



Improving Medication Reconciliation

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Medication reconciliation

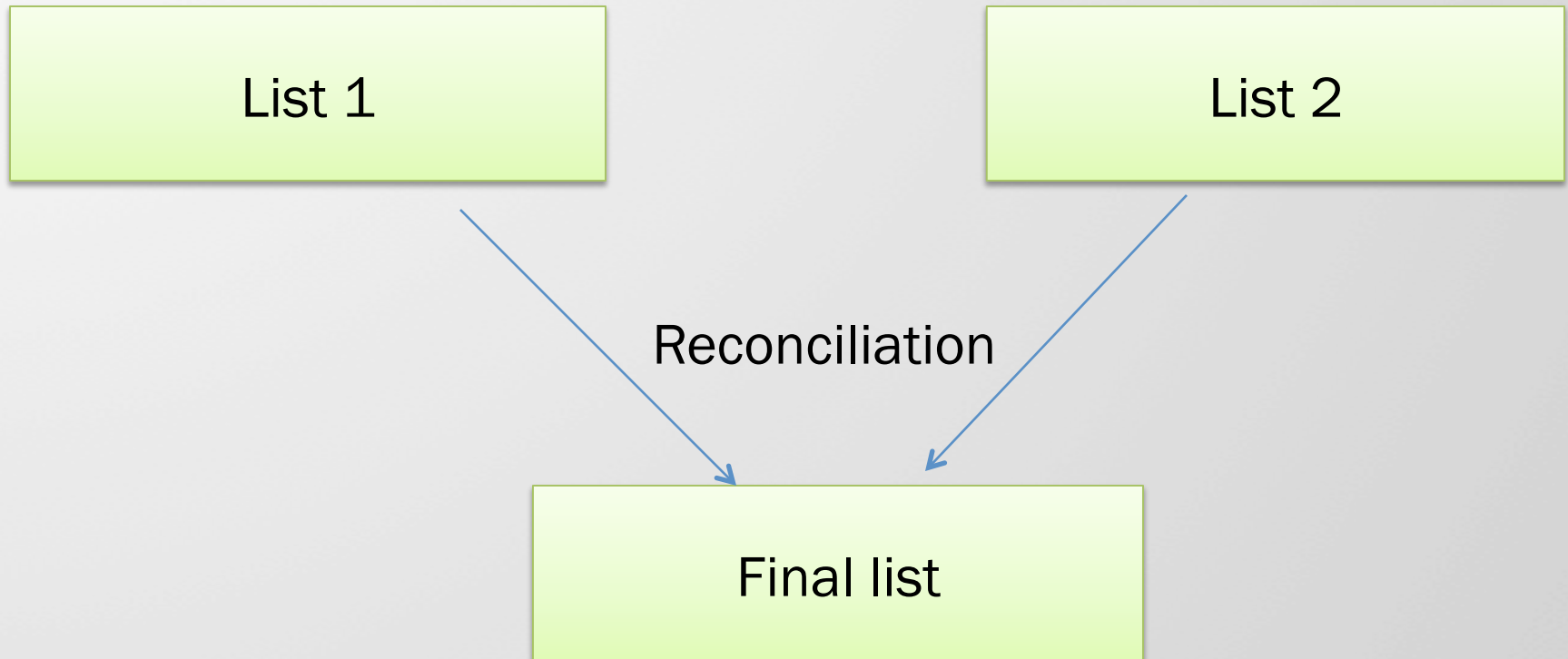
Many definitions, e.g.

- Develop list of current medications
- Develop a list of medications to be prescribed
- Compare the lists
- Make clinical decision based on comparison
- Communicate the new list to appropriate caregivers and to patient

One definition from:

http://www.ihs.gov/cio/ehr/index.cfm?module=medication_reconciliation

Compare and reconcile



Scenario 1: In Physician's Office



Interviews

Meds Patient says
he is taking

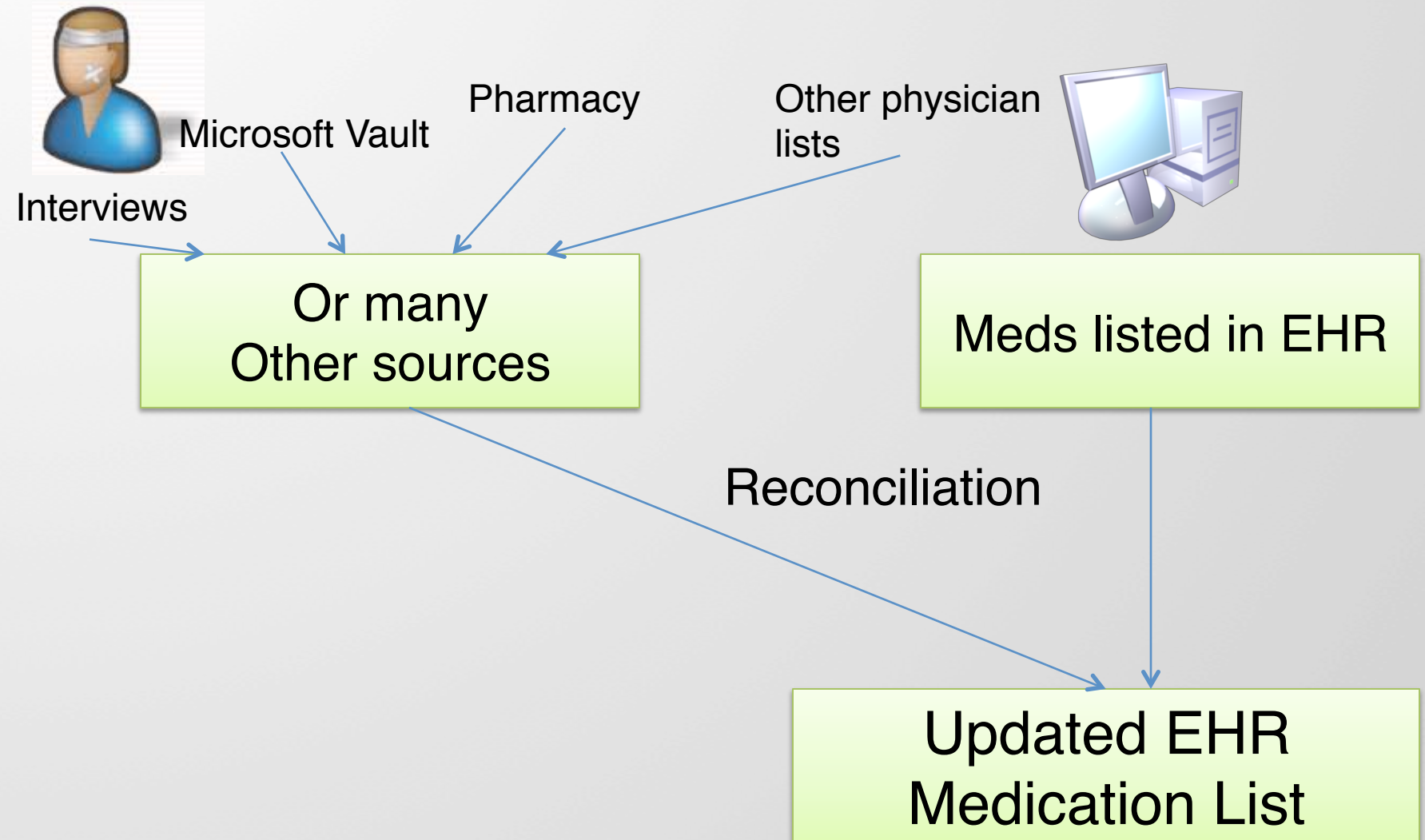


Meds listed in EHR

Reconciliation

Updated EHR med
List

Scenario 1: In Physician's Office



Scenario 2: At hospital (at discharge)



Meds reported by
patient during Intake



Meds given during
stay at the hospital

Reconciliation

Meds patient should
take after going home



Example of Medication Lists

Medication	Dosage	Frequency	Form
Quinapril	40 MG	b.i.d.	Oral
Warfarin	5 MG	q.d.	Oral
Lipitor	10 MG	q.d.	Oral
Sotalol	80 MG	q.d.	Oral
Sertraline HCl	50 MG	q.d.	Oral
Acetaminophen	325 MG	q.d.	Oral

Medication	Dosage	Frequency	Form
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Warfarin	5 MG	q.d.	Oral
Lipitor	10 MG	q.d.	Oral
Sotalol	80 MG	q.d.	Oral
Zoloft	50 MG	q.d.	Oral
Vicodin	5/500 MG	q.d.	Oral
Levaquin	10 MG	q.d.	Oral

- What's unique?
- What's identical?
- What's equivalent?

