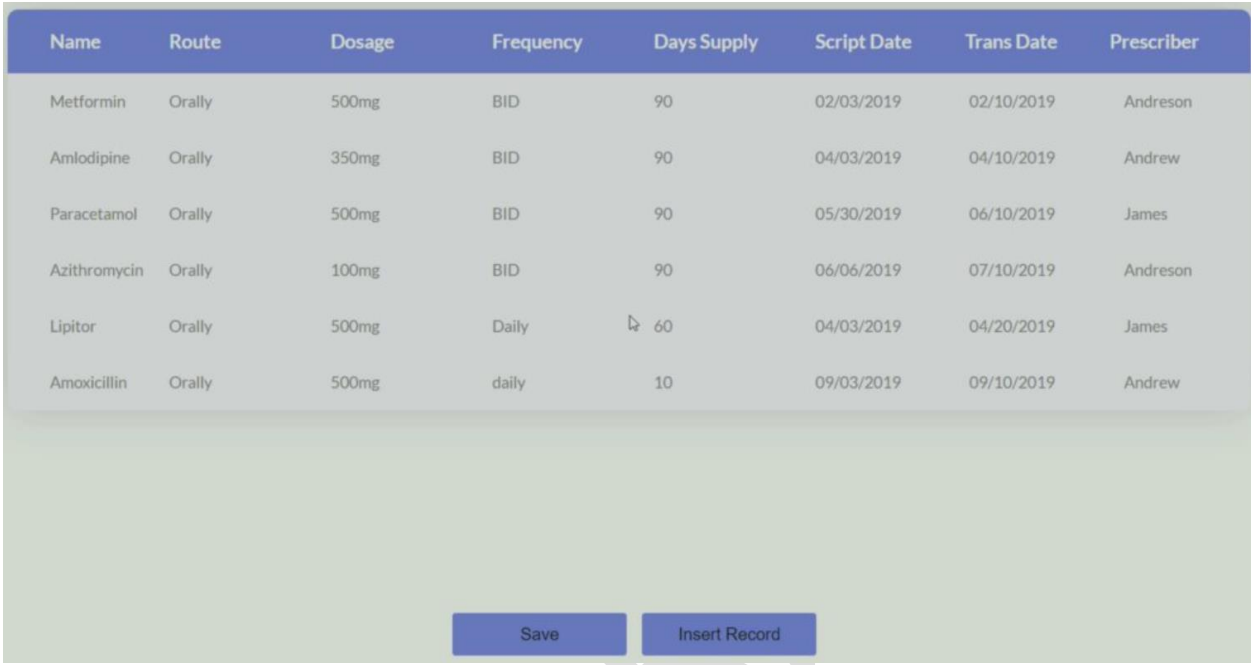
Recommended Solution:

- Use FHIR to populate an electronic form to help facilitate medication reconciliation
- Leverage a variety of sources of medication information such as (medication dispensing, medication claims, medication history, PDMP, expanded PDMP, and/or national PDMP) to create a transaction ledger
    - The information in this transaction ledger could be filtered and/or customized based on the end-users needs (Examples: comprehensive view, discrepancy view, hypertension medication view, historical view for prior authorization)

Workflow: Create a central medication list.

Scenario: The home care nurse makes a home visit. The nurse attempts to reconcile the care plan from the discharge paperwork from the hospital. The nurse requests the electronic continuity of care document (CCDA) and the medication list from the HIE. The FHIR resources call up a medication list from the new enhanced PDMP via the HIE:

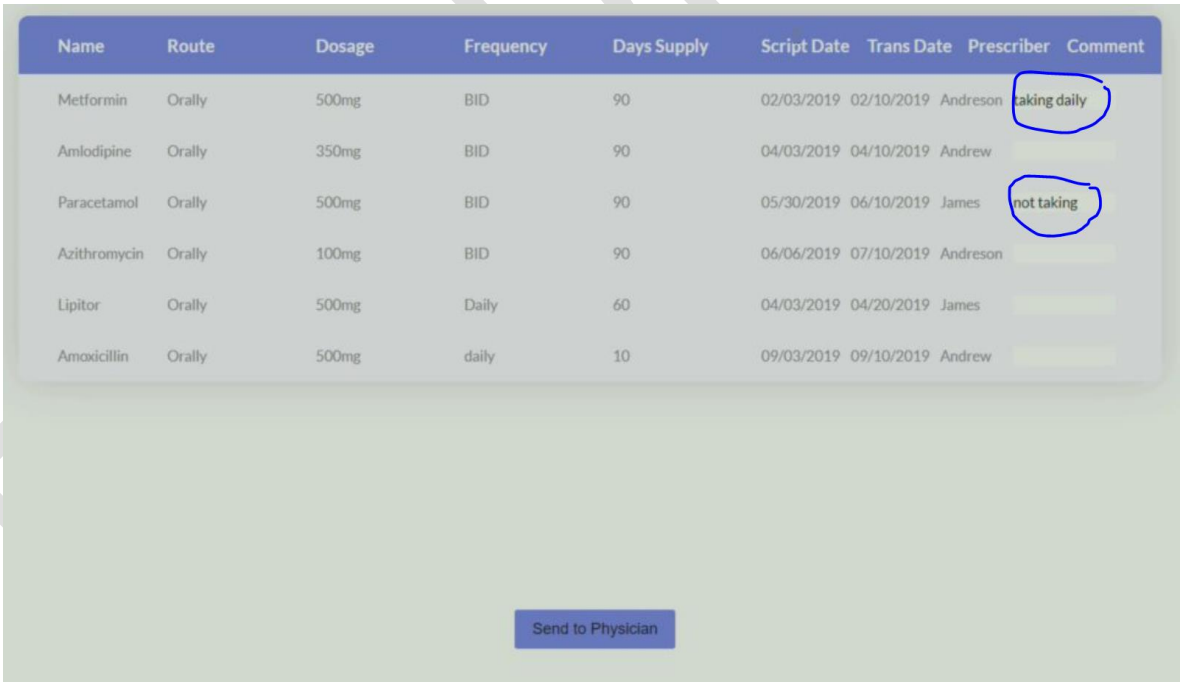
The HIE displays the following list of medications and instructions.



Name	Route	Dosage	Frequency	Days Supply	Script Date	Trans Date	Prescriber
Metformin	Orally	500mg	BID	90	02/03/2019	02/10/2019	Andreson
Amlodipine	Orally	350mg	BID	90	04/03/2019	04/10/2019	Andrew
Paracetamol	Orally	500mg	BID	90	05/30/2019	06/10/2019	James
Azithromycin	Orally	100mg	BID	90	06/06/2019	07/10/2019	Andreson
Lipitor	Orally	500mg	Daily	60	04/03/2019	04/20/2019	James
Amoxicillin	Orally	500mg	daily	10	09/03/2019	09/10/2019	Andrew

Save Insert Record

The nurse notes several discrepancies:



Name	Route	Dosage	Frequency	Days Supply	Script Date	Trans Date	Prescriber	Comment
Metformin	Orally	500mg	BID	90	02/03/2019	02/10/2019	Andreson	taking daily
Amlodipine	Orally	350mg	BID	90	04/03/2019	04/10/2019	Andrew	
Paracetamol	Orally	500mg	BID	90	05/30/2019	06/10/2019	James	not taking
Azithromycin	Orally	100mg	BID	90	06/06/2019	07/10/2019	Andreson	
Lipitor	Orally	500mg	Daily	60	04/03/2019	04/20/2019	James	
Amoxicillin	Orally	500mg	daily	10	09/03/2019	09/10/2019	Andrew	

Send to Physician

Paracetamol (acetaminophen) is an over the counter medication, which the patient is no longer taking. In addition to the two noted above, two others exist. Current state is that the nurse writes up a report to the supervising physician and later faxes it to the physician's office.

The group envisions that the information might be transmitted from the home for more immediate resolution than possible from a faxed report, for example through a secured electronic portal.

The nurse creates a communication back to the patient's physician who is supervising the home visit. There are three medications with conflicts. The report might look as follows:

Patient Name: **Millie Bryant**
DOB: **10/28/1940**

DISCREPANCY REPORT
Report Date 3/15/2019
By Testy Nurse
Agency VNA CHCH

Status	Name	Route	Frequency	Days Supply	Effective Date	Prescriber	Note
Prescribed	Metformin 500 mg	PO	BID	90	3/5/2019	Anderson	Taking daily
Unfilled	Bactrim DS	PO	BID	3	1/14/2019	Merrick	
Reported	Symbicort 160-4.5	inhalation	BID	30	3/1/2019	Star	Found in home

Comments on the form allows the home health nurse to communicate adherence issues related to individual medications:

- The first is that Metformin is 500 mg twice a day (BID) but the patient is actually only taking one tablet a day. The confusion exists because the patient had been switched during hospitalization from 850 mg once a day, to increase to a split dose totaling 1,000 mg each day. So the patient is taking only one half of the daily dose.
- The second is the patient has not yet filled a prescription for Bactrim DS twice a day (BID).
- The third is the patient reports using a Symbicort inhaler twice a day, and in fact has that medication in the home.

As the nurse prepares a communication to the physician that the patient is on Symbicort, the nurse can add it.

Name	Route	Dosage	Frequency	Days Supply	Script Date	Trans Date	Prescriber
Metformin	Orally	500mg	BID	90	02/03/2019	02/10/2019	Andreson
Amlodipine	Orally	350mg	BID	90	04/03/2019	04/10/2019	Andrew
Paracetamol	Orally	500mg	BID	90	05/30/2019	06/10/2019	James
Azithromycin	Orally	100mg	BID	90	06/06/2019	07/10/2019	Andreson
Lipitor	Orally	500mg	Daily	60	04/03/2019	04/20/2019	James
Amoxicillin	Orally	500mg	daily	10	09/03/2019	09/10/2019	Andrew
✓ Symbicort	inhalation	160/4.5 mcg	daily	90	1/15/19	4/30	jake

The above screenshot confirms home care nurse successfully adds Symbicort.

This group's solution would also enable the nurse to send the message electronically (rather than a faxed sheet of paper today). The solution would create a transaction ledger. The transaction ledger helps healthcare providers see where medication changes and discrepancies may have occurred.

The prescriber can acknowledge receipt of the report and communicate back to the home care nurse through the "in box/bin" in their EHR. The prescriber can then reach out to the patient to clarify or resolve the discrepancy.

The prescriber responds back electronically with a digital signature verifying receipt of the information and the updates. This process fulfills the home health organization's notification requirements.

The new interface creates an ongoing medication history report as these electronic interchanges (e.g. *SureScripts* ePrescribing or other vendor data) occur between the physician and home care nurse:

Patient Name: Millie Bryant
DOB: 10/28/1940

Medication Ledger
Report Date 3/15/2019

Domain		Status	Name	Route	Frequency	Days Supply	Effective Date	Date Asserted	Prescriber	informationSource	Note
Request	Script	active	Metformin 850 mg	PO	daily	30	2/1/2019	2/1/2019	Anderson	Anderson	
Dispense	Fill	active	Metformin 850 mg	PO	daily	30	2/1/2019	2/3/2019	Anderson	CVS	
Dispense	Fill	active	Metformin 850 mg	PO	daily	30	2/1/2019	3/3/2019	Anderson	CVS	
Request	Modify	active	Metformin 500 mg	PO	BID	90	3/5/2019	3/5/2019	Anderson	Anderson	
Dispense	Fill	active	Metformin 500 mg	PO	BID	90	3/5/2019	3/7/2019	Anderson	CVS	
Statement	Reconcile OK	active	Metformin 500 mg	PO	BID	90	3/5/2019	3/8/2019	Anderson	VNA CHC	
Statement	Reconcile Accept	active	Metformin 500 mg	PO	BID	90	3/5/2019	3/8/2019	Anderson	Anderson	
Statement	Discrepancy Rpt	active	Metformin 500 mg	PO	BID	90	3/5/2019	3/15/2019	Anderson	VNA CHC	Taking Daily
Statement	Discrepancy Ack	active	Metformin 500 mg	PO	BID	90	3/5/2019	3/16/2019	Anderson	Anderson	Followup
Request	Script	active	Lisinopril 30 mg	PO	daily	90	2/1/2019	2/1/2019	Anderson	Anderson	
Dispense	Fill	active	Lisinopril 30 mg	PO	daily	90	2/1/2019	2/1/2019	Anderson	CVS	
Request	Script	unfilled	Bactrim DS	PO	BID	3	1/14/2019	1/14/2019	Merrick	Merrick	
Statement	Discrepancy	active	Symbicort 160-4.5	inh.	BID	30	3/1/2019	3/15/2019	Star	VNACHC	

In summary, this transaction log helps the physician and nurse to see how the medication errors and changes occur. The physician is able to interact with the report and communicate back to the home care nurse through the "in-box / in-bin" of the electronic health record (EHR). Physician can approve, disapprove, or modify the "message".

Note: One participant suggested to include the dispensing pharmacy on the transaction log. Another suggested the patient / caregiver should also have a mechanism to contribute to the transaction ledger.

Additional notes on Skilled Nursing and Home Care not part of the group's presentation:

- We need to better define the issues of Prescription Stewardship
    - Who owns / manages the prescriptions in each scenario?
    - Who is authorized to make changes?
    - Who is responsible for reconciling the medications?
    - How is this responsibility handed off across various transitions of care?

- Home Health EHR - The adoption rate in home health and skilled nursing facilitates tends to be low so paper records are kept instead.
- There need to be better ways of identifying and flagging discrepancies in the EHR to conduct medication reconciliation. Discrepancies are often noted by healthcare providers and need to be validated by someone with prescriptive authority.
- Claims dispensing history could help identify adherence issues.

