

Design of a Clinical Decision Support System to Improve Medication Reconciliation

Team Members: Gordon Bleil, Jeremiah Rothschild, Lisa Beckman, Hugo Fernandes, Lisa Nelson

Table of Contents

■ Introduction	2
■ Approach	3
■ Use Case	4
■ Solution Overview	8
■ Information Model	9
■ System Logic	10
■ Prototype	11
■ Knowledge Acquisition and Maintenance	16
■ Architecture	17
■ Evaluation	19
■ Recommendations and Conclusions	21

Introduction

- With the implementation of the electronic medical record (EHR) at major health systems nation-wide, focus has begun to shift from electronic storage and retrieval of data to electronic coordination of care augmented by clinical decision support.
 - The present working definition of a [CDSS], according to Dr. Robert Hayward, a physician with Center for Health Evidence is:
 - *“CDSS link health observations with health knowledge to influence health choices by clinicians for improved (Wikipedia, 2010) (Liaw & Pradhan, 2010).”*
 - Our group project focused on improving medication reconciliation by employing an intelligent CDSS.
 - The CDSS is designed to bridge the medication information gap that exists between settings by providing a reconciled medication list in an electronic form.
 - Specifically, the objective is to have the CDSS tools facilitate discharge from an inpatient facility by considering the patient’s complete admission medication list while determining the discharge medication list.
 - The CDSS aims to improve detection of potentially harmful drug interactions within the fully reconciled list and to optimize medication selection based on knowledge of the indications of a patient’s problems, available drug therapeutic classifications, available medication formulary information and other outcomes data.
-

Approach

- Use case based with detailed workflow maps to clarify current process and future state for medication reconciliation.
- New design formed basis for an information schema used for knowledge model and specify processing logic required to create the application.
- Plan developed to address acquisition and maintenance of knowledgebase.

■ Planning

- Workflow maps to clarify current process and future state
- Information schema for knowledge model and processing logic
- Performance goals set for evaluation
- Plan for acquisition and maintenance of knowledgebase

■ Criteria

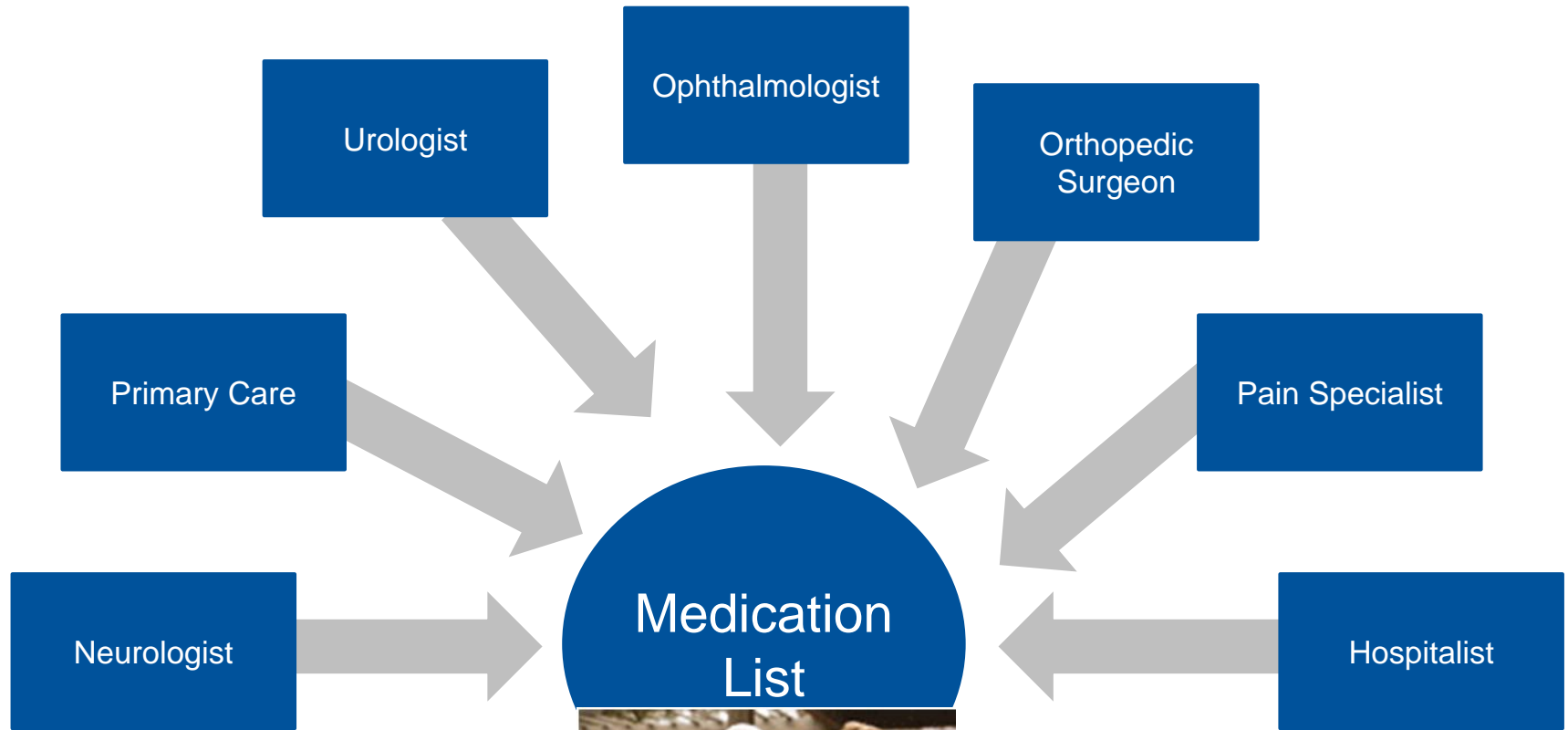
- 5 tasks of Medication Reconciliation
- Actors and stakeholders
- 3 simple scenarios
- EMR exists with CPOE
- Meaningful use
- Criteria for acceptance of the system