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Vicodin	5/500 MG	q.d.	Oral
Levaquin	10 MG	q.d.	Oral

Goal: A reconciled therapeutically appropriate list

Actions

- Continue/Accept
- Discontinue/Reject

- Modify and continue

Note: drug interaction alerts and ordering out of reconciliation definition

Levels of equivalences

Equivalence	Criteria	Example
Form Equivalence	Identical except for brand vs. generic	Advil = Ibuprofen Senormin = Atenolol
Functional Equivalence	Same therapeutic intent	Atenolol and Propanolol both betablockers
Partial Equivalence	Form or functional equivalence, but differ in dosage, frequency, or route	Advil 100 mg Acetaminophen 200mg
No equivalence	Unique in form and function	

2 prototypes

- #1. Interleave the 2 lists in one table
- #2. Spread the lists horizontally

#1. Interleave the 2 lists in one table

Lead: Eliz Markowitz

also Elmer V. Bernstam, Jorge Herskovic, Jiajie Zhang, Todd R. Johnson

National Center for Cognitive Informatics and Decision Making in Healthcare, Houston TX


Brad Blakenship

DOB: 12/26/1950

Sex: Male

Height: 77 IN

Weight: 200 LBS

Dr. Jorgito Herskovic

Date: 03/07/09

ID: 000000002



Original Lists

Reconcile Lists

Approve

Consolidated Record

Entry	Origin	Medication	Dosage	Frequency	Start Date	End Date	Form	Relation	
1	Dr. P	Zoloft	50 MG	q.d.	05/22/2006	Continuous	Oral	Brand	≡
		Sertraline HCl			03/22/2007			Generic	≡
2	Dr. P	Vicodin ▶	5/500 MG	q.d.	05/22/2006	Continuous	Oral	Brand	≡
		Acetaminophen	325 MG		03/22/2007			Generic	≡
3	Dr.	Levaquin	10 MG	q.d.	02/25/2009	03/10/2009	Oral	Unique	≡

Reconciled Record

Entry	Origin	Medication	Dosage	Frequency	Start Date	End Date	Form	Alerts	
1	Both	Quinapril	40 MG	b.i.d.	12/15/2000	Continuous	Oral	F	≡
2	Both	Warfarin	5 MG	q.d.	09/07/2008	03/06/2009	Oral	DI, F	≡
3	Both	Lipitor	10 MG	q.d.	12/15/2000	Continuous	Oral	DI, F	≡
4	Both	Sotalol	80 MG	q.d.	12/15/2000	Continuous	Oral	F	≡

Save



Exit



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1 ?	P	Sertraline HCl	50 MG	q.d.	03/22/2007	Continuous	Oral	Generic	≡
2	Dr. P	Vicodin ▶	5/500 MG	q.d.	05/22/2006	Continuous	Oral	Brand	≡
		Acetaminophen	325 MG		03/22/2007			Generic	≡
3	Dr.	Levaquin	10 MG	q.d.	02/25/2009	03/10/2009	Oral	Unique	≡

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3	Both	Lipitor	10 MG	q.d.	12/15/2000	Continuous	Oral	DI, F	≡
4	Both	Sotalol	80 MG	q.d.	12/15/2000	Continuous	Oral	F	≡
5 ?	Dr.	Zoloft	50 MG	q.d.	05/22/2006	Continuous	Oral	DI	≡

View Relations

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2	Dr.	Vicodin	5/500 MG	q.d.	05/22/2006	Continuous	Oral	Brand	≡
	P	Acetaminophen	325 MG		03/22/2007			Generic	≡
3	Dr.	Levaquin	10 MG	q.d.	02/25/2009	03/10/2009	Oral	Unique	≡

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2	Both	Warfarin	5 MG	q.d.	09/07/2008	03/06/2009	Oral	DI, DI, F	≡
3	Both	Lipitor	10 MG	q.d.	12/15/2000	Continuous	Oral	DI, F	≡
4	Both	Sotalol	80 MG	q.d.	12/15/2000	Continuous	Oral	F	≡
5	Dr.	Zoloft	50 MG	q.d.	05/22/2006	Continuous	Oral	DI	≡

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3	Both	Lipitor	10 MG	q.d.	12/15/2000
4	Both	Sotalol	80 MG	q.d.	12/15/2000
5 ?	Dr.	Zoloft	50 MG	q.d.	05/22/2006



quinapril ↔ food

Applies to: quinapril

GENERALLY AVOID: Moderate-to-high dietary intake of potassium can cause hyperkalemia in some patients who are using angiotensin converting enzyme (ACE) inhibitors. In some cases, affected patients were using a potassium-rich salt substitute. ACE inhibitors can promote hyperkalemia through inhibition of the renin-aldosterone-angiotensin (RAA) system.