Key Insights for this Group:

- There are four separate FHIR domains and this group's solution uses three of them:
  - **Request** (The prescription)
  - **Dispense** (Pharmacy action)
  - **Statement** (Communications)
  - **Administration** (which is more inpatient and nursing home focused)

- The fields across domains are not always consistent. The "request" domain has an "intent" field, but the "statement" domain does not. This complicates the communication between nurse and prescriber.

- All fields should be available across the different domains.

- The current paradigm is only to have an audit trail that the prescriber received the message. Currently, there is technical acknowledgement (ACK) – ability for person receiving message from to acknowledge and accept or not accept. This group felt that the prescriber must be able to also acknowledge and either validate or update the medication plan through the interaction between prescriber and home care nurse.

Inpatient Venue

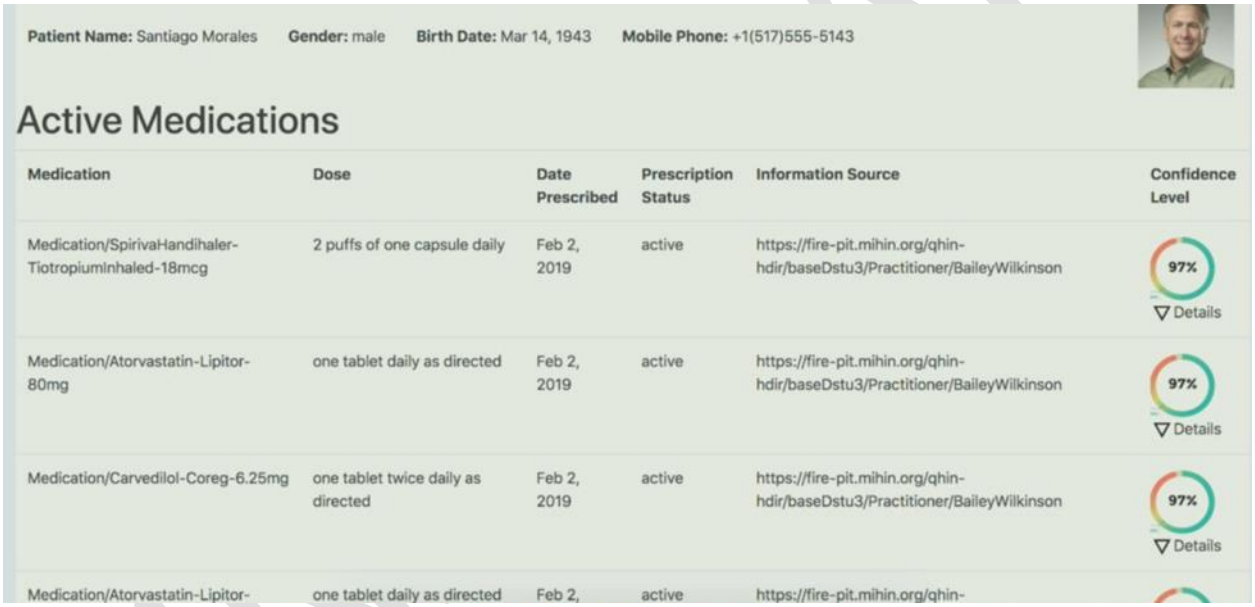
Participants: Ankur Bhargava, Madalene Crow, Anne VanHaaren, Teresa Allen, Scott Bonczek, Jesse Olsson, Madalene Crow, Linh Ho, Natasha Lunin, Pat Prendergast, Vinod Durairaj, Preit Gupta and Brandon Elliott (facilitator),

Focus: The new patient that presents to the emergency department acutely. Need a complete and accurate medication list to make safe, efficient and effective decisions.

Findings and Recommendations:

Current state is that there is no one single medication list that gives the care team complete medication information necessary to make informed decisions.

A provider and clinician-facing application, **ARM-MD** (Automated Reconciliation of Medications for Medical Decision-making).



Features include:

- A patient photo for associating the right patient to the right record as well as demographics including date of birth and phone number
- Standard nomenclature with both brand and generic names of medications helps to standardize the medication list across all platforms.
- Quick snapshot with most important information that is with the rest of the information designed as “There when you need it” to allow access to more specific data, such as:
    - Medication Information
        - Start/End date of medication
        - Capturing medication administration history over specified period (3 months, 6 months, 12 months, etc.)
        - Route

        - Indication
        - Frequency
    - Refill history
        - Refill/fill amount
        - Filled or not filled
        - Date last filled
        - Dispensed
        - Prescriber
    - Last dose
        - Reason if no longer taking medication
    - Modifications
    - Data source of medication information
        - Patient, caregiver, family member, etc.
    - Order Level Special instructions
        - "Prefers Liquid if possible"
        - "Need Teva Brand"
        - Etc.
    - Confidence level leveraging comprehensive algorithm
        - Details of the Confidence Level would be available for drill down (i.e. an ability to access more specific information as desired.).
            - Provenance of information
                - Patient confidence level
                - Provider confidence level
                - Staff recording medication history confidence level
            - Refill History
            - Adherence Instructions/Expectations
            - Number of Matching External Sources, Etc.
- Last date of medication reconciliation and who performed it
    - Relevant labs to meds - Utilize LOINC to RXNORM Code Matching
        - Prothrombin Time/INR when on warfarin
        - Potassium on ACE Inhibitors or ARBs
        - Phenytoin Levels on Phenytoin
- Ability to sort/filter
    - Alphabetical
    - Indication
    - Drug class
    - Prescription, OTC, Herbal supplement
    - Etc.
- Patient Level Special Comments
    - Taking differently than as prescribed
    - Difficulty swallowing
    - Etc.

- Recently discontinued medications
- Scratch list of low-confidence meds (i.e. "Flagged meds" that the patient may or may-not be taking).

Used FHIR resources to create dynamic dashboard. FHIR resources of interest to leverage: *Medication*, *MedicationStatement*, *MedicationRequest*, *MedicationDispense* and *Medication Administer*.

Claims data for prescription refills can help supplement and support the confidence algorithm.

Key Insights for this Group:

FHIR resources can create a unique physician / clinician view for faster and more accurate **medical decision-making** than is available now.

- The dashboard must include a quick summary (snapshot) of current medication information
- Machine learning algorithms should be leveraged to create a confidence level/indicator using many disparate information systems
- Snapshot will allow for a drill down of detailed information pertaining to medication, prescriber, refill histories, comments, confidence levels, and past medication history
- Must better harmonize the various FHIR resources and their unique attributes

Ambulatory Primary Care Physician (PCP) Venue

Participants: Liz Turi, Anne Van Haaren, Julian Nieves, Abhishek Gorla, Christina Polomoff, Lauren Kosowski, Lauren Rodriguez, Stacy Ward-Charlerie, Susan Israel, Andrew Cadorette, Aya Salmeh, Dan Russell, Zeeshan Ahmed, Gregory Anderson and Phil Smith (facilitator),

The Ambulatory / PCP Group decided to approach the problem with the assumption that "a centralized medication database accessible through the HIE" is a needed foundation for addressing the medication reconciliation failings. This was reflective in the following statements that the current state is inherently flawed – and as they labelled, "reckless".

Focus: Obtaining a Single Source of Truth to solve the problem of "Suboptimal Medication Management Processes" that can lead to poor patient outcomes in the ambulatory setting.

Findings and Recommendations:

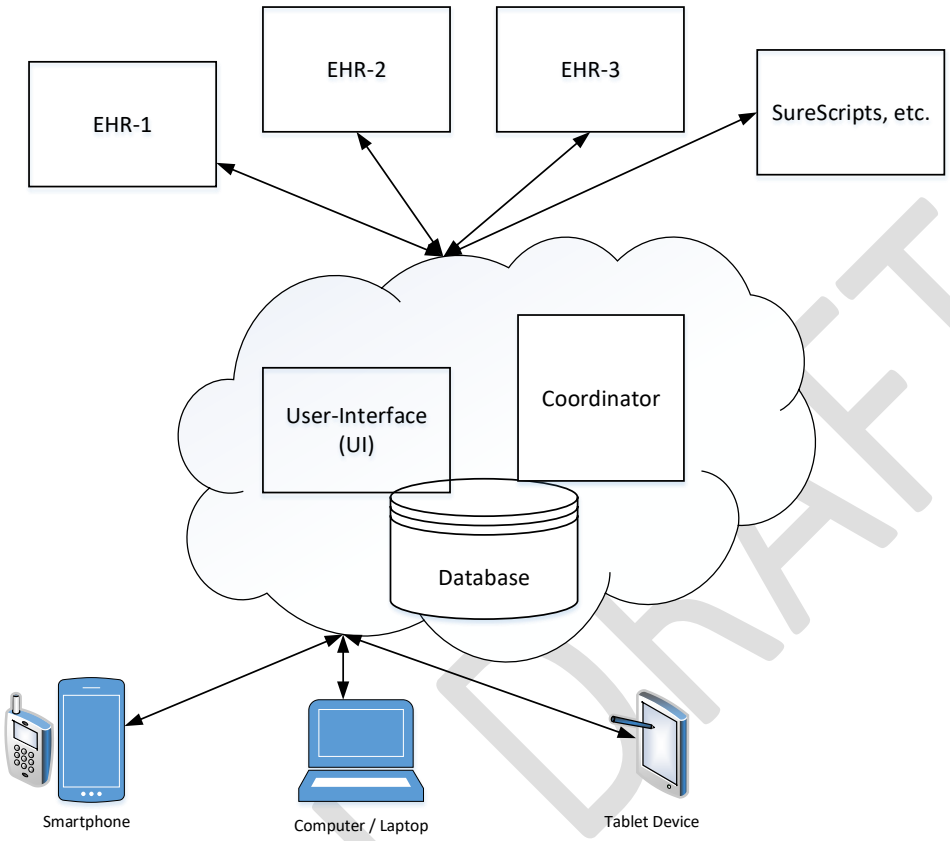
Current Systems result in:

- Fragmentation of data
- Silo'd, inefficient workflow, (because no central source)
- Uninformed decision-making (liability),
- All leading to preventable adverse drug events (ADEs) and unnecessary costs.

The Current State of Med Rec is "RECKLESS!"

Technical Design: Create a Single Source of Truth: Medication Record in the Cloud (HIE)

Ambulatory / PCP Workgroup Overall Technical Model



The diagram above demonstrates the structure of the proposed solution. A coordinator within the HIE would manage the interactions with the various electronic health records, pharmacies, pharmacy benefits managers, (collectively known as clinical information systems) and other reliable sources to aggregate, update and maintain a centralized medication database. This new database would allow additional fields to provide a "richer" experience for medication management as adherence, patient feedback and clinical indication(s) would be housed in a single source of truth.

The following requirements would fill the gaps noted of the current med rec process:

Clinical Business Requirements:

- Ability for patient to report on adherence (e.g. "taking", "not taking", "taking, but not as prescribed", "completed course", etc.) and allow provider to "Validate" those adherence comments at next visit.
- Ability for patient to document side effects, and allow providers to validate as well as update allergy – side effects tables.
- Ability to track communication modifications and discontinuation of any existing medications. Today, these occur at the single EHR and single pharmacy level and does not

provide any updates to other providers' records or secondary pharmacies, such as mail order.

  - (Currently ***CancelRx*** message only goes from cancelling provider to dispensing pharmacy. This data base would send the cancellations and modifications to any future EHR queries to the cloud database.