Use Case

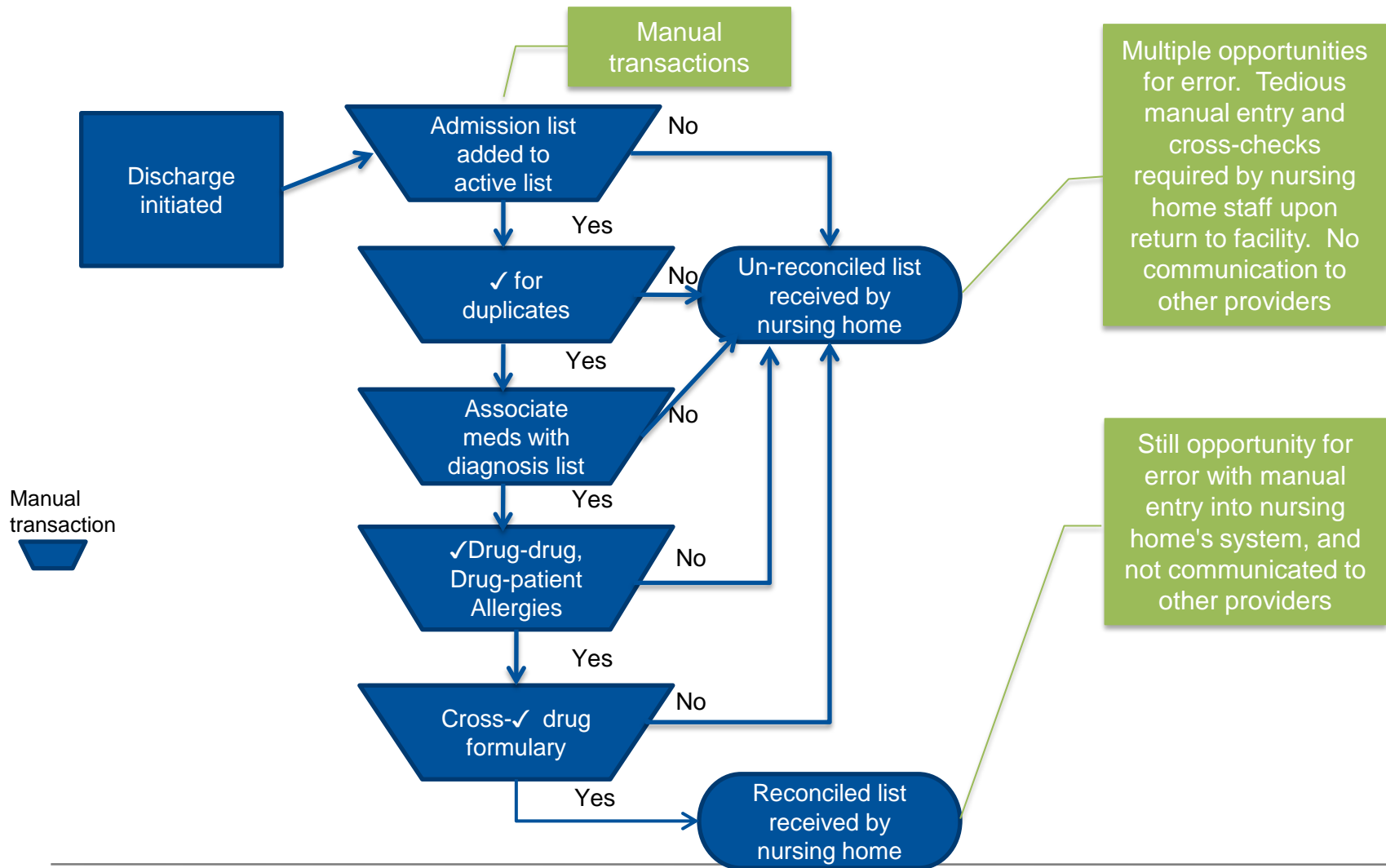
Medication Reconciliation to Support Care Transition for an Elderly Patient