MANAGEMENT: It is recommended that patients who are taking ACE inhibitors be advised to avoid moderately high or high potassium dietary intake. Particular attention should be paid to the potassium content of salt substitutes.

View Relations

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2	Dr.	Vicodin ▶	5/500 MG	q.d.	05/22/2006	Continuous	Oral	Brand	≡
	P	Acetaminophen	325 MG		03/22/2007			Generic	≡
3	Dr.	Levaquin	10 MG	q.d.	02/25/2009	03/10/2009	Oral	Unique	≡

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3	Both	Lipitor	10 MG	q.d.	12/15/2000	Continuous	Oral	DI, F	≡
4	Both	Sotalol	80 MG	q.d.	12/15/2000	Continuous	Oral	F	≡
5 ?	Dr.	Zoloft	50 MG	q.d.	05/22/2006	Continuous	Oral	DI	≡

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Entry	Origin	Medication	Dosage	Frequency	Start Date	End Date	Form	Relation	
1	Both	Warfarin	5 MG	q.d.	09/07/2008	03/06/2009	Oral	Equivalent	≡
2 ?	P	Sertraline HCl	50 MG	q.d.	03/22/2007	Continuous	Oral	Generic	≡
3	Dr. P	Vicodin ▶	5/500 MG	q.d.	05/22/2006	Continuous	Oral	Brand	≡
		Acetaminophen	325 MG		03/22/2007			Generic	≡
4	Dr.	Levaquin	10 MG	q.d.	02/25/2009	03/10/2009	Oral	Unique	≡

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2	Both	Lipitor	10 MG	q.d.	12/15/2000	Continuous	Oral	F	≡
3	Both	Sotalol	80 MG	q.d.	12/15/2000	Continuous	Oral	F	≡
4 ?	Dr.	Zoloft	50 MG	q.d.	05/22/2006	Continuous	Oral		≡

View Relations

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1	Both	Warfarin	5 MG	q.d.	09/07/2008	03/06/2009	Oral	Equivalent	≡
2 ?	P	Sertraline HCl	50 MG	q.d.	03/22/2007	Continuous	Oral	Generic	≡
3	Dr.	Vicodin ▼	5/500 MG	q.d.	05/22/2006	Continuous	Oral	Brand	≡
		Hydrocodone	5 MG						
		Paracetamol	500 MG						
	P	Acetaminophen	325 MG		03/22/2007	Generic	≡		
4	Dr.	Levaquin	10 MG	q.d.	02/25/2009	03/10/2009	Oral	Unique	≡

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3	Both	Sotalol	80 MG	q.d.	12/15/2000	Continuous	Oral	F	≡
4 ?	Dr.	Zoloft	50 MG	q.d.	05/22/2006	Continuous	Oral		≡

View Relations

Save



Exit

**Brad Blakenship**

DOB: 12/26/1950

Sex: Male

Height: 77 IN

Weight: 200 LBS

Dr. Jorgito Herskovic

Date: 03/07/09

ID: 00000002



Original Lists

Reconcile Lists

Approve

Consolidated Record

Entry	Origin	Medication	Dosage	Frequency	Start Date	End Date	Form	Relation	
1	Both	Warfarin	5 MG	q.d.	09/07/2008	03/06/2009	Oral	Equivalent	≡
2 ?	P	Sertraline HCl	50 MG	q.d.	03/22/2007	Continuous	Oral	Generic	≡
3 ?	P	Acetaminophen	325 MG	q.d.	03/22/2007	Continuous	Oral	Generic	≡

Reconciled Record

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1	Both	Quinapril	40 MG	b.i.d.	12/15/2000	Continuous	Oral	F, DI	≡
2	Both	Lipitor	10 MG	q.d.	12/15/2000	Continuous	Oral	F	≡
3	Both	Sotalol	80 MG	q.d.	12/15/2000	Continuous	Oral	DI	≡
4	Dr.	Levaquin	10 MG	q.d.	02/25/2009	Continuous	Oral	DI, DI	≡
5 ?	Dr.	Zoloft	50 MG	q.d.	05/22/2006	Continuous	Oral	DI	≡
6 ?	Dr.	Vicodin ▶	5/500 MG	q.d.	05/22/2006	Continuous	Oral	DI	≡

View Relations

Save



Exit



Exit

#1. Interleave the 2 lists in one table
Group equivalent drugs

#2. Spread the lists horizontally

Leo Claudino, Sameh Khamis, Ran Liu, Ben London, Jay Pujara
Students of CMSC734 Information Visualization class
TwinList project