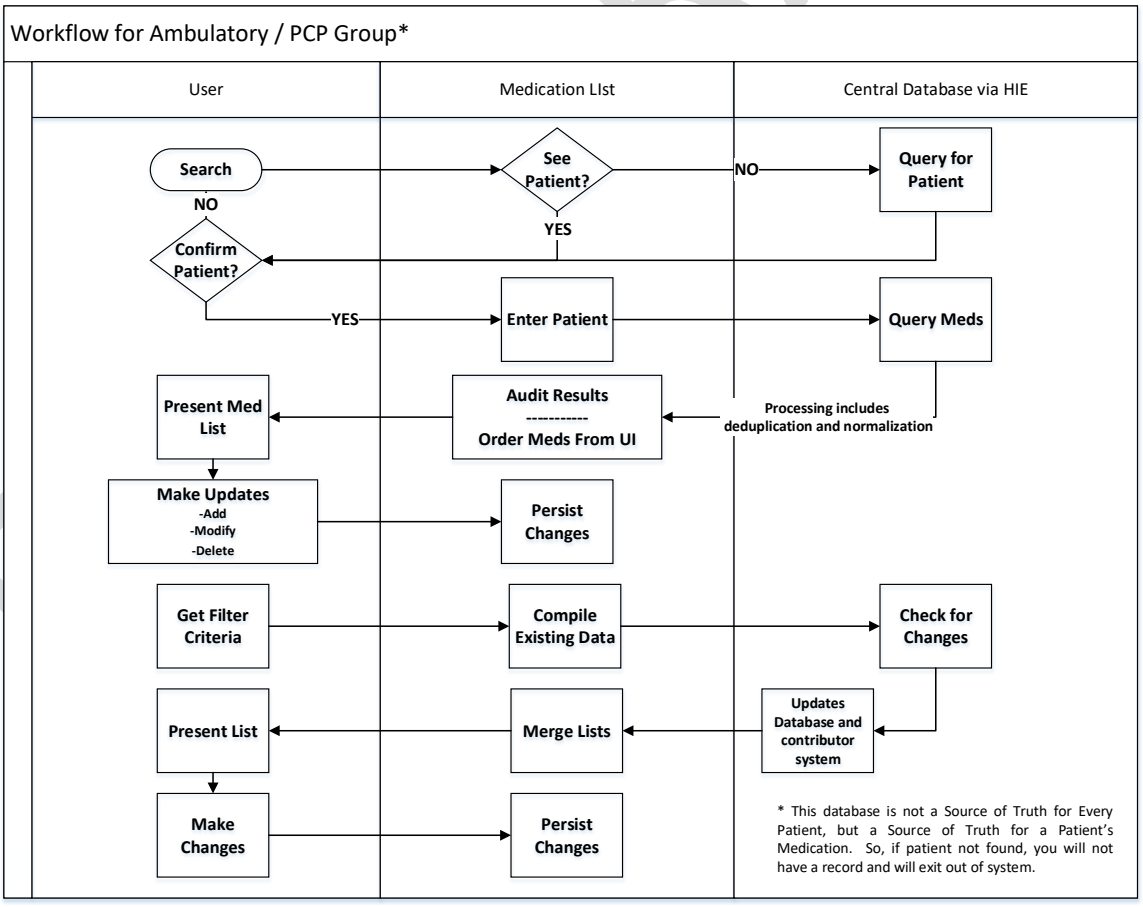
- Ability for patient to add and provider to validate over-the-counter (OTCs) and supplements. These are often missed, or not kept up-to-date since context of OTC meds is different for various users in their decision-making process.
- Ability to accept and persist an Indication(s) for each medication (drop down by medication and off-label comments if not on list.). Indications represent the "reason for prescribing the medication." A SureScripts representative at the Hackathon reports about 40% of meds have an indication at some point. However, this indication is updated or even viewable in the various clinical information systems. Often patients do not see this information either and may not know the indication for every medication they take. Thus decision-making occurs without this information.
- Ability for Subspecialists to "validate" their prescribed specialty medications and have the Primary Care Physicians focus on full reconciliation. As pharmaceuticals have evolved into highly specialized treatments such as immune system modification for oncology (cancer) and rheumatological conditions, the complexity of side effects and drug-drug interactions has increased. This makes it difficult to manage outside of the expertise of the specialists who prescribe them. Even common diseases like diabetes now have over eight classes of medications that make it difficult for subspecialists (e.g. an ophthalmologist or orthopedic surgeon) to properly reconcile each medication. The current med rec process is for every physician and provider to perform reconciliation of all medications, despite the difficulty in determining a true and accurate list (meds, doses and their instructions) from which to work. It would be akin to insisting that a plumber sign off on the electrical system of a new home. Yet, we are dealing with a process that has significant risk for each patient.
  - This puts medication management decisions squarely in the court of the specialist most qualified to manage specialty medications.
- Central database in the cloud (hosted by HIE or could be modified from the PDMP) that initially serves as the coordinator across multiple platforms. It is important to note that the PDMP has already been established to help monitor prescriptions of controlled substances. However there are issues with the current design. First, methadone therapy, a long-acting opioid used in the treatment of opioid abuse is not reported to the PDMP. Second, physicians in their first year of training do not have access. And most important, the PDMP is a separate database that is not fully integrated into the EHR workflow from which medical decision-making and electronic prescribing occurs.
  - Future state might be a service that the EHRs would access rather than having their own medication list silo in their system. This would prevent unnecessary duplication which create silos of conflicting medication lists, and allow full integration into the EHR workflow.
  - So our initial vision is a pull of data using FHIR. Future state would be a push of data. (Pull means that the user would request the information from the HIE within the workflow. Ultimately, as the HIE database becomes a service, the information

would automatically be included in the EHR workflow – i.e. a "push" – without the user having to request the information.

- Ability to capture a "current list of medications" that persists as a snapshot at decision making points in care (e.g. at handoffs, office visits, etc.). Current HIE decision is to compile all the available lists, leading to duplications, omissions, and conflicting information.
- Filters to allow multiple views and sorting of the current and historical medications. Sorting and filtering of longer lists allow the users to better understand the entire context of all medications on a patient list and to address specific clinical decision-making questions, such as "What are all the medications the patient is current taking for their high blood pressure / hypertension?"

Workflow: Envisioning a solution based on the requirements, the group devised an initial workflow to query this central medication database through a user interface that could be incorporate into an EHR as well as into a patient-facing application. Not every patient would initially have a record in the HIE central medication database. There would have to be matching of available attributes to confirm the right record is connected to the right patient. The diagram below shows the process flow:

Workflow:



Each role would interact with this database through the user interface with various "permissions" appropriate to their role. Below is a partial list. It would need to be expanded to other healthcare and administrative roles based on appropriate needs. Note that the patient (parent/guardian) would have the ability to view their medication list and report side effects (e.g. "This upsets my stomach."), changes in how they take them (e.g. "I'm only taking it once a day, not twice," or "I cannot afford to get this filled.") and additions/discontinuation of OTC medications and supplements.

Roles:

- Provider: ADD, VIEW, MODIFY/CHANGE, CANCEL, Validate their own meds as well as perform full reconciliation.
- Patient: VIEW, ADD (OTC, Supplement, new Rx, Comments – All pending Provider validation)
    - Comments include side effects, adherence (Not taking, not as prescribed, discontinued, taking)
- Pharmacist: ADD, VIEW, MODIFY/CHANGE, CANCEL, receive Cancel notifications (CancelRx)
- Nurse/Office Medical Asst.: ADD Historical Meds, VIEW, MODIFY/CHANGE, CANCEL

User Interface:

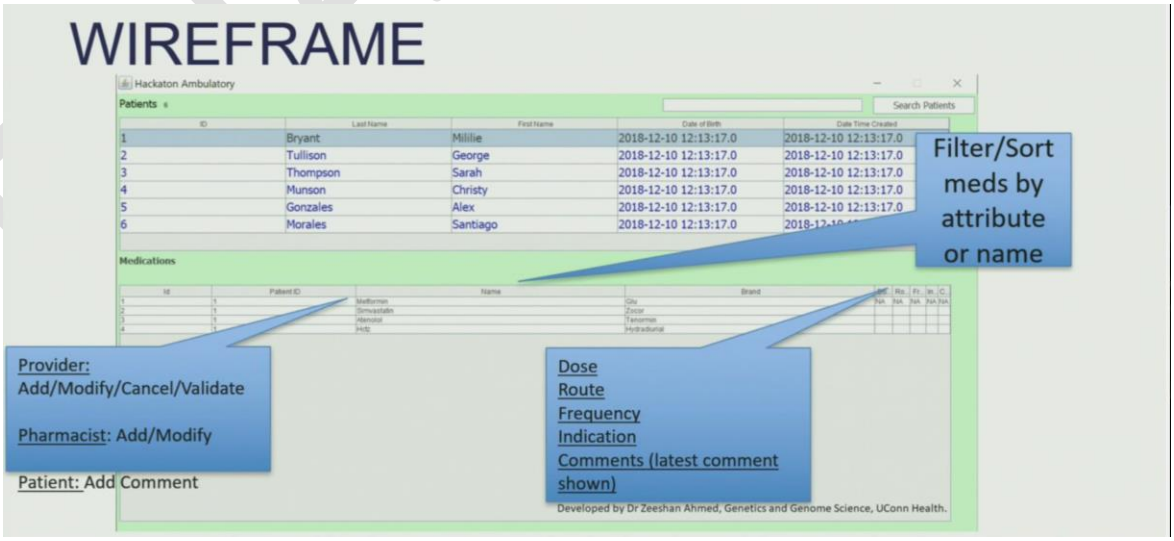
The Group designed a user interface "wireframe" to show how medications information might be enhanced. For example, both the generic and prescribed Trade Name of each medication would be displayed (currently one or the other is displayed, making the identification of duplicates more difficult, especially for the patient.).

From this screen, the clinical team or patient could add comments and view comments. The action to the right allows validation, modifications and discontinuation. A provider / pharmacist can add a new patient or a new prescriptions. Patients can add new OTCs and supplements which will require validation by a licensed provider.

Generic	Brand	Dose	Route	Frequency	Indication	Comments	Action
Atenolol	Tenormin	50 mg	oral	once daily	blood pressure	Clinical Team	Modify
						Patient Comments	Discontinue
							No Change
Atorvastatin	Lipitor	10 mg	oral	once daily	cholesterol	Clinical Team	Modify
						Patient Comments	Discontinue
							No Change
Fish Oil	omega 3	1200 mg	oral	twice daily	cholesterol	Clinical Team	Modify
						Patient Comments	Discontinue
							No Change
Warfarin	Coumadin	5 mg	oral	once daily	atrial fibrillation	INR - 1.1	Modify
						Patient Comments	Discontinue
							No Change
Warfarin	Coumadin	7.5 mg	oral	once daily	atrial fibrillation	Increase due to low INR.	Modify
						Patient Comments	Discontinue
							No Change
						Clinical Team	Modify
						Patient Comments	Discontinue
							No Change
						ADD Patient	**Prescribe** R_x

Confidence will be improved by the system looking at whether or not the patient is filling prescriptions. Because this solution is in the cloud, each provider will be informed from every prior encounter. Indications would only need to be entered once when initially prescribed or when indication changes.

Initial wireframe of the back end would not expose a patient until called by a patient locator event. It is important to protect the privacy and security of each individual at the HIE level. HIE governance will handle consent issues.



Next Steps:

- An electronic master patient index (EMPI or stack ID*) critical to make this work across Connecticut. This would be a requirement for the HIE as well.
- Add CDS –Hooks on med list for a ***CancelRx*** trigger to send notification to the pharmacy, PBMs, etc. which have an active relationship with the patient.
- SMART on FHIR enable UI for integration into EMR workflow. As noted above, providers and pharmacists need to be able to access the information from within the workflow of their clinical systems and not have to access a separate system and search for the patient each time. A patient facing application would be developed and is addressed in the Patient Care group above.
- RxNorm for single source of truth normalization. Free-text entry of medications would limit the ability for clinical decision support (CDS) rules to address duplications, interactions, and validations. RxNorm provides better specificity than the National Drug Code (NDC, which is managed by the Food and Drug Administration (FDA) and are reused at times.).

Additional comments:

- Validation is a "partnership" between the patient and the prescriber to ensure effectiveness, efficacy and adherence.
- Privacy, consent and security discussions would need to occur at the State level to proceed with this model.
- The State of Connecticut stands to lead the country in piloting a solution that could become a *de facto* standard to solve not only medication management but interoperability issues.
- Blockchain technologies may be useful in the future.

Desired Requirements:

- Ability to view latest reconciled list. This provides a "point in time record used in decision-making." It is important for chart reviews and medico-legal reasons.
- Continuous available medication service that everyone has access to in their workflow
    - E-prescribing (the transmission of new prescriptions, cancellations and modifications between providers, pharmacies and PBMs)
    - Dispense records (which indicates what the patient received, quantities, and who dispensed)
    - Patient acquired meds (OTCs + Rx). Patients sometimes acquire prescriptions medications outside of normal e-Prescribing and should be empowered and able to document these updates if they desire.
    - View every reconciled event. Beyond the reasons above for seeing the last reconciled event, it may be helpful for a provider to review past reconciliation to reconstruction decision-making by themselves or others on a temporal (i.e. over time) basis.
    - Clinical Comments (which are currently not included or shared beyond the original clinical system in which it is entered).
        - Patient view/access (can comment but not edit)
            - Comments – patient's experience / feedback
    - Sample meds dispensed as a trial by a physician are often not captured nor shared.
    - Validation steps / verification to allow sub-specialists to contribute to their personally prescribed medications (such as an ophthalmologist who is best able to manage glaucoma medications for both adherence, appropriateness and effectiveness.).

- Medication indications (categorize by condition) visible at each refill. Throughout the hackathon it was noted how useful it would be for patient, pharmacists and providers to see the current indication for each chronic medication. This would be most acceptable if it could be entered once upon initial prescribing and persist until changed. A central database would permit this and avoid indications that are "guessed" by other clinicians taking a history and not really knowing the original intent for each medication.
- Inpatient meds +/- includes filter (could be information overload but also helpful to know how patient was treated). As this central medication database could incorporate inpatient medications, they are not always pertinent to long-term medication management. For example, the administration of IV potassium chloride would be a medication administration, but probably not useful at other times. So filters would be necessary to allow viewing as needed, but suppress that information for the "first look" at a patient's medications when ambulatory.
- Med rec validation is a concept supported by the group. Politically, The Centers for Medicare and Medicaid (CMS) and The Joint Commission (TJC) have recommended all doctors should reconcile all meds at transitions of care, regardless of the unintended consequences of reconciling medications without proper expertise or context in the current process.
- Audit of reasons for changes (e.g. not effective). Currently we have to "reinvent" the wheel each time since we have no persistent way to understand why medications have been changed, discontinued or have poor adherence in the past. We need longitudinal comments that will persist as part of the medication history. Since these comments would be "near real time" (i.e. as they occur) they would be more accurate than expecting patients (or others) to recall why changes occurred in the remote past.
- Ability to flag allergy related to medication and add comment for adverse reaction. Many nuisance alerts occur because EMRs often flag side effects and other non-allergies as allergies in their system. Some of this occurs because the patient themselves may call a side effect "an allergy" (e.g. "I'm allergic to codeine" when the really is that "Codeine makes me vomit." This is not an allergy, but a side effect, and should not alert as an allergy for a post-op dose of morphine in the post-anesthesia care unit ("the recovery room") and interfere with acute pain management when the patient is unable to explain the type of reaction reported.