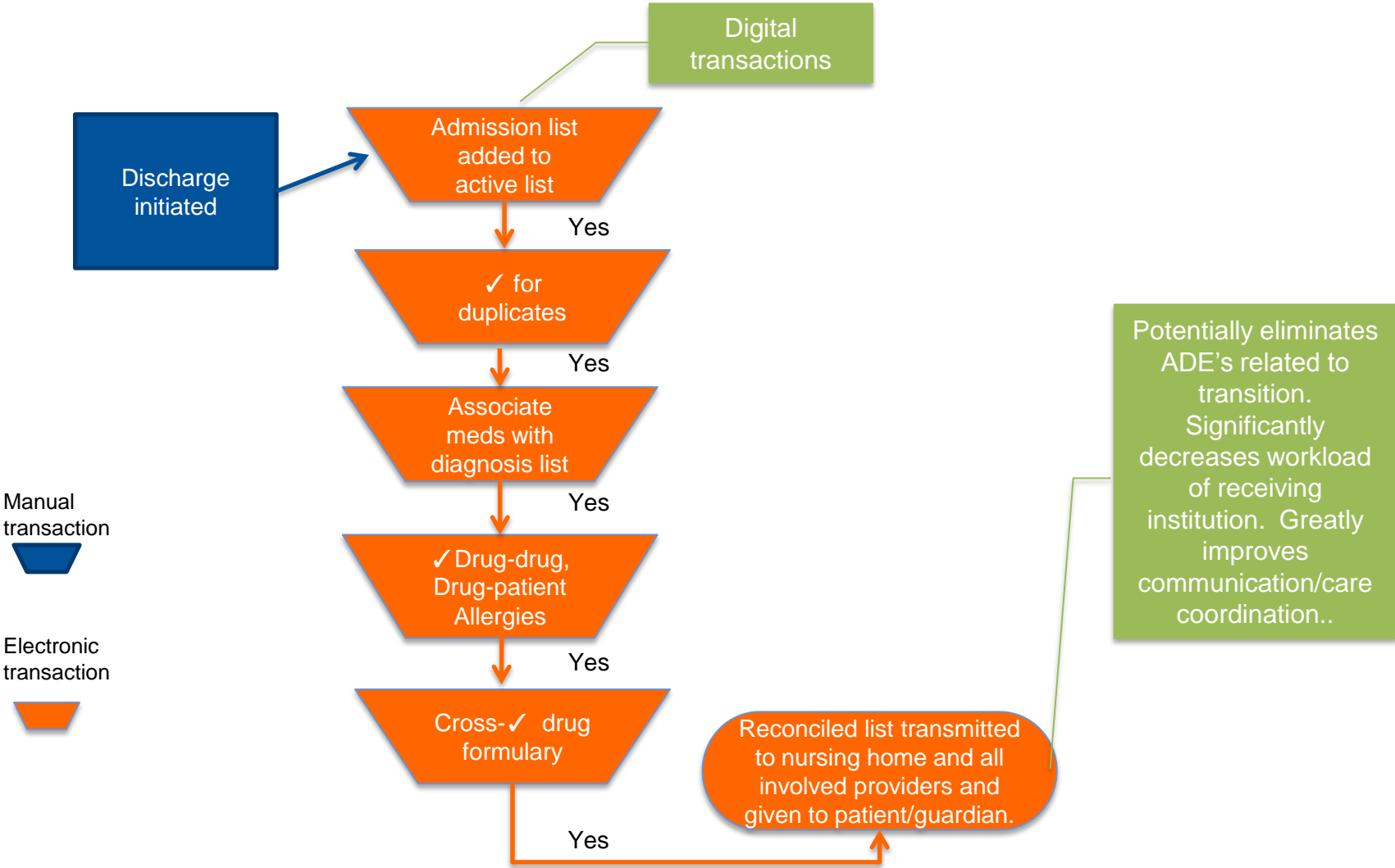
Use Case



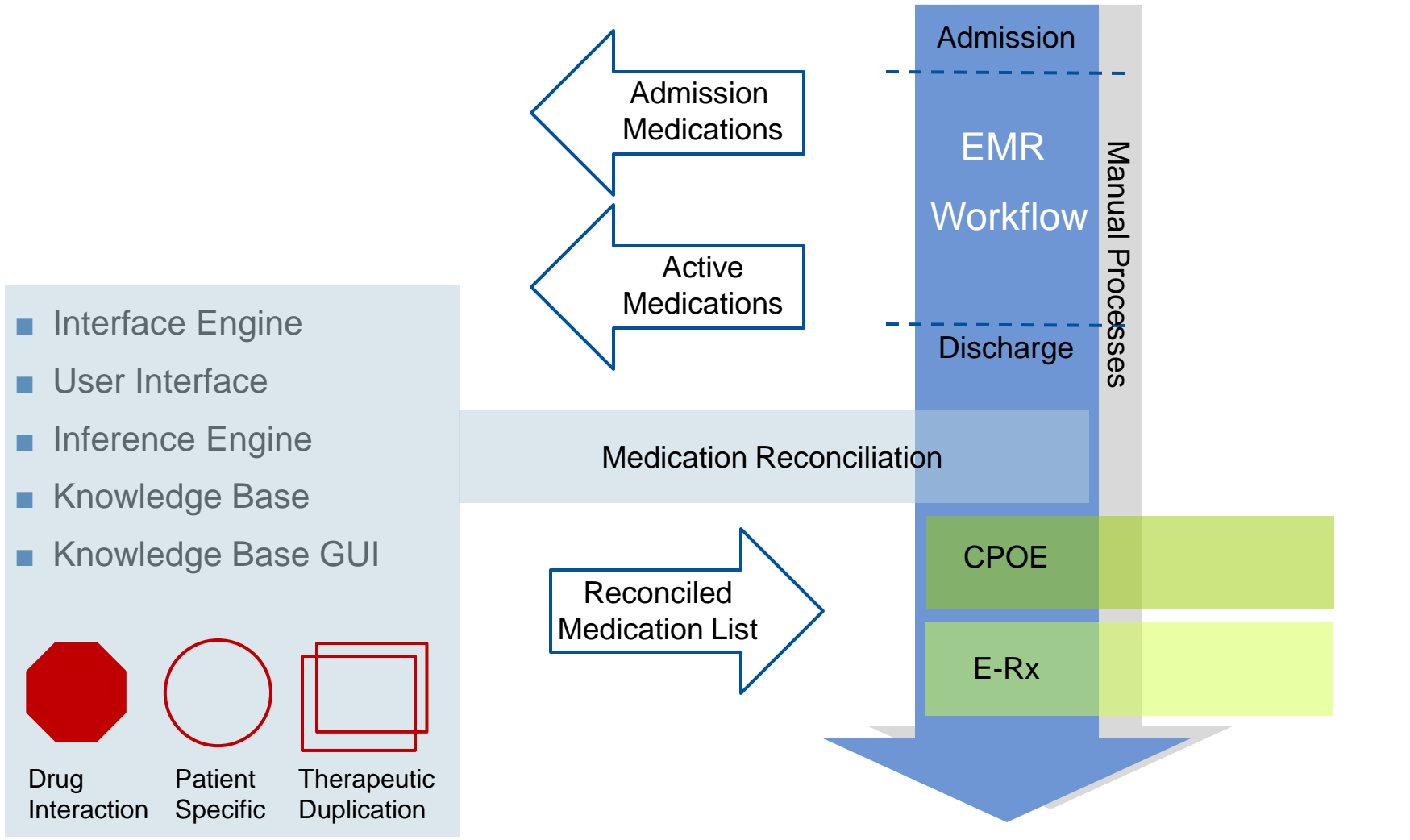
Current State Workflow for Medication Reconciliation