The group did not address the following Parking Lot items, which are being addressed by the Consent and Privacy subcommittee of the MRP Work Group:

- Consent
- Privacy
- Ethics
- HIPAA special considerations

Key Insights for this Group:

- Starting with an end goal of creating a single source of truth medication database for the State of Connecticut, we would first create a database in the cloud that would coordinate compilation and transformation of current medication lists from all contributor systems available with patient data.
- Allowing a single place to manage transactions (add, modify, cancel, comment, validate and reconcile would create safety and efficiencies for medication management and reduce errors.
- The current paradigm of reconciliation by every licensed physician would be replaced by the ability for ongoing validation of specialty meds by the prescribers who are most knowledgeable and managing the ongoing medication. Validation should have a minimum frequency (i.e. interval) that the system should warn when validation is overdue and trigger the physician using the system to seek updates of the validation of these "overdue" meds.
- This group also echoed the need for "Indication" on each medication to drive improved care and more CDS, filtering, and AI opportunities. Especially if it only is entered at time of initial prescription and is only touched if indication changed.
- Long term solution would be to create this database as a SERVICE that the EMR's would call rather than duplicate medication list management in the EMR but make it integrated into the EHR workflow.

Hackathon Closing Thoughts

Each of the four team leaders was asked to provide three words that summed up their take-a-ways. Below is the list:

- Interoperability across sources
- Accessible (2)
- Timely
- Simple
- Accountability
- Confidence (2)
- Indication (2)
- Relevance

Indications for a prescription:

Throughout the Hackathon, one topic that persisted as a central theme of discussions was 'whether chronic medications should include an "indication" that would be visible at the point of prescribing (provider), dispensing (pharmacist), administration (nurse or patient/caregiver/parent) and reconciliation'. An indication could be a "reason", a diagnosis (ICD-10CM code), a problem (SNOMED-CT) or as result of a procedure or event.

The groups discussed that there are various situations that currently impact what might be a "reason" on a prescription:

- An EHR often allows a diagnosis code (which in the U.S. is codified using a system known as ICD-10 CM) for that encounter to be selected during the medication ordering (inpatient) and prescribing (discharge or outpatient) process.
- The EHR also includes a Problem List. Problems in the U.S. are most-often codified using a system known as SNOMED-CT). While a problem is a longitudinal concept (i.e. independent of the current encounter of care), the diagnosis is an episodic concept associated for billing purposes to the current encounter.
    - It is important to note that a condition such as diabetes mellitus may be both a problem and a diagnosis during a given encounter, while an acute issue (such as strep throat) may be a diagnosis only.
- A specific field for "indication" or "reason" for a prescription may be codified or free text.
- Any one concept may not successfully communicate the precise reason a medication has been prescribed. For example, some medications, such as ACE inhibitors are indicated for hypertension (high blood pressure) but may be specifically prescribed due to a finding of diabetic proteinuria (a complication of high protein in the urine which occurs with diabetes impacting the kidney function.). Such nuances are often not well communicated among physician, pharmacist and patient when one system for indicating "reason for the prescription" is selected or even mandated over another.

The National Council for Prescription Drug Programs (NCPDP) has provided that the Diagnostic codes (ICD-10CM) and SNOMED-CT (used in Problem Lists and for Conditions) can be used for indications during electronic prescribing. Both the SCRIPT v10.6 (current) and v2017071 (effective 1/1/2020 but present in some systems now) standards include a field for indication. Pharmacists report that they don't receive a clear indication on most medications. Indication may be difficult to add in some EHRs.

In some cases, the pharmacist receives a diagnosis code from the doctor, but only because the insurance company demands a diagnosis for reimbursement. The pharmacist may find that the diagnosis code is either too generic or seems to be unrelated to the medication being prescribed. This may potentially lead to pharmacists disregarding this coding (since it is used for reimbursement and not treatment) or require additional communications between the prescriber and the pharmacist to clarify the true diagnosis of the patient.

In other cases, the pharmacist may benefit from knowledge of specific laboratory results that support informed, medication management (such as the renal function of a patient). In the hospital setting, the pharmacist often has access to the entire EHR. They can determine indication for use and assess laboratory data to assure appropriateness of prescribing. Community and long-term care pharmacists routinely lack access to such information. They are left to make informed decisions about diagnoses. Identifying and accessing appropriate laboratory data is often restricted to employees only.

There was a concern expressed by some members against including indication due to patient privacy. Currently labs and often imaging charges need an indication (or diagnosis) in order to get paid by insurance companies. Connecticut is now proposing legislation to require indication for opioids. Some physicians are pushing back due to an anticipated increase in the work overload and concerns about patient privacy.

One group presentation highlighted that making the linked-indication for a drug prescription available would increase patient awareness and engagement in the medication adherence process. For example, they may be able to identify two different hypertension medications prescribed by two different providers and address it before potential complications arise.

Several participants noted the highest value for an indication occurs when one prescribes chronic and high risk meds as opposed to short-courses of episodic meds (such as for an ear infection). [C]

There are different script standards for transmission of prescriptions. In 2020, the EHRs must be certified to send the new message types (NCPDP v2017071). In this version, there are new data fields added. As noted above, the indication has been there for some time. According to a representative of SureScripts, about 40% of meds today have an indication. ICD-10 does not always align as well to the indication, but both diagnosis and indication are available.

Additional Considerations:

It was mentioned by participants that the Department of Consumer Protection (DCP) has been mentioned as a potential source of a medication repository by adding non-controlled drugs to the

[C] One major health system in Connecticut requires indications on all outpatient prescriptions (excluding Emergency Departments). They report minimal issues and no patient privacy complaints.

state's Prescription Drug Monitoring Program (PDMP). This is currently not under active consideration by our state given the legislative, financial and policy considerations that are implied.

The Pharmacy HIT collaborative could serve as a resource in clarifying messaging standards and promoting the uniform use of NCPDP standards. www.pharmacyhit.org. The Pharmacist Services Technical Advisory Coalition PSTAC also plays a role in this space to help support billing for pharmacists' professional services..

Medication Management Projects in Other States:

Participants reported that:

- Nebraska is adding all meds to their PDMP which is housed within their HIE.
- Maryland PDMP is operated by Maryland CRISP[19], their HIE.
- North Carolina is considering adding non-controlled meds to their PDMP.

There was no definitive knowledge among participants on how inclusion of non-controlled substances in the PDMP or within an HIE, is impacting medication reconciliation but this deserves further investigation and consideration.

It was also mentioned that there are issues with funding because the PDMP Is only funded for controlled substances. To expand the PDMP to include all medications in CT, funding would need to be secured.

In order to positively affect prescribing of opioids and other controlled substances it is important that the PDMP data be effectively integrated into the workflow of clinicians within the EHRs. When considering whether to add non-controlled substances, it was suggested that this might increase reporting requirements from pharmacies ten-fold and there would be the additional challenges in parsing out reporting for the various classes of agents from controlled and non-controlled requirements. SureScripts states that integration would require the PDMP to standardize message type to the same NCPDP dispense message used for ePrescribing, which is currently not the case.

Privacy and Consent:

The MRP Workgroup has a policy subcommittee currently considering consent, privacy and security, as well as the HIT Advisory Council for the state, which has a separate consent policy design group. Its work and recommendations will be critical to transforming medication management in Connecticut. It will be important to give individual patients a voice in how their information is shared in an effort to help ensure the best possible medical care in a way that is consistent with their values and needs. It is anticipated that as we free up more information to be transported securely and in an interoperable format within CT that they will see substantial benefits in their personal ability to actively contribute to their overall health.

Education of Stakeholders is Essential:

Overall, there is great Importance that all stakeholders in Connecticut are educated on the value of transforming electronic medication management to reduce cost and improve the safety and care of patients in CT, as well as reduce provider burden of manual reconciliation of medications. An evaluation of the best education and outreach strategy for medication management should be considered as part of the MRP Workgroup final recommendations.

Summary

The Medication Reconciliation Hackathon brought together SMEs for education and collaboration on improving medication management for the State of Connecticut. There was general agreement that the current drug prescription process often impedes our ability to determine a current and accurate list of medications for each patient.

Common challenges include:

- Despite widespread adoption of medication reconciliation at the time of transitions of care, there are still large number of medication errors impacting patient's outcomes. Not having a single source of medication lists seems an inherent flaw in the process.
- Compiling multiple medication lists from numerous sources often creates long lists of duplicates and inaccurate information. These lists often lack consistent data structure and integrity as well as no clear "reason or indication for each prescription, which makes it difficult to electronically filter or sort (i.e. "post-processing") these lists into meaningful categories. Physicians and pharmacists report a significant cognitive load in trying to compile and manage these lists for medical decision-making and medication management, especially when indication / reason is unknown or unclear.
- As noted above, the majority of chronic medications do not include an "indication" (or reason) that the prescriber intended for the medication. While this information is available in the current and future e-Prescription transmission standards, it is often not visible to the patient or across different pharmacy and other clinical information systems. Having an indication that everyone with access to the medication list could view, would be helpful for patients, pharmacists and providers for management and decision-making and may impact adherence as well.
- Currently, the prescriber may indicate one or more "indications" or diagnoses for a medication. However, only the first indication is transmitted to the pharmacy. The patient may not be able to see the indication on the prescription bottle.
- The ***CancelRx*** communication is an underutilized tool that electronically transmits cancellation of a prescription from physician to a specific pharmacy. By current design, the CancelRx message is not communicated to other physicians or pharmacies (such as mail order pharmacies) involved with that patient's care. In January 2020, all certified EHRs will need to adopt ***CancelRx*** capabilities.
- Physicians are currently expected to perform medication reconciliation on all medications at every transition of care, even if they are unfamiliar with specific medications, clinical effectiveness or reason they were prescribed (if prescribed by a different doctor). For example, a primary care doctor currently may reconcile a list of therapeutic eye medications for glaucoma without being able to determine the appropriateness or effectiveness of those medications. Physicians similarly report knowledge issues with bio-active medications which oncologists (cancer specialists) or rheumatologists may prescribe for the patient. (Today it is a manual process for the patient or another caregiver to contact the prescriber for clarification.)

- Patient-reported information is not consistently documented across clinical information platforms nor persistent (i.e. discoverable by other caregivers on different EHRs or platforms) in the current medication reconciliation process. As nurses, pharmacists and physicians gather patient information on medication adherence or other issues, they may document this information in their clinical or pharmacy information system. However, this information may not be easily sharable to other members of the patient's healthcare team in the absence of a health information exchange.
- Some over-the-counter (OTC) medications and supplements may lack specific codes (e.g. RxNorm) for interoperability. Despite this, these drugs may interact with the patients' current medications. This does not provide a vital link among physicians and pharmacist and impacts the efficiency, effectiveness and safety of the medication reconciliation process.

The Hackathon demonstrated that current technology standards exists, such as the FHIR RESTful API and RxNorm that could improve the acquisition of a medication list and permit new user interfaces) and features (e.g. specialty applications or features in a patient portal that could empower the patient (or guardian/parent) to report useful information (e.g. side effects, adherence, and undocumented OTC meds, prescriptions and supplements) and improve the longitudinal sharing of this information across platforms and venues of care. Prescribers including "indications" would improve medical-decision making, management and potentially adherence.

A centralized medication database for the state-wide prescription data could potentially evolve into a single source of truth for medication reconciliation. If successful, this could eventually become a service that would replace the proprietary medication lists in each clinical and administrative database.

Such a centralized model would empower both patients, physicians and pharmacists. It would provide a foundation for allowing improved confidence in the list of medications and enhanced clinical decision support (CDS) for both decision-making and adherence monitoring,

Access, consent, privacy and security are four important areas of specific focus of the MRP Work Group that are under discussion in a separate regulatory subcommittee and a Consent Design group for the HIE. It was recently announced that new FHIR resources for consent are under national discussion.[20]

Consent, privacy and security issues should be addressed and solved. Ultimately the public has a vested interest in a safer medication management system for themselves and their loved ones. Healthcare and the State has a responsibility ensure this is done safely and effectively.

This Hackathon created an essential first step for our mission. We are enthusiastic that we can move forward with solutions that make a significant difference in the health and welfare of our citizens. Our hope is that these electronic medication reconciliation prototypes including FHIR code and user interfaces can serve as a springboard for future work

Appendices

Appendix A: Participants' Testimonials

"The Medication Reconciliation Hackathon at UConn was a great opportunity to work with young teams from different disciplines to share ideas around the use of new technologies and methodologies to enhance the current state of medication management. Having the technology participants as part of the process really helped to bring the ideas to life! I look forward to the impact this meeting has on future state of medication reconciliation in Connecticut! "

Anne VanHaaren, Pharm D | Director, Health System Alliance

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"The Med Rec Hackathon gave me insights into the 'Med Rec' problem and an opportunity to explore the applications of Artificial Intelligence (AI) in 'Medication Management'. I researched the subject and have posted a few papers in the event's GitHub repository[D] and also listed these below. I believe the 'MedRec' complexity can be solved to a good degree using AI techniques. I plan to expand this brief note to a paper on applying AI in 'Medication Management'.

Information Technology in Medication Reconciliation

"Medication Reconciliation addresses a costly complex problem and information technologies are widely used for 'MedRec'[E]. Various tools and techniques that integrates with EMRs, admission and discharge procedures, and medication list management have been deployed[F]. Recent improvements include User Interface (UX) and Workflows that engages the patients to manage their medication[G].

[D] AIMS-CDAS MedRec Hackathon 2019 - GIT Repository https://github.com/aims-cdas/medrec-hackathon-2019

[E] Use of Information Technology in Medication Reconciliation: A Scoping Review - Annals of Pharmacotherapy May 2010 https://journals.sagepub.com/doi/abs/10.1345/aph.1M699

[F] Electronic tools to support medication reconciliation: a systematic review. - JAMIA Jan 2017 https://academic.oup.com/jamia/article/24/1/227/2631462

[G] An Observational Study to Evaluate the Usability and Intent to Adopt an Artificial Intelligence–Powered Medication Reconciliation Tool - Interactive Journal of Medical Research Apr-Jun 2016 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4904823/

Digital Medicine and AI

"With the advent of 'digital medicine' and wider access to healthcare data (HIE deployment) it provides more sophisticated analytics and opportunities to address the 'MedRec' problem. A potential approach that could provide solutions is with the applications of Artificial Intelligence (AI) tools and procedures[H]. One example uses computer vision and neural networks in a 'smart phone' application to aid a patient's medication adherence. Another application from Microsoft Research[I] performs fast and accurate visual identification of medications using the NIH NLM Pill Image Recognition Challenge dataset (with about 94% accuracy).

"I believe there is good potential in developing and implementing AI applications for 'Medical Management'. However, this entails dependency on healthcare data that is timely and of greater quality[J]. AI algorithms demands pristine data management with zero-tolerance for data errors. 'DataOps' data management techniques will help address the demanding requirements[K]. Underlying data systems architecture should provide easier and secure access using the HIE and API facilities for AI applications. This architecture[L] should extend to the other facets - 'MedRec' is but one chapter in 'Medication Management'."

Supriyo SB Chatterjee MSc MBA MA (Econ) | Consultant and Entrepreneur

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[H] Artificial intelligence powers digital medicine - Nature NPJ 14 March 2018 With a section on Medication Adherence https://www.nature.com/articles/s41746-017-0012-2

[I] Fast and accurate medication identification - Nature Digital Medicine Feb 2019 https://www.nature.com/articles/s41746-019-0086-0

[J] Putting the AI cart before the data horse — "DataOps" as part of a new enterprise stack - July 2018 https://medium.com/@alex.thinath/putting-the-ai-cart-before-the-data-horse-dataops-as-part-of-a-new-enterprise-stackb85ef2366071

[K] What is DataOps? Everything You Need to Know - ORACLE March 2018 https://www.datascience.com/blog/what-is-dataops/

[L] Designing and building artificial intelligence infrastructure - Enterprise AI April 2018 https://searchenterpriseai.techtarget.com/feature/Designing-and-building-artificial-intelligence-infrastructure

Surescripts currently can find nearly every patient nationwide and provide medication history to nearly every clinician in the country into the through their EMR workflow…but that is not enough. More progress needs to be made beyond providing the data to truly solve medication reconciliation to make the workflow efficient. Events like the Hackathon that convene clinical and technical stakeholders are critical to improving complex workflows such as medication reconciliation. Done well, medication reconciliation has the potential to improve patient outcomes by ultimately reducing preventable medication errors and adverse events. When you bring the right people together at the right time and right place to solve the right problem, great things can happen. The Hackathon was one of those events and Surescripts was glad to be there and part of the solution. We look forward to scaling potential solutions nationally.

Stacy Ward-Charlerie, PharmD, MBA | Manager, Product Innovation, Med History & PDMP | Surescripts LLC

Appendix B: Event Sponsors

Office of Health Strategy

The Office of Health Strategy (OHS) was created in 2017 and established in 2018 by a strong bipartisan effort of the CT General Assembly to forward high-quality, affordable, and accessible healthcare for all residents. The legislation re-organized existing state resources into one body, redeploying people and programs more efficiently, and centralizing health policymaking to advance the healthcare reform initiatives that will drive down healthcare costs; close Connecticut's deeply entrenched racial, economic, and gender health disparities, and undertake technology-driven modernization efforts throughout the system. OHS has a multitude of statutory and regulatory responsibilities including Health Systems Planning and the Certificate of Need program, the development of the state's Health Information Exchange, administering the All Payer Claims Database and Consumer Information Website, and initiatives to improve drug pricing transparency. The work of the Office of Health Strategy is funded, in part, by tens of millions of dollars in federal grants that are secured through a competitive process, positioning Connecticut as a leader in healthcare policy reform.

OHS collaborates with a variety of experts, consumers, and provider stakeholder groups to examine and address the barriers in Connecticut's health system—cost, access, and outcomes. A healthy population creates value for employers, is necessary for a strong economy, and is key to a high quality of life.

OHS
CONNECTICUT
Office *of* Health Strategy

UConn Health

A commitment to human health and well-being has been of utmost importance to UConn Health since the founding of the University of Connecticut schools of Medicine and Dental Medicine in 1961. Based on a strong foundation of groundbreaking research, first-rate education, and quality clinical care, we have expanded our medical missions over the decades. In just over 50 years, UConn Health has evolved to encompass more research endeavors, to provide more ways to access our superior care, and to innovate both practical medicine and our methods of educating the practitioners of tomorrow.

Bioscience Connecticut, an $864 million plan to jump-start Connecticut's economy, is allowing us to deliver health care like never before. This initiative is helping us improve and expand our research facilities, hire more scientists, enroll 30 percent more medical and dental students, and provide better care at new hospital, ambulatory care, and outpatient facilities.

As a result of Bioscience Connecticut, UConn has partnered with The Jackson Laboratory to open The Jackson Laboratory for Genomic Medicine on our Farmington campus. This institute will enable Connecticut to assume a position of global leadership in developing new medical treatments tailored to each patient's unique genetic makeup, allowing us to push our quality care to the next level.

UCONN
HEALTH

University of Connecticut School of Medicine

The primary mission of the UConn School of Medicine is innovation, discovery, and education. The school trains the next generation of medical students, residents, specialty fellows, and clinical practitioners in an environment of exemplary patient care, research, and public service. The School of Medicine's mission is reflected in its programs, which incorporate four basic interrelated goals:

- to advance knowledge through basic, biomedical, clinical, translational, behavioral, and social research;
- to provide educational opportunities for Connecticut and U.S. residents pursuing careers in the patient care professions, education, public health, biomedical and/or behavioral sciences;
- to develop, demonstrate, and deliver health care services based on effectiveness, efficiency, and the application of the latest advances in clinical, translational and health care research;
- To help health care professionals maintain their competence through continuing education programs.

UCONN
SCHOOL OF MEDICINE

UConn School of Pharmacy

The University of Connecticut School of Pharmacy has distinguished itself by educating leaders in pharmacy and the pharmaceutical sciences for over 90 years. Based at a research intensive university, our students have the opportunity to be taught and mentored by faculty pursuing cutting-edge research in all arenas of the field. In addition to its highly regarded pharmacy program, the school boasts exceptional graduate programs in medicinal chemistry, pharmaceutics, and pharmacology/toxicology. We collaborate with practice partners to offer specialized residencies and fellowships in both disciplines.

Universities and their schools are defined by the quality of their people: students, faculty, staff, and alumni. The exceptional people who comprise the UConn School of Pharmacy “phamily” are ultimately what make us one of the nation’s truly great schools of pharmacy.

UCONN
SCHOOL OF PHARMACY

Health Information and Management Systems Society (HIMSS)

HIMSS is a global advisor and thought leader supporting the transformation of health through information and technology. As a mission driven non-profit, HIMSS offers a unique depth and breadth of expertise in health innovation, public policy, workforce development, research and analytics to advise global leaders, stakeholders and influencers on best practices in health information and technology. Through our innovation companies, HIMSS delivers key insights, education and engaging events to healthcare providers, governments and market suppliers, ensuring they have the right information at the point of decision. Headquartered in Chicago, Illinois, HIMSS serves the global health information and technology communities with focused operations across North America, Europe, United Kingdom, the Middle East and Asia Pacific. Our members include more than 72,000 individuals and 630 corporate organizations.

HIMSS
NEW ENGLAND *Chapter*

SMC Partners, LLC

SMC Partners, LLC is an information technology and consulting company serving health providers, health insurers and social services organizations; essentially they intend to help those in the caring professions. They aim to make healthcare and social services better by designing, building, and operating new administrative and care delivery capabilities, enabled by information technology applications..

By helping improve the quality of their clients' services, they ultimately enhance the quality of life for their clients' customers. SMC's employees enjoy balance in their lives, continuous learning, teamwork and entrepreneurship. This culture nurtures happy, engaged employees who are energized to deliver great things for their clients.

SureScripts

In 2001, pharmacy associations formed SureScript Systems to create a link to physicians and replace paper prescriptions with more accurate e-prescribing with the goal to build a national network to connect clinicians, EHRs, hospitals, PBMs, pharmacies and technology vendors. They believed in the value of having comprehensive patient information at the point of care. They believe in more actionable patient intelligence at critical points of care. This results in better decisions; better decisions means lower cost, higher quality, and increased safety- the "holy grail" of healthcare.

Their Intelligence Enablers include a provider directory of 1.47 million, a master patient index of 233 million patients and revolutionary workflow, administration and analytic tools.

Their Trust, Quality & Reliability offerings include the highest security levels and Surescripts Sentinel™, which is on track to analyze the accuracy of two billion prescriptions by 2018.

Sure Script's Governance best practices encourage innovation and competition via an alliance framework, adoption tiers and development partnerships.

CVS Health

CVS Health is the nation's premier health innovation company helping people on their path to better health. Whether in one of its pharmacies or through its health services and plans, CVS Health is pioneering a bold new approach to total health by making quality care more affordable, accessible, simple and seamless. CVS Health is community-based and locally focused, engaging consumers with the care they need when and where they need it. The Company has more than 9,900 retail locations, approximately 1,100 walk-in medical clinics, a leading pharmacy benefits manager with approximately 92 million plan members, a dedicated senior pharmacy care business serving more than one million patients per year, expanding specialty pharmacy services, and a leading stand-alone Medicare Part D prescription drug plan. CVS Health also serves an estimated 38 million people through traditional, voluntary and consumer-directed health insurance products and related services, including rapidly expanding Medicare Advantage offerings. This innovative health care model increases access to quality care,

delivers better health outcomes and lowers overall health care costs. Find more information about how CVS Health is shaping the future of health at https://www.cvshealth.com.

CT Health Foundation

The Connecticut Health Foundation is dedicated to achieving health equity. They focus on improving health outcomes for people of color and assuring that all Connecticut residents have access to affordable and high-quality care. Through public policy, grant making, and leadership development, we work to make lasting changes that improve lives.

From the beginning, CT Health has reflected its founders' deep commitment to taking on the challenges facing Connecticut in a data-oriented, mission-driven, and responsible way. The founding board members spent more than a year planning, examining the public health challenges facing Connecticut, and conducting a listening tour throughout the state, with sessions in English and Spanish.

Many of the decisions they made continue to shape the character of the foundation. Those include:

A focus on changing systems. The founders recognized they could throw all the foundation's money at the problems in health care and solve them – for about five minutes. Instead, they decided to focus on changing the systems that affect people's health.

Targeting the greatest needs. Facing a choice between focusing on the greatest number of people or the greatest need, the founders chose to focus the foundation's resources on underserved and unserved populations, and to select priority areas based on levels of need, gaps no one else was addressing, and the potential to effect sizable change.

More than grantmaking. Awarding grants has always been a central part of CT Health's work, but grantmaking is far more powerful when it works in concert with partnerships, policy work, and leadership development.

Integrity and credibility. Raymond Andrews Jr., a founding board member, said those who created CT Health envisioned working to change the system "in a respectable way." The idea, he said was, "To be looked at as credible people who did their homework, who came forward with a strong position on things, but had it grounded in research and grounded in good, solid thinking."

Analytical, but with heart. Data drives the foundation's work, but the implications of decisions on real-life experiences is critical to what it does.

Society for Information Management (SIM) -Central Connecticut

The Central Connecticut chapter of SIM strives to strengthen professional communications among members who direct the application of information technology in private and public organizations.

SIM holds meeting to share innovative ideas and real world experiences which address enterprise information needs. Speakers at these meetings may be members, industry executive, or subject matter experts from many sources. SIM provides presentations by leading national information-management professionals and executives

who benefit from management-information systems. SIM strives to challenge their comfort levels by exchanging ideas with peers and business counterparts. SIM prides itself on being a resource for each other and personal networking.

Every year SIM Central CT gives back to the community by providing Scholarships to future IT leaders, holding Programs at local universities to prepare graduates for the IT world they are about to enter, and coaching and mentoring High School students interested in STEM careers

Appendix C: Table References (Provided to workgroups)

The mechanics of med rec…

- Obtain a medication history
  - Done by staff, nurse, pharmacist and/or provider
  - Done from patient and/or caretaker/parent/guardian
- Review against existing medication list (such as within the electronic health record (EHR))
- Provider determines, for the new venue…
  - What to continue,
  - What to discontinue, and
  - What to add to the treatment plan

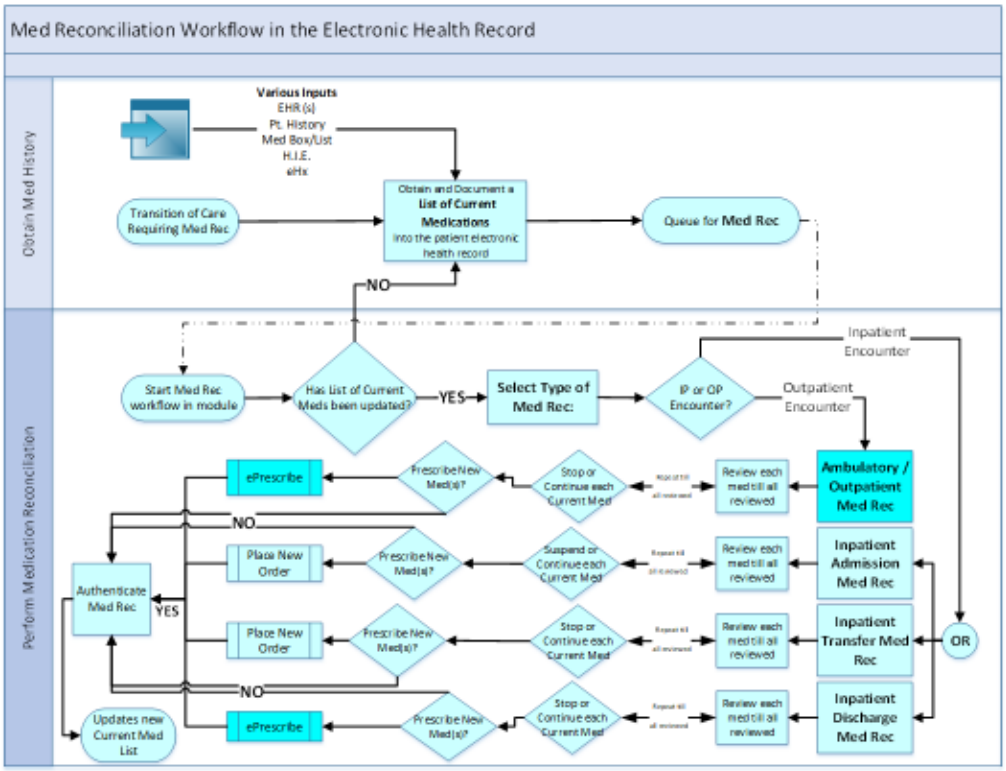
Discontinue

Add new med

Continue

- This creates a new, "reconciled" list of medications.