Future State Workflow for Medication Reconciliation CDSS

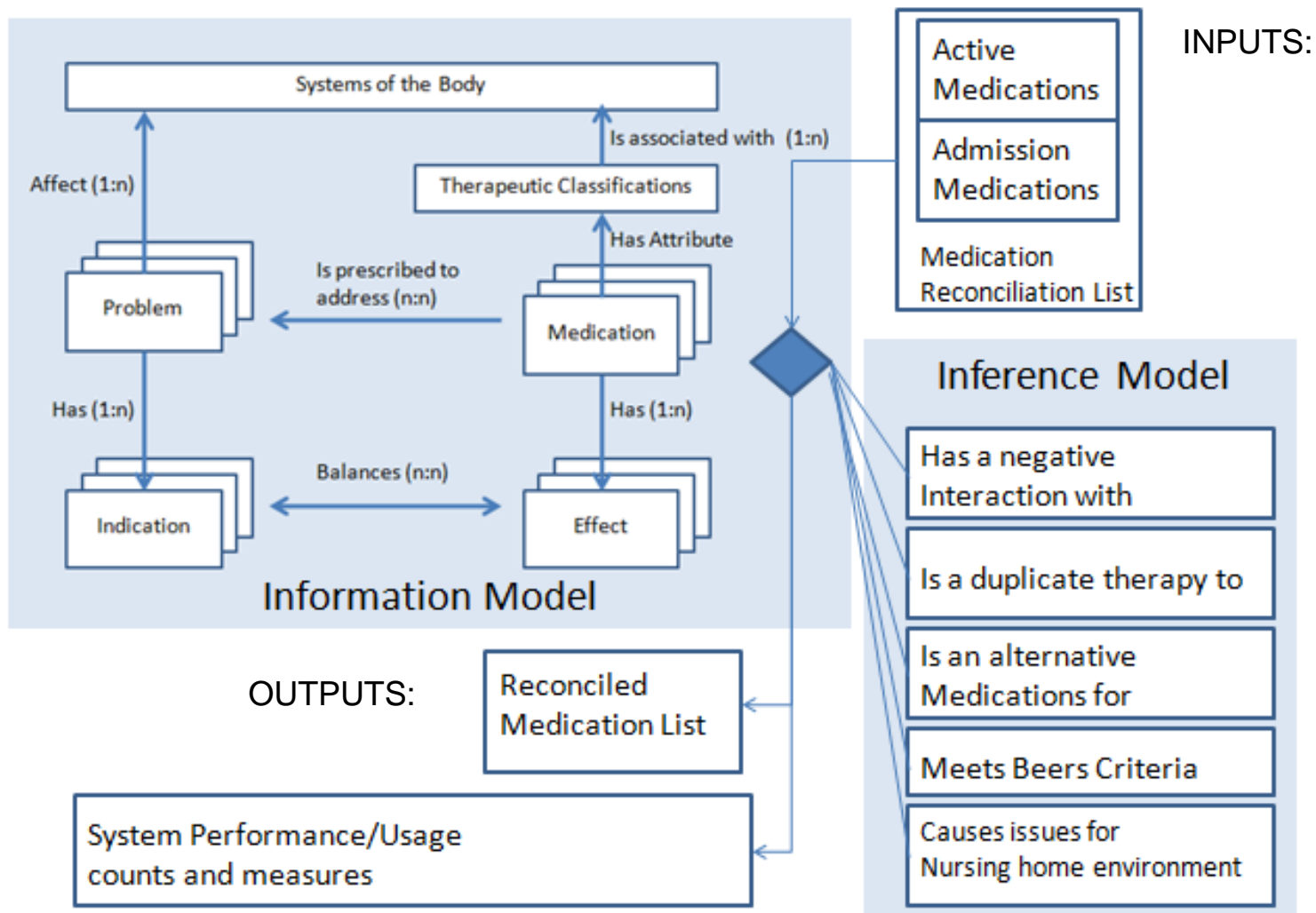


Solution Overview – Medication Reconciliation CDSS



Efficient, Complete, Safe and Optimized

Information Model



System Logic

■ Completeness

- if medication AdmissionMedList? then mark-A
- if medication Active? then continue
- if medication Stopped? then stop

■ Safety

- if medication DDInteract? then flag-s, group(conflict)

■ Duplication

- if medications DupTherp? then flag-d, group(class)

■ Other (Personalization)