NOTE: Formulary limitations also contribute to changes in the medication list.



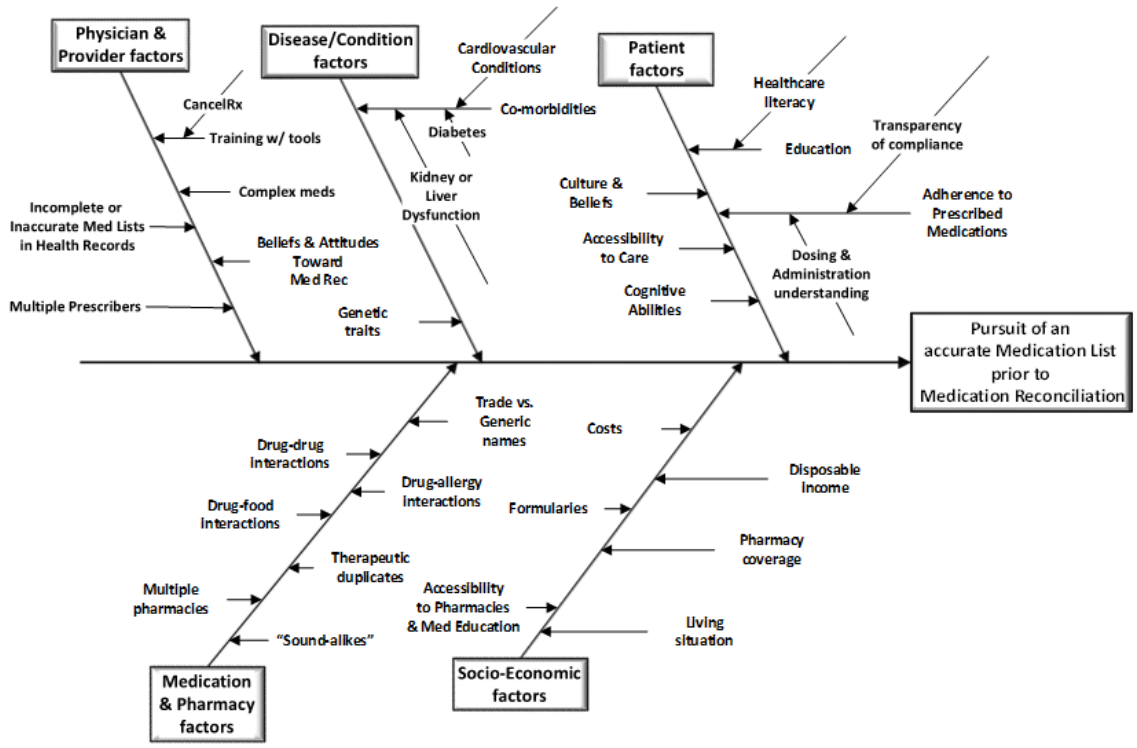
Typical EMR Medication Profile w/Med Rec:

+Add Med

Medication	Directions	Type	Refills	Ordered by	Continue	Stop	Rx (Start)
Lisinopril 40 mg Tab	PO, Daily	Rx	3	Phil Smith, MD			
Baby Aspirin 82 mg Tab	PO, Daily	Hx	-	Outside Provider			
Pravastatin 20 mg Tab	PO, QHS	Rx	1	Phil Smith, MD			

QHS = Take daily at bedtime. (a frequency)
PO = Take by mouth (a route)
Mg = milligrams (a dose strength)

*Meta Data may also be available on each med, like compliance (taking, not taking, not taking as prescribed) and last dose.



Sources of Current Medications

- Patient / Family / Guardian / Parent
- Shoebox / Bag of pill bottles
- Medication List from patient
- Current Physician Electronic Health Record
- Old records
- Hospital Records including EHR.
- Other physician records through HIE
- SureScripts eHistory
- Contact Pharmacy or other physicians.

Appendix D: Speakers' / Facilitators' Biographies

Andrew Agwunobi, MD, MBA

Dr. Andrew Agwunobi is the Chief Executive Officer and the Executive Vice President for Health Affairs for UConn Health system. In this role he is responsible for University of Connecticut's $1-billion academic health system.

Prior to joining UConn Health Dr. Andrew Agwunobi — a pediatrician with an MBA from the Stanford Graduate School of Business — served as managing director and a co-leader of Berkeley Research Group's (BRG) Health System performance improvement consulting practice. Before BRG, Dr. Agwunobi served as CEO of Providence Healthcare, a five-hospital region of Providence Health & Services in Spokane, Washington. He also previously held the positions of president and CEO of Grady Health System in Atlanta; president and CEO of Tenet South Fulton Hospital in East Point, Georgia; chief operating officer of 14-hospital St. Joseph Health System in California; and secretary of the Florida Agency for Health Care Administration in which capacity he was responsible for Florida's $16 Billion healthcare administration budget.

In 2003, Tenet Healthcare awarded Dr. Agwunobi its "CEO Circle of Excellence" award. In 2005, Dr. Agwunobi was named one of the "100 Most Influential Georgians" by Georgia Trend magazine. In 2007, Dr. Agwunobi was named one of the "50 Most Powerful Physician Executives" nationally by Modern Healthcare magazine. Other honors include CEO of the Year, Trailblazer category (Atlanta Business League, 2005), Most Influential Atlantans (Atlanta Business Chronicle, 2005), Speaker and Citizen of the Year (Atlanta Peachtree Rotary, 2004) and Agent of Change award (Catalyst magazine, 2002).

Dr. Agwunobi served on the Board of Directors of Gonzaga University where he also taught in the business school as adjunct faculty. Dr. Agwunobi is a published author. His book, An Insider's Guide to Physician Engagement, was published in July 2017 (Health Administration Press, Chicago).

Bruce T. Liang, MD, FACC

UConn School of Medicine Dean Bruce Liang, M.D. is a nationally-recognized Dean of Medicine and an internationally-recognized cardiovascular physician-scientist. He has led the School of Medicine in implementing a new curriculum to foster active learning and to establish clinical integration with basic sciences that starts in the first year of medical school. The School also successfully completed limited and full LCME surveys under Dr. Liang's direction. UConn School of Medicine ranked highly in both Research and Primary Care categories in the U.S. News and World Report in 2017 and 2018.

Prior to becoming Dean, his cutting-edge translational research contributions advanced scientific knowledge for heart biology receptor signaling and heart failure. His work has been continuously funded since 1986 by the NIH, the American Heart Association, and the U.S. Department of Defense.

Dr. Liang is a fellow of the American College of Cardiology, the American Heart Association and is an elected member of the American Society for Clinical Investigation, the Association of University Cardiologists, and the Connecticut Academy of Science and Engineering.

Tom Agresta, MD, MBI

Dr. Agresta is a seasoned family physician, clinical informatician, educator, administrator, researcher and innovator with a history of bringing together multidisciplinary teams to focus on developing novel methods for creating, using and evaluating technology in both clinical and teaching settings. He has a bachelor's degree in biomedical engineering from Stevens Institute of Technology, a medical degree from New Jersey Medical School and master's degree in biomedical informatics from Oregon Health Sciences University. He has held state-level leadership roles in adoption and implementation for Health Information Exchange and Electronic Health Records. Dr. Agresta also oversees the Electronic Medical Records for the Family Medicine residency clinic at St. Francis Hospital. He serves as the section leader for Informatics in the Connecticut Institute for Primary Care Innovation, Director of Clinical Informatics at the Center for Quantitative Medicine at UConn Health and a Physician Informatician working with the Office of Health Strategy of Connecticut to facilitate Health Information Exchange. His research interests include using technology to enhance the care of patients while increasing efficiency for providers. All of this work serves to promote leveraging technologies for interoperability across systems to reduce cost and improve care delivery.

Robert Hausam, MD

Rob Hausam, MD, is a consultant in clinical informatics with a background in computer engineering and as a Family Physician with substantial medical practice experience. His current work focuses on clinical terminology, data modeling and healthcare data standards development. He is actively working with HL7 on the development of the FHIR standard and is a member of the FHIR Core Team. He also works on other HL7 standards and with other standards development organizations including SNOMED International and Regenstrief (LOINC), and he currently serves as a Co-Chair of the HL7 Vocabulary and the Orders and Observations (OO) Work Groups.

John DeStefano, MBA

John DeStefano has been the Director of Innovation and Health Information Exchange at SMC Partners, LLC since 2014. In that role he leads SMC's Health Data Integration Practice amongst other duties. Prior to that John was the Chief Technology Officer at the Health Information Technology Exchange of Connecticut, HITE-CT. He has been working in the healthcare industry for almost 40 years and healthcare information technology in particular for more than 25 years. He holds a Bachelor of Pharmacy degree from the University of Connecticut and a Master of Business Administration degree from Rensselaer Polytechnic Institute.

Allan Hackney, CISM, CRISC

Allan is an outcome-driven, people-oriented leader recognized for developing and executing pragmatic strategies that drive growth, improve efficiency and control risk. He serves as Connecticut's Health Information Technology Officer within the Office of Health Strategy, a role appointed by Lt. Governor Nancy Wyman to develop and coordinate the implementation of a state-wide health information technology (HIT) strategy, and to build and implement health information interoperability services.

Previously, Allan served as SVP & Chief Information Officer (CIO) at John Hancock Financial Services with oversight of the company's technical teams. In this role, he introduced mobile computing and the first company-wide customer data repository. As a catalyst for change, he created shared services and optimized vendors, generating millions in free cash flow to reinvest in new functions and capabilities.

Allan joined John Hancock from AIG Consumer Finance Group where, as CIO and Operations Executive, he led the effort to reposition autonomous banking and lending operations into a more integrated global platform to enable significant expansion. Previously, he was SVP of IT for Bank of America Commercial Finance.

Allan started his career at GE, where he held a number of leadership positions in the USA and Japan for GE Capital's global consumer finance business, led more than 50 global IT due diligence and M&A integration transactions, and headed GE Capital's initiative to launch Six Sigma across its IT function.

Professionally, he holds CISM and CRISC certifications. He was named a Computerworld Premier 100 CIO during 2012, and is a Mentor in Columbia University's Technology Management Masters program.

In the community, Allan is co-founder and member of the Regional Board of Directors of buildOn in Boston, a national non-profit organization that empowers youth is to break the cycle of poverty, illiteracy and low expectations through service and education. He is also on the Board of Directors for Common Impact, the national leader in developing tomorrow's leaders through skill-based volunteering and community engagement.

Allan graduated with a Bachelor's degree from Colgate University. He and his wife Jane reside in New Canaan, CT and Boston, MA.

Philip A. Smith, MD, FAAFP

Philip A. Smith is a healthcare IT consultant/principal of MedMorph LLC, and Senior Editor of Applied Health IT Experts, LLC (website HealthITAccelerator.com). He is author of Med Wreck: Proposing a Solution for the Nightmare of Medication Reconciliation (©2017) and a subject matter expert on the topic.

He has been in healthcare 40 years, first as a surgical Physician Assistant then as a family physician in New Port Richey, Florida. He was an early adopter of electronic medical records in 1993. He is a Board-certified in both family medicine and the ABPM subspecialty of Clinical Informatics. He has special interests in healthcare strategic planning, change leadership, remote patient monitoring and reforming medication reconciliation.

Phil chaired AMIA's Maintenance of Certification (MOC) Committee (Subcommittee under Education) 2016-17 and joined Doug Fridsma and Pesha Rubinstein in Chicago in meetings with the American Board of Preventive Medicine. During Phil's tenure as Chair, the MOC Committee established processes for MOC-IV and reviewed thousands of questions for MOC-II credits at the iHealth (now Clinical Informatics Summitt) and annual symposia.

Phil has a broad background in healthcare, which began as a Physician's Assistant in surgery (CWRU) and then medical school (M.D, M.S.) at Wright State University. He was Co-Chief Resident in Family Medicine at University of Missouri-Columbia. After a year in a multi-specialty practice in a rural Illinois community, Phil moved to New Port Richey, FL and established a private practice in 1987. He automated his practice in 1993. He learned quickly how to use the EMR to enhance his practice and patient experiences, growing it to five providers in the next four years. He sold the practice and retired in 1997 to pursue his interests in improving healthcare.

He started a small company, Cognitive Analysis, Inc. and assembled a team to perform business process modeling of healthcare information flow and he and a group of entrepreneurs filed a patent in 1999 to create Medical Informatics Utilities at the state-level to serve as universal patient records repositories. However, during the dot-com bust, attempts to raise capital for the endeavor were unsuccessful, so Phil went to Cerner Corporation to consult on their new Care Transformation team. He worked for Cerner for over two years, mainly during turnarounds of less successful installs and then leading over two dozen successful implementations including academic, pediatric and community hospitals as well as physician practices.

Following Cerner, He has served as a VP in healthcare operations as a Chief Medical Officer and 12 years as Chief Medical Information Officer for both Adventist Health System (2003-12, $7B 10-state IDN. Now AdventHealth) and the Moffitt Cancer Center (2013-16). At AHS he created and implemented the strategic plan to fully automate 26 hospitals big bang over 24 months. He has successfully automated over 60 hospitals and in recent years, all to HIMSS Analytics EMRAM Stage 6 or 7. He also designed Cerner's initial eQuality solution while at AHS as a Cerner client to capture hospital quality metrics and provide actionable alerts within the workflow to drive process improvement.

For the past three years he serves on the (150-member) Cybersecurity Information Sharing Act of 2015 (CISA 405(d)) task force at the Department of Health and Human Services. He is the only physician on the task force who has practiced/worked in the four main provider spaces targeted by the Task Force (small physician practice, med-large group, community hospital, and large health system). He is author of Making Computerized Provider Order Entry Work (Springer, London 2012). He has taught Healthcare Operations Management and Change Management at the Masters level (MS in Applied Health Informatics, Bryan University). He attributes his contributions and quirkiness to his personal accomplishment of reading one non-fiction book per week, 1993-2013; specifically selecting 3-5 books per topic during those 20 years and over 1,000 titles.

Sean Jeffery, PharmD, CGP, FASCP, FNAP, AGSF

Sean is a pharmacist who enjoys caring for seniors. His training in geriatrics began at the Duke Center for the Study of Aging under Dr. Joseph Hanlon. He then joined the University of Connecticut School of Pharmacy faculty and established a geriatric pharmacy consult service at VA Connecticut. Over 16 years, his work at VA Connecticut included caring for home-based primary care, short-term rehabilitation, hospice, geropsychiatry and geriatric consult service patients. He is currently a Trustee for the American Pharmacist Association and a past president of the American Society of Consultant Pharmacists and in 2019 will join the APhA Board of Trustees. In 2015, Sean joined Hartford Healthcare's Integrated Care Partners, as their Director of Clinical Pharmacy Services, where he applies his background in senior care across an integrated health system. He is responsible for pharmacy network development and strategy, population health management, and support of an integrated care-management team.

Riddhi Doshi, PhD, MBBS

Riddhi Doshi is a Postdoctoral Fellow in Public Health at the Center for Population Health within the Division of Behavioral Sciences and Community Health in the School of Dental Medicine at UConn Health. She is trained in Medicine (MBBS) and has a PhD in Public Health (concentration in social behavioral research) from UConn Health. She has extensive experience utilizing large population-level health and claims data to examine predictors of suicidal behaviors, healthcare utilization and health outcomes. She is passionate about utilizing technology to develop innovative health solutions including consumer informatics solutions like electronic personal health records and mobile phone applications to improve medication adherence and health outcomes. She is a recipient of the prestigious NARSAD young investigator award 2018. Dr. Doshi is a strong proponent of improving health outcomes and care delivery through a state-level health information exchange for Connecticut.

Jason Cory Brunson, PhD

Cory Brunson is a Postdoctoral Fellow in the Laubenbacher Lab at the Center for Quantitative Medicine. He completed a Ph.D. in Mathematics at Virginia Tech in the areas of algebraic geometry and combinatorics.
Cory has published original research in network science, scientometrics, and health informatics, and has developed several software packages in the statistical programming language R. He represented postdocs with University Health Professionals (AFT Local 3837) in the 2016 contract negotiations, co-founded the UConn Health–JAX Genomic Medicine Postdoctoral Association, and regularly brings student interns at the graduate, undergraduate, and high school level onto his research projects. He is currently pursuing a research agenda in topological data analysis of administrative healthcare data alongside collaborations in immunology, cell biology, and physiology.

Brandon Elliott, MD

Dr. Elliott is a Consultant for Velatura, a subsidiary of the Michigan Health Information Network Shared Services (MiHIN).

With Velatura, Dr. Elliott has multiple responsibilities focused on business development and improving health information exchange around the country. He leads the strategy, design, implementation, analytics, digital health initiatives, and adoption of health information solutions and health information technology (HIT) for Velatura customers. Dr. Elliott is blending his technical and clinical backgrounds by supporting the nationwide electronic case reporting (eCR) initiatives that reduces provider burden by sharing clinical insights and increases the value of quality reporting for providers.

Dr. Elliott serves as a key resource for various Health IT projects in Velatura and MiHIN, including implementation of health information exchange (HIE) services and refining a Synthetic Patient Simulator. He also serves as a subject matter expert regarding healthcare data standards and he routinely leverages his clinical and technical expertise to assist in creating and advising on improving clinical accuracy throughout projects in both organizations.

Dr. Elliott previously worked as an electronic data interchange (EDI) Business Analyst at VITG Global and as a research scientist within a variety of disciplines at multiple universities across the nation.

Courtney Delgoffe, BS

Courtney Delgoffe is an Associate Consultant for Velatura, a subsidiary of the Michigan Health Information Network Shared Services (MiHIN).

In this role, Ms. Delgoffe has multiple responsibilities focused on business development and increasing the visibility of Velatura and its multiple services and capabilities, each working to improve the exchange of health information around the country. One way she supports business development is by documenting data process flows through health information networks, investigating requirements for functional improvements, and developing enhancements for technical services. She also creates materials for product development by identifying operational, market, and environmental impacts around health information.

Ms. Delgoffe serves as a key resource for various Health IT projects in Velatura and MiHIN, including implementation of health information exchange (HIE) services; the Persona Library, where she leverages clinical experience to assist in creating synthetic patient data and narratives; and training materials.
Ms. Delgoffe graduated from Michigan State University with a Bachelor of Science in Interdisciplinary Studies-Health and Society.

Matt Englehart, MS

Matt Englehart is a Senior Digital Services Product Manager at Michigan Health Information Network Shared Services (MiHIN), a public and private nonprofit collaboration dedicated to improving the healthcare experience, improving quality and decreasing the cost for Michigan's people by making valuable data available at the point of care through statewide health information sharing. Matt has over 12 years of digital product management experience in the finance and healthcare space where he has led cross-functional digital product development teams turning consumer insights and business intelligence into engaging branded digital experiences that align customer goals, business objectives and technological feasibility. Matt received a MS in Computer Information Systems from Grand Valley State University and a BBA in Finance from the College of William and Mary.

Joseph Anderson, BS

Joseph Anderson is a Software Developer with the Michigan Health Information Network Shared Services (MiHIN).
As a member of the Software Development team at MiHIN, Mr. Anderson focuses on Java and Python development. He oversees the technical needs of the "Ring" of MiHIN's FHIR®- PITs (Fast Health Interoperability Resources- Pilot Interoperability Testbeds) and HAPI FHIR server APIs (Application programming interfaces) that house synthetic data. For MiHIN, this data is created with MiHIN's PatientGen. This service gives users an opportunity to test health information data without using real (and protected) health information. Joe also attends MiHIN's Connectathons as a technical resource.
Mr. Anderson is knowledgeable in C++, Git, SQL, PHP, jQuery, and HTML; and has experience in Bootstrap web framework, RESTful API calls, and authorization services. He has also managed and organized software projects using AGILE, source code control, and code review.
Mr. Anderson graduated from Northern Michigan University with a Bachelor of Science in Computer Science. He began at MiHIN as a summer intern where he learned FHIR by developing an HL7-to-FHIR parser.

Appendix E: Agenda for Hackathon Event

Friday April 5th 2019

- 8:00 AM- 8:30 AM Check-in & breakfast
- 8:30 AM- 11:45 AM Lecture
    - 8:30 AM -9:00 AM Introductory Remarks (Dr. Agwunobi & Allan Hackney)
    - 9:00 AM - 9:45 AM Background – *CancelRx*, Office of Health Strategy (OHS) Medication Reconciliation & Polypharmacy (MRP) Workgroup, Funding opportunities, Goals for event and long-term outcomes with some examples (Dr. Agresta)
    - 9:45 AM – 10:45 AM Current State of Affairs - "*Medication Wreck*" (Dr. Smith)
    - 10:45 AM – 11:45 AM Discussion of Technical Solutions – *How Fast Healthcare Interoperability Resources (FHIR) can be a game changer* – with examples of recent work (Dr. Hausam)
- 11:45 AM – 12:30 PM – Lunch
- 12:30 PM – 2:30 PM Split into Workshops
    - Clinician / Administrator group /Patient advocate
        - Review and decide on simple requirements from Med Rec Use Case as developed by OHS MRP group.
        - Develop Med Rec storyboards
    - Programmer / Developer / Informatics
        - Review FHIR resources, FHIR-Pilot Interoperability Test Bed (PIT), examples of code
        - Practice development with simple pre-built scripts to pull several meds
- 2:30 PM – 3:00 PM Pitch Clinical Ideas and form teams
- 3:00PM- 5:00 PM Formation of Teams to work on prototypes – classroom breakouts
    - Focus on a variety of medication list users (within an EHR, Patient facing Mobile APP and/or Pharmacy System)
    - Focus on one end-user system but work on different components

Saturday April 6th 2019

- 8:00 AM - 8:15 AM Check-in & breakfast
- 8:15 AM – 12:00 PM Continue Team based prototype development – breakouts
- 9:00 AM – 11:00 AM Clinical Discussion Group on Further Opportunities
- 12:00 PM – 12:45 PM – Lunch
- 12:45 – 1:45 PM – Finalize Team prototype and prepare for presentation
- 2:00 PM – 4:00 PM Team demonstration of prototypes developed and explanation about lessons learned.
- 4:00 PM - 5:00 PM Group discussion
- 5:00 PM Reception

Links to Hackathon presentations:

Opening Lectures (8:30-12:30pm)

Date: Friday, April 5, 2019
Time: 8:30 AM EDT
Duration: 4:00:00
Link: https://tinyurl.com/y6q3eplz

Clinical Workshop (12:30-2:30pm)

Date: Friday, March 15, 2019
Time: 12:30 PM EDT
Duration: 2:00:00
Link: https://tinyurl.com/y5u2squo

Technical Workshop (12:30-2:30pm)

Date: Friday, April 5, 2019
Time: 12:30 PM EDT
Duration: 2:00:00
Link: https://tinyurl.com/y2cvwbdc

Final Presentations (1:30-5:00pm)

Date: Saturday, April 6, 2019
Time: 1:30 PM EDT
Duration: 3:35:00
Link: https://tinyurl.com/yyzyyc6a

Appendix F: Hackathon Attendees

Tom Agresta
Zeeshan Ahmed
Teresa Allen
Mostafa Analoui
Joe Anderson
Gregory Anderson
Olga Armah
Ahmad Asgharian
Grace Austin
Kathir Bala
Sudeep Bansal
Lesley Bennett
Manish Bhardwaj
Ankur Bhargava
Vimal Bhat
Jennifer Boehne
Scott Bonczek
Curtland Brown
Jason Cory Brunson
Daniel Bruzeguez
Andrew Cadorette
John Cantelmo
Patricia Carroll
Supriyo Chatterjee
Ormand Clarke
Carmen Cotto
Madalene Crow
Sandra Czunas
Courtney Delgoffe
Steven Demurjian
John DeStefano
Mohitkumar Dhiman
Riddhi Doshi
Vinod Durairaj
Gill Eapen
Brandon Elliott
Matt Englehart
Kevin Fazio
Katie Flynn
Alan Fontes
Terry Gerratana
Chris Gilman
Marghie Giuliano
Alejandro Gonzalez-Restrepo
Abhishek Gorla
Leslie Greer
Prerit Gupta
Terry Guzauckas
Allan Hackney
Robert Hausam
Katherine Hayden
Brady Hecht
Linh Ho
Edward Hochman
Susan Israel
Sean Jeffery
Lauri Johnson
Ruth Kalish
Vikram Kalmegh
Nitu Kashyap
Vipul Kashyap
Tejas Khandelwal
David King
Lauren Kosowski
Bruce Liang
Maya Llyod
Jeff Loughlin
Natasha Lunin
Brian Ly
Michael Malmrose
Velandy Manohar
Campbell Marchant
Kaitlyn McCarthy
Christopher Merrick
Bruce Metz
Brittany Mills
Richard Munger
Marinka Natale
Mina Nguyen
Julian Nieves
Jesse Olsson
Patrick Parisi
Candace Pettigrew
Samantha Pitts
Christina Polomoff
Pat Prendergast
Joseph Quaranta
Jamie Reuter
Nathaniel Rickles
Lauren Rodriguez
Dan Russell
Steve Ruth
Aya Saleh
Mark Schaefer
John Schnyder
Sarju Shah
Greeta Sharma
Dong-Guk Shin
Sabina Sitaru
Adam Skawinski
Philip Smith
Marie Smith
Jake Star
Cecil Tengatenga
Marshall Thompson
Liz Turi
Anne VanHaaren
Alla Veyberman
Erika Vuernick
Stacy Ward-Charlerie
Mark Weiner
James West

Appendix G: Glossary of Terms

The anatomy and physiology of a medication order/prescription

Prinivil / lisinopril, 10 mg tablet, P.O., daily, for hypertension. Prescribed by Phil Smith, MD

Prinivil / lisinopril, 10 mg tablet, P.O. daily, for hypertension. Prescribed by Phil Smith, MD

TRADE / generic name, dose-strength with units of measure, form, Route, Frequency, indication, prescriber.