- if medication not(DFormulary?) then flag-o, group(alts)
- if (age \geq 75) and (medication BeersCriteria?) then flag-o, group(alts)
- if (DischDest medication NursHomeIssue? then flag-o, group(alts)

■ Approval

- if medication not(Reconciled?) then prompt-missing, repeat
- if issue not(Exists?) then return-list,notes
- if issue Exists? then return-list,flags,notes

■ Performance, Improvement

- if Used? then count
- if evaluate Used? then count
- if conflict Resolved? then count
- if dup Removed? then count
- if alt Picked? then count
- if note Used? then count
- if medrec Incomplete? then count

■ Object

■ Criteria

■ Action

Prototype – Paperless, Complete View, Familiar Feel


Patient ID: MRN#999-999-99999		Medication Reconciliation			
Patient: LastName, FirstName		Worklist for:	Dr. Discharging Physician		
Formulary: Insurance Provider					
Reconciliation List		View Reconciled Meds		Approve	
Add Change				Evaluate Note	
	Medication	Class	Problem	Cont.	Stop
+ A	Aspirin	Analgesic Antipyretic Anti-platelet	Atrial fibrillation	<input type="checkbox"/>	<input checked="" type="checkbox"/>
+ A	Inderal	Beta blocker Antihypertensive	Artial fibrillation	<input type="checkbox"/>	<input checked="" type="checkbox"/>
+ A	nitroglycerine	Vasodilator	Angina	<input type="checkbox"/>	<input checked="" type="checkbox"/>
+ A	Restoril	Sedative	Insomnia	<input type="checkbox"/>	<input checked="" type="checkbox"/>
+ A	Tylenol	Analgesic Antipyretic	Pain	<input checked="" type="checkbox"/>	<input type="checkbox"/>
+ A	Coumadin	Anticoagulant	Atrial fibrillation	<input checked="" type="checkbox"/>	<input type="checkbox"/>
+ A	Imdur	Vasodilator	Angina	<input checked="" type="checkbox"/>	<input type="checkbox"/>
+ A	metoprolol	Beta blocker Antihypertensive	Coronary artery disease	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Cont.	Stop	System Suggestion
<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Cont.	Stop	Physician Confirms Suggestion
<input type="checkbox"/>	<input checked="" type="checkbox"/>	
OR		
Cont.	Stop	Physician Selects Alternative
<input checked="" type="checkbox"/>	<input type="checkbox"/>	

Prototype – Identify Potential Issues

Patient ID: MRN#999-999-99999		Medication Reconciliation			
Patient: LastName, FirstName		Worklist for:		Dr. Discharging Physician	
Formulary: Insurance Provider					
Reconciliation List		View Reconciled Meds		Approve	
Add Change		● ○ 📄 Evaluate Note			
A	Medication	Class	Problem	Cont.	Stop
+	A Inderal	Beta blocker Antihypertensive	Artial fibrillation	<input checked="" type="checkbox"/>	<input type="checkbox"/>
+	metoprolol	Beta blocker Antihypertensive	Coronary artery disease	<input checked="" type="checkbox"/>	<input type="checkbox"/>
+	Imdur	Vasodilator	Angina	<input checked="" type="checkbox"/>	<input type="checkbox"/>
+	A nitroglycerine	Vasodilator	Angina	<input checked="" type="checkbox"/>	<input type="checkbox"/>
+	A Restoril	Sedative	Insomnia	<input checked="" type="checkbox"/>	<input type="checkbox"/>
+	A Aspirin	Analgesic Antipyretic Anti-platelet	Atrial fibrillation	<input type="checkbox"/>	<input checked="" type="checkbox"/>
+	Coumadin	Anticoagulant	Atrial fibrillation	<input checked="" type="checkbox"/>	<input type="checkbox"/>
+	A Tylenol	Analgesic Antipyretic	Pain	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Hover over Flag to see the description



- Drug Interaction
- Patient Specific
- Therapeutic Duplication

Prototype – Expand Issue to Reveal Details

Patient ID: MRN#999-999-99999		Medication Reconciliation	
Patient: LastName, FirstName		Worklist for:	Dr. Discharging Physician
Formulary: Insurance Provider			

Reconciliation List	View Reconciled Meds
---------------------	----------------------

Add Change Evaluate

Medication	Class	Problem		
A Inderal	Beta blocker Antihypertensive	Atrial fibrillation	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input type="checkbox"/> Beta blocker <input checked="" type="checkbox"/> Antihypertensive		<input checked="" type="checkbox"/> Irregular heart beat <input checked="" type="checkbox"/> hypertension		
metoprolol	Beta blocker Antihypertensive	Coronary artery disease	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input type="checkbox"/> Beta blocker <input type="checkbox"/> Antihypertensive		<input type="checkbox"/> Irregular heart beat <input type="checkbox"/> hypertension		
A Imdur	Vasodilator	Angina	<input checked="" type="checkbox"/>	<input type="checkbox"/>
A nitroglycerine	Vasodilator	Angina	<input type="checkbox"/>	<input checked="" type="checkbox"/>
A Restoril	Sedative	Insomnia	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Ambien	Sedative	Insomnia	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Effects	Indications
Inderal	Atrial fibrillation
<input type="checkbox"/> Beta blocker <input checked="" type="checkbox"/> Antihypertensive	<input checked="" type="checkbox"/> Irregular heart beat <input checked="" type="checkbox"/> hypertension

Prototype – Physician Thoughts Captured

Patient ID: MRN#999-999-99999		Medication Reconciliation			
Patient: LastName, FirstName		Worklist for:	Dr. Discharging Physician		
Formulary: Insurance Provider					
<input type="button" value="Reconciliation List"/> <input type="button" value="View Reconciled Meds"/>		<input type="button" value="Approve"/>			
<input type="button" value="Add"/> <input type="button" value="Change"/>		<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="button" value="Evaluate"/> <input type="button" value="Note"/>			
A	Medication	Class	Problem	Cont.	Stop
A	Inderal	Beta blocker	Angina	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/> Beta blocker <input checked="" type="checkbox"/> Antihypertensive				
	metoprolol	Beta blocker Antihypertensive	coronary artery disease	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	<input type="checkbox"/> Beta blocker <input type="checkbox"/> Antihypertensive		<input type="checkbox"/> Irregular heart beat <input type="checkbox"/> hypertension		
	Imdur	Vasodilator	Angina	<input checked="" type="checkbox"/>	<input type="checkbox"/>
A	nitroglycerine	Vasodilator	Angina	<input type="checkbox"/>	<input checked="" type="checkbox"/>
A	Restoril			<input checked="" type="checkbox"/>	<input type="checkbox"/>
	Ambien			<input type="checkbox"/>	<input type="checkbox"/>

Note

More selective, longer acting agent is my preferred choice.

Note

Risk of wandering at night higher with Ambien, prefer Restoril.

Prototype – System Supports, Physician Decides

Patient ID: MRN#999-999-99999		Medication Reconciliation	
Patient: LastName, FirstName		Worklist for:	Dr. Discharging Physician
Discharge Formulary: Nursing Home XYZ			

Reconciliation List	View Reconciled Meds	Approve
---------------------	----------------------	---------

Add Change		Evaluate Note	
------------	--	---------------	--

	Medication	Class	Problem	Cont.	Stop
+ A	Coumadin			<input checked="" type="checkbox"/>	<input type="checkbox"/>
+ A	Imdur			<input checked="" type="checkbox"/>	<input type="checkbox"/>
+ A	Inderal			<input checked="" type="checkbox"/>	<input type="checkbox"/>
+ A	Tylenol			<input checked="" type="checkbox"/>	<input type="checkbox"/>
+ A	Aspirin	Antipyretic Anti-platelet		<input type="checkbox"/>	<input checked="" type="checkbox"/>
+ A	metoprolol	Beta blocker Antihypertensive	Coronary artery disease	<input type="checkbox"/>	<input checked="" type="checkbox"/>
+ A	nitroglycerine	Vasodilator	Angina	<input type="checkbox"/>	<input checked="" type="checkbox"/>
+ A	Restoril	Sedative	Insomnia	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Approve the Reconciliation?

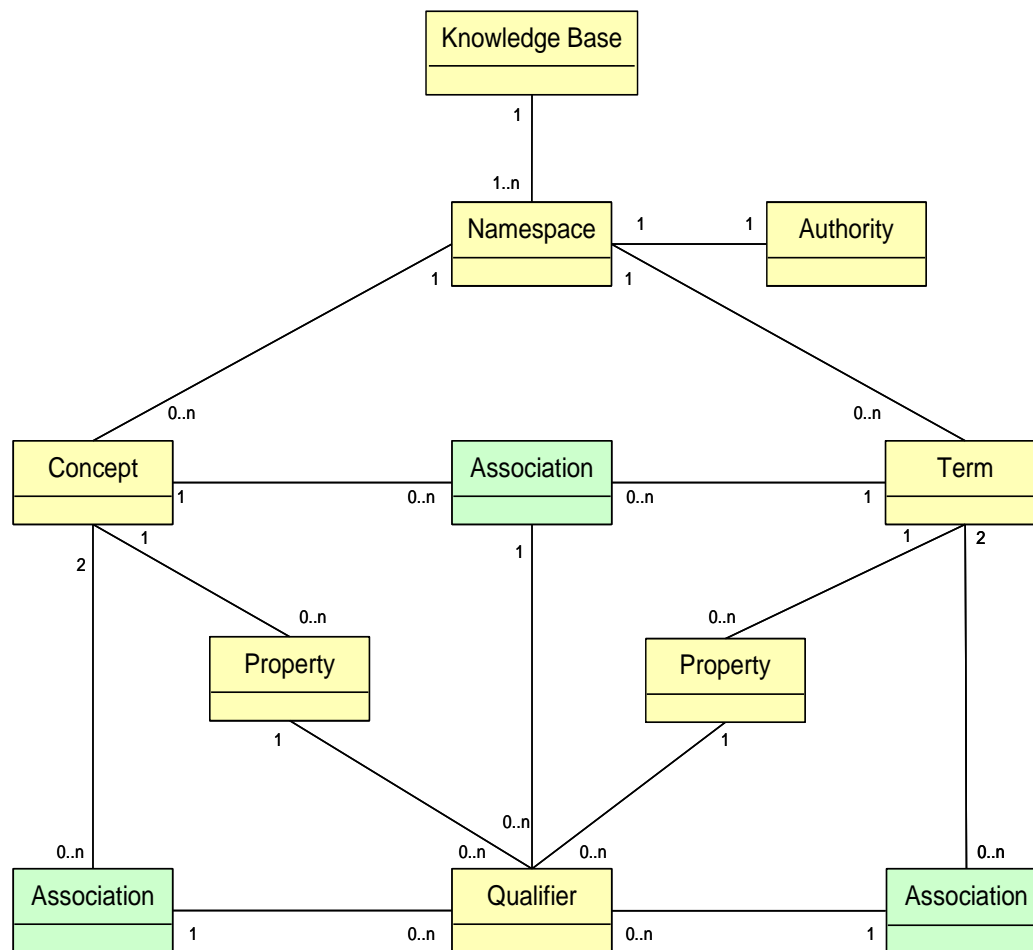
Alert messages and your notes will be included in the Discharge Summary.