Other data: Quantity prescribed, Pharmacy filling, Number of refills. Start date, Stop date, Drug class (ACE-inhibitor), Duration, Do Not Substitute indicator, Controlled-substance indicator, Over-the-Counter (OTC) indicator. Cost data, price data, RxNorm, NDC, priority code

Item	Structure	Function	Comment
Trade name of medication	Text, Usually capitalized	Identifies a medication produced as a Brand, typically from one manufacturer	Standard format is first letter capitalized. May be one or more Trade names for every generic name. Essentially works as a familiar "alias" to the generic name.
Generic name of medication	Text, usually all lower-case	Identifies a specific medication as its FDA approved chemical name.	Generic name is specific. It may have one or more aliases of Trade names.

Item	Structure	Function	Comment
NDC (National Drug Code	10-digit/character*, 3-segment numeric identifier assigned by FDA to each product. **Segment 1**: is 4-5 digits long and represents the "Labeler code" A labeler is any firm that manufactures, repacks or distributes a drug product. **Segment 2:** is 3-4 digits long and identifies a specific strength, dosage form and formulation of a particular firm/manufacturer. **Segment 3**: is 1-2 characters long and identifies the package forms and sizes. This segment may contain numbers and/or letters.	FDA assigns to each medication in the U.S. intended for human use. It contains 3 segments that identifies the vendor, product and trade package of the drug. https://www.fda.gov/Drugs/InformationOnDrugs/ucm142438.htm	NDC's have been historically reused from time to time. ***CMS has created an 11-digit NDC derivative to create a fixed 5-4-2 segment length with a leading zero as needed in each segment.*** Some applications use a 9-digit code with a 5-4 representation of first two segments (whenever packaging is irrelevant.).
DIN (Drug Identification Number)	8-digit. Randomly assigned to all medication sold in Canada.	Identifies all prescription and OTC meds in Canada and are displayed on the label. A DIN uniquely identifies the following product characteristics: manufacturer; product name; active ingredient(s); strength(s) of active ingredient(s); pharmaceutical form; route of administration	DIN is used for Canadian drugs, while NDC is used for U.S.A. drugs.
RxNorm	https://www.nlm.nih.gov/research/umls/rxnorm/	RxNorm provides standard names for clinical drugs (active ingredient + strength + dose form) and for dose forms as administered to a patient. It provides links from clinical drugs, both branded and generic, to their active ingredients, drug components (active ingredient + strength), and related brand names. Updated weekly as new drugs are released in the U.S. for human use.	Maintained by the National Library of Medicine (NLM) as part of the Unified Medical Language System (UMLS). Updated quarterly and free to use in U.S. Developed for interoperability across clinical systems.

Item	Structure	Function	Comment
Therapeutic class	A grouping of medications with similar structure and function. There are classes and subclasses. For example: Cardiovascular agents Antihypertensives Alpha Blockers Beta Blockers Highly-selective Calcium Channel Blockers Dihydropyridines Phenylalkylamines ACE Inhibitors (ACE-I) Angiotension Receptor Blockers (ARBs)	Used mainly for clinical decision support rules to allow duplicate checking by class or sub-class. However, this can also lead to nuisance alerts as there are legitimate reasons to have a patient on two or more drugs in the same class. (for example, prescribing both long and short acting insulin is best practice)	Drugs are often used for their action outside of their class. For example, alpha blockers may be used for both hypertension and/or for men with enlarged prostate glands.
Strength and/or volume	Typically numeric. Always requires a "unit of measure" to follow to provide meaning. Some medications are prescribed by volume of dose (e.g. 5 mL or 1 tablet) rather than by strength (e.g. 7 mg). **Leading zero is ALWAYS** used if any value exists right of the decimal point (for example 0.088 mg). **A trailing zero is NEVER** used if no value to the right of the decimal point. (for example 1 mg should never be written as 1.0 mg).	To avoid mis-dosing errors on the order of a magnitude (for example confusing 1.0 as 10 mg and thus over-dosing 10x or one order of magnitude of intended dose.)	The Leading Zero and Trailing Zero rules are national standards in the US originally set by The Joint Commission
Units of Measure	Typically a defined code-set in the EMR and never free text. Alpha characters. Examples: mg, Gm, units, mg/dL, tablet(s), mL	The same UoM codeset is used for lab reporting as well as pharmacy and important	

Item	Structure	Function	Comment
Duration	Typical has two components in the EMR. First component is the multiplier and the second is the unit of measure. Example: 3, day(s); where 3 is the multiplier and day(s) is the unit of measure.	Drives tasks in the EMR such as on the electronic medication administration record (eMAR) or on staff Tasks Lists. Used on both medications and lab tests.	Some acute medications (e.g. antibiotics) are prescribed for a defined interval and discontinue once duration is met. Chronic medications (e.g. for hypertension) do not have a duration and therefore stay continuously as an active medication, even if the patient has quit it or refills have expired.
Dose Form	Tablet, Capsule, Extended-release capsule, vial, syringe, injection, liquid, suspension, solution. Typically driven by a code set, not free text.	To indicate how the product is dispensed. Used in machine logic to limit the available routes (For instance, a tablet cannot be given as an injection, and a long-acting tablet cannot be crushed (since that would make it an immediate release do	Important for two reasons: 1. Dispensing from an automatic cabinet 2. Delayed release system. The drug Cardizem/diltiazem comes in immediate release capsule, extended release capsules (Cardizem CD) and long acting tablets (Cardzem LA). This is usually managed as a dose form, but could be managed as a product.
Sig: (instructions)	Typically the collection of prescribing instructions on a medication order to clarify at least four requirements: 1. Dose and unit of measure 2. Route 3. Frequency 4. Duration	To provide requirements for proper use of the medication for the indicated patient. NOTE: Nursing refers to the Five Rights of Medication Management: 1. Right patient 2. Right dose 3. Right route 4. Right time (and frequency) 5. For the Right duration.	Sig is abbreviation for Latin word signetur, or “let it be labelled”. Prescriptions may also allow “special instructions” or “Order Comments” to the patient and/or to the pharmacist.

Item	Structure	Function	Comment
Quantity Dispensed	Numeric value of the number of units (volume, tablet(s), capsule(s) dispensed by the pharmacy	To ensure the number of units the patient should receive in fulfilling a prescription.	Some drugs, such as opioids may be limited to a few days at a time. Many chronic medications may be dispensed with one month to 3 month intervals.
Refills	Numeric value indicating the number of times the Quantity Dispensed can be re-dispensed (i.e. refilled)	To limit the number of times a prescription can be refilled until a new prescription is issued	Some systems limit the window during which a prescription can be refilled. This may be on the low side (e.g. cannot refill a 90-day prescription earlier than 75 days passed the prior dispensing) or long side (cannot refill a prescription older than one year.
Pre-authorization	Indicates that a payor is willing to reimburse the pharmacy for the prescription at a maximum amount. Usually stored as an authorization code, date, and payor information with notes.	To limit risk for the pharmacy benefit manager and the dispensing pharmacy when a medication insurance plan exists	Especially important for high cost agents such as monoclonal antibody drugs used for autoimmune diseases and malignancies.
Indication	Usually defined from one or two code sets in the EHR 1. Problem list in SNOMED CT 2. Diagnosis in ICD-10 3. Rarely for a procedure in CPT-x	To indicate a disease or condition for which a medication has been prescribed.	Especially important when a medication is used for a rare or off-label indication to prevent inadvertent discontinuation by another provider
Patient Data	Factors that impact choice of medications, dosages and routes. Includes: 1. Allergies 2. Intolerances 3. Idiosyncratic reactions 4. Weight (typically in kg.) 5. Height (typically in cm.) 6. Body-surface area (BSA in M^2) 7. Body mass index (BMI in kg/M^2) 8. Age 9. Renal function (GFR of CrClearance) 10. Liver Function	**Allergies** are reactions to medications that are often generalized to classes and create immune-mediated reactions including anaphylaxis. **Intolerances** are common side effects that preclude the patient successfully taking the medication (example: Nausea and vomiting from codeine)	``This data typically comes from clinical data sets in the EHR and not be easily accessible to the pharmacist.

Item	Structure	Function	Comment
Patient Data (continued)		**Idiosyncratic reactions –** are rare reactions associated with certain medications that would preclude use of that medication or similar meds in the future. (Example: Stevens-Johnson Syndrome which is a life threatening reaction to drugs such as Sulfa and some diuretics) **Wt/Ht/BSA/BMI** impact dosage adjustments that are recommended of some medications of for infants and children. **Age** –some drugs may not be administered to all ages. **Renal and Liver Function** – May require dose reduction or avoidance of certain medications.	
Prescriber (or ordering provider)	Usually defined in a personnel table or free text (which can cause duplicates). Prescribers are ideally associated to a Unique Provider Identification Number (UPIN)	The provider who has authorized or ordered the medication last.	This is confusing during medication reconciliation in which the prescribing physician/provider may not be known.
DEA Number	Unique Alphanumeric code provided by the Drug Enforcement Agency to allow providers to prescribe controlled substances.	Serves as authorization and authority that a prescriber can legally prescribe a controlled substance.	Not all physicians / providers have a DEA number.
Dispensing Pharmacy	Name of a pharmacy, usually in a code set (such as from SureScripts), from where the current medication was dispensed. Metadata includes address, phone and fax number for the pharmacy.	Allows identification of where a medication was last obtained.	Not always available and there are other sources of medications (spouses, samples, mail order, Canada, street drugs, etc.)
CancelRx	A specific SureScripts communication to indicate the specific intention that a specific medication is to be discontinued for a specific patient at this time.	Communicates that a medication is to be moved from ACTIVE to Inactive/historical status.	Functionality is often overlooked and sometimes unavailable.

Item	Structure	Function	Comment
eHx - Electronic prescribing history	An active query from SureScripts to the EHR showing active medications and refill histories.	Allows person doing query to see medications that the patient has been taking and may still be taking.	Is not a source of truth since it may be incomplete and/or inaccurate due to many factors.
SureScripts	A service that manages data transfer between prescriber, pharmacies and pharmacy benefit managers (PBMs).	Is the backbone for electronic prescribing in the United States. May include electronic prescribing of controlled substances (EPCS) transactions.	Note: PBMs typically store dispense quantities and refill history but rarely include specific instructions.
Medication Reconciliation	The process of comparing multiple sources of patient medication lists and agreeing on a current medication treatment list.	To ensure the patient, provider and all care givers know a current list of medications that is accurate. Then apply START, STOP, CONTINUE decision-making to determine a true and accurate current list.	The act of reconciliation has two major steps: 1. Compiling a complete list of medications that the patient is currently on. 2. Determining which of these should be **Stopped**, which should be **Continued**, and what new meds should be **Started.**
Admission / Discharge / Transfer Med Rec	Represents 3 distinct times that medication reconciliation is documents during an inpatient/hospital encounter 1. Upon Admission 2. Upon Transfer from one level of care to another (e.g. ICU to med/surg unit) 3. At time of Discharge from hospital.	Current day EMR's provide each of these three functions in their med rec module. At discharge, new prescriptions need to be produced and transmitted or printed.	

Item	Structure	Function	Comment
CDS – Clinical Decision Support	Rules based on Boolean logic using IF, THEN, AND, OR, ELSE Statements	CDS rules are used in various manners in the medication management process: - Drug-drug interactions - Drug-allergy interactions - Drug-food interactions - Drug duplicates - Weight-dosing and Age-dosing mismatches More complex rules also look at clinical-drug interactions such as involving lab values and other clinical data.	Varies by each EMR and by each provider.
HL7	Health Level 7 refers to a set of international stand for transfer of clinical and administrative data between software applications	HL7 focuses on the application level of data transfer between systems.	HL7 is also the organization that oversees multiple HL7 standards, including version 2, version 3, C-CDA (a standard for clinical notes) and FHIR.
JSON	JavaScript Object Notation is an open-standard file format that uses human-readable text to transmit data objects consisting of attribute-value pairs and array data types.	Provide a standard for communication using the FHIR Restful API	JSON is one of the standard formats used for the FHIR Restful API. The origin FHIR collaboration team members dubbed themselves as the Argonauts as homage to the classic mythological tale of Jason and the Argonauts.
XML	Extensible Markup Language defines a set of rules for encoding documents that are both human-readable and machine-readable	To create programming code that a user can quickly review and understand.	A common standard on both the web and in healthcare applications.
RDF	Resource Description Framework is a family of specifications used on the world wide web.	Originally designed as a metadata data model for the Web.	A common standard on the Internet.

Item	Structure	Function	Comment
HTTP	Hypertext Transfer Protocol is an application protocol for distributed, collaborative, hypermedia information systems	To create a standard for exchanging data across internet connected servers and devices.	This is the foundation for data exchange over the Internet.
FHIR	Fast Healthcare Interoperability Resources	Provide an open standard for a restful API (Application Programming Interface) to enhance communication across different systems, such as electronic medical records (EMRs)	Current version, R4 includes the first Normative content. Work is ongoing to advance the remaining "Trial Use" content to Normative status as rapidly as possible.

Appendix H: The Nine Major Objectives and Activities of the MRP Work Group

1. Goal: Develop, implement and operate an **effective organizational structure and process**.
2. Goal: Establish **foundational definitions** for Work Group activities.
3. Goal: **Secure funding** for planning, design and implementation activities.
4. Goal: Develop strategies to **operationalize medication reconciliation** by defining responsibilities,
5. Goal: Identify mechanisms to enhance efficiency and effectiveness of **cancelling prescription medications**.
6. Goal: Develop strategies to **operationalize deprescribing** by defining responsibilities,
7. Goal: Develop strategies for **communicating with and engaging key stakeholders**.
8. Goal: **Support the implementation of priority recommendations** based on funding availability
9. Goal: **Evaluate the effectiveness** of any implemented standards and solutions.

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