Do you wish to approve the reconciliation with some alerts remaining?

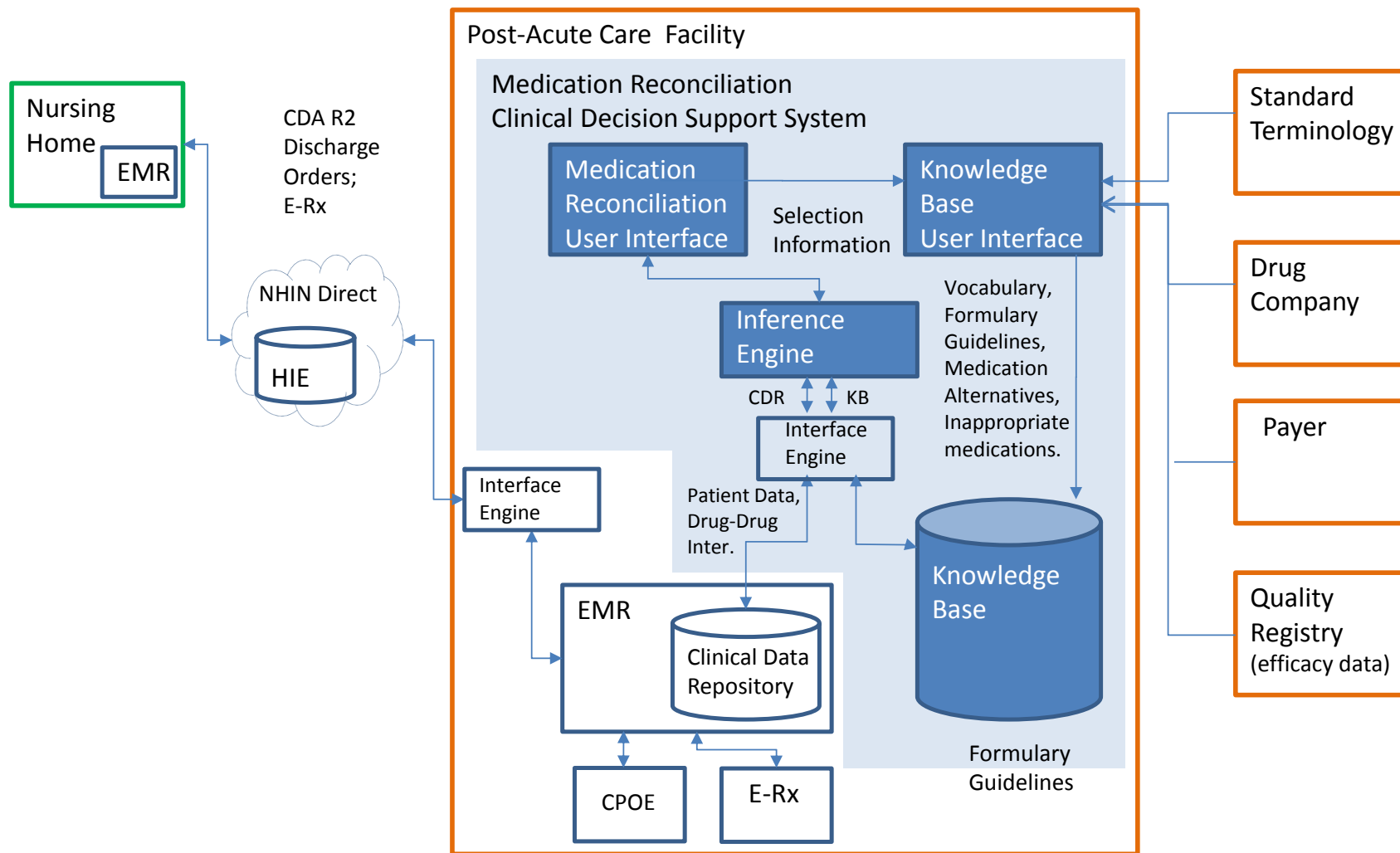
O.K. Cancel

Knowledge Acquisition and Maintenance

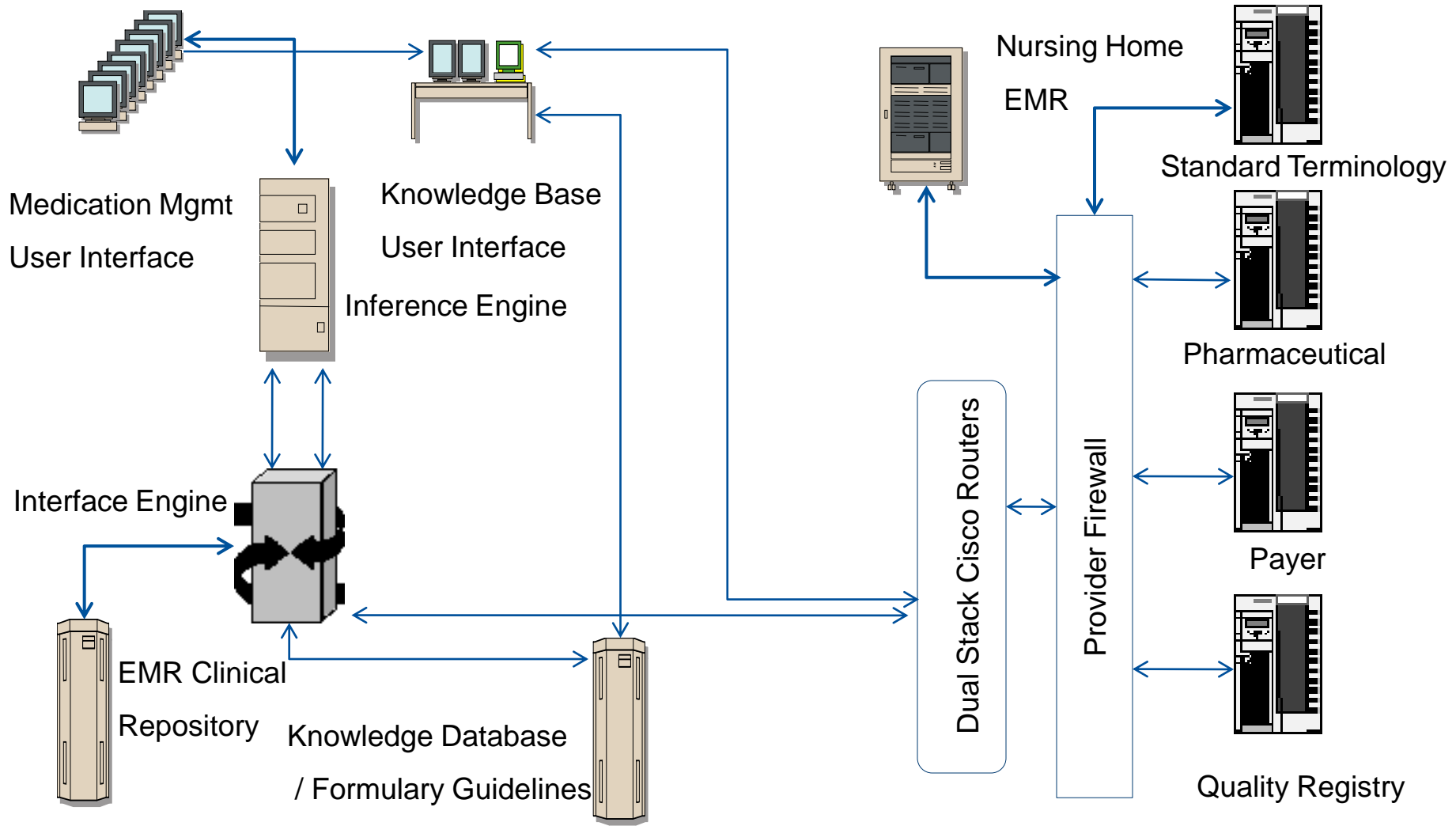
- Medication Terminology
 - RxNorm, NDF-RT
 - SNOMED CT
- Drug Formulary
 - Medicare Part D
 - Payer Formularies
 - Nursing Facility Formularies
 - Registries (Beers Criteria)
- Other
 - Nursing Home Issues
 - Personal Preference



Architecture – Logical Design



Physical Design



Evaluation (patient-centered)

Goals:	Measures:
<ul style="list-style-type: none">▪ Increase percentage of discharges where medication reconciliation is performed	<ul style="list-style-type: none">▪ Percentage of discharge encounters in which medication reconciliation was performed
<ul style="list-style-type: none">▪ Decrease ADEs related to transition of care:<ul style="list-style-type: none">– Complete/reconciled medication list upon transition to nursing home– No transcription errors during transition– Drug-drug, drug-allergy, drug-patient interactions avoided– Timely delivery of medications: no duplicated or missed doses	<ul style="list-style-type: none">▪ Percentage of ADEs related to transition of care, comparing pre- implementation to post-implementation
<ul style="list-style-type: none">▪ Decrease readmission related to ADEs	<ul style="list-style-type: none">▪ Percentage of readmission due to ADEs pre and post implementation
<ul style="list-style-type: none">▪ Improve communication between providers	<ul style="list-style-type: none">▪ Percentage increase in discharge encounters where reconciled list is shared with other providers
<ul style="list-style-type: none">▪ Improve communication to patient/guardian	<ul style="list-style-type: none">▪ Percentage increase in discharge encounters where reconciled list is shared with patient/guardian

Evaluation (user-centered)

Goals:	Measures:
<ul style="list-style-type: none">Discharging clinician will utilize medication reconciliation CDSS for 100 percent of discharge encounters	<ul style="list-style-type: none">Percentage discharge encounters in which medication reconciliation is performed
<ul style="list-style-type: none">Discharging clinician will perceive medication reconciliation as:<ul style="list-style-type: none">UsefulReliableUser-friendly	<ul style="list-style-type: none">Periodic (frequent and timely) end user surveys for timely evaluation and incorporation of suggested improvements, as well as error correction
<ul style="list-style-type: none">Receiving clinicians will perceive medication reconciliation as:<ul style="list-style-type: none">UsefulReliableUser-friendly	<ul style="list-style-type: none">Periodic surveys to nursing homes and other stakeholders to capture qualitative feedback
<ul style="list-style-type: none">“Error free” CDSS software/knowledge base	<ul style="list-style-type: none">On-going tracking of errors, with timely correction and frequent updates

Recommendations and Conclusions

Recommendations

- Select a system
 - Assure standardization & decision support
 - Invest users
 - Produce the linked GUI
 - Partner with supporting organizations
 - Solicit super-users
 - Engage nursing homes in data collection
- Effectively implement within 6 months
- Evaluate success long term

Conclusions

- Consistency
- Convenience
- Clarity
- Comprehensiveness