TWINLIST

CMSC Class project. See Twinlist links in https://wiki.cs.umd.edu/cmsc734_11/index.php?title=Project_Teams

Animation

TwinList ☒ Separate ☐ Find Identical ☐ Find Unique ☐ Find Similar

Patient (Accept All)	E.R. (Accept All)
Aspirin daily 81 mg PO	Omeprazole daily 40 mg PO
Docusate Sodium BID 100 mg PO	Docusate Sodium BID 100 mg PO
Darbepoetin qFriday 60 mg SC	Ferrous Gluconate TID 300 mg PO
Calcitrol daily 0.25 mg PO	Darbepoetin qFriday 60 mg SC
Acetaminophen q4h 325 mg PO	Calcitrol daily 0.25 mg PO
Metoprolol daily 50 mg PO	Acetaminophen q4h 325 mg PO
Calcium Carbonate TID CC 500 mg PO	Metoprolol BID 100 mg PO
Meloxicam daily 7.5 mg PO	Ciproflaxocin daily 500 mg PO
Ramipril daily 5 mg PO	Calcium Carbonate TID CC 1000 mg PO
Atorvastatin daily 40 mg PO	Ramipril daily 5 mg PO
	Atorvastatin daily 60 mg PO



TwinList ☐ Separate ☐ Find Identical ☐ Find Unique ☒ Find Similar

Patient Unique (Accept All)	Patient Similar (Accept All)	Identical (Accept All)	E.R. Similar (Accept All)	E.R. Unique (Accept All)
Aspirin daily 81 mg PO				Omeprazole daily 40 mg PO
		Docusate Sodium BID 100 mg PO		
		Darbepoetin qFriday 60 mg SC		
		Calcitrol daily 0.25 mg PO		
		Acetaminophen q4h 325 mg PO		
	Metoprolol daily 50 mg PO		Metoprolol BID 100 mg PO	
	Calcium Carbonate TID CC 500 mg PO		Calcium Carbonate TID CC 1000 mg PO	
Meloxicam daily 7.5 mg PO				Ciproflaxocin daily 500 mg PO
	Atorvastatin daily 40 mg PO		Atorvastatin daily 60 mg PO	
		Ramipril daily 5 mg PO		

Patient

(Accept All)

Acetaminophen
q4h 325 mg PO

Aspirin
daily 81 mg PO

Atorvastatin
daily 40 mg PO

Calcitrol
daily 0.25 mg PO

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Docusate Sodium
BID 100 mg PO

Meloxicam
daily 7.5 mg PO

Metoprolol
daily 50 mg PO

Ramipril
daily 5 mg PO

E.R.

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Acetaminophen
q4h 325 mg PO

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Darbepoetin
qFriday 60 mg SC

Docusate Sodium
BID 100 mg PO

Ferrous Gloconate
TID 300 mg PO

Metoprolol
BID 100 mg PO

Omeprazole
daily 40 mg PO

Ramipril

SEE VIDEO on www.cs.umd.edu/hcil/sharp

Size by:

Color by:

Group by:

Sort by:

Name

Item Detail:

Attribute	Value

Just a start...

TwinList ☐ Separate ☐ Find Identical ☐ Find Unique ☒ Find Similar

Patient Unique (Accept All)	Patient Similar (Accept All)	Identical (Accept All)	E.R. Similar (Accept All)	E.R. Unique (Accept All)
Aspirin daily 81 mg PO	Atorvastatin daily 40 mg PO	Acetaminophen q4h 325 mg PO	Atorvastatin daily 60 mg PO	
	x Calcium Carbonate TID CC 500 mg PO	Calcitrol daily 0.25 mg PO	✓ Calcium Carbonate TID CC 500 mg PO	
		Darbepoetin qFriday 60 mg SC		Ciproflaxocin daily 500 mg PO
		Docusate Sodium BID 100 mg PO		Ferrous Gloconate TID 300 mg PO
Meloxicam daily 7.5 mg PO	Metoprolol daily 50 mg PO		Metoprolol BID 100 mg PO	

Telling a story
(layout as timeline?)



Can display be more compact?

More/better animation

Drugs with multiple compounds

Drugs with multiple therapeutic use

Undo ?

Show interactions graphically?

Medication Reconciliation

- More complex than it looks
- Multiple ways to address it



Original Lists			Reconcile Lists			Approve		
Consolidated Record								
Entry	Origin	Medication	Dosage	Frequency	Start Date	End Date	Form	Relation
1	Dr. P	Zoloft Sertraline HCl	50 MG	q.d.	05/22/2006	03/22/2007	Continuous Oral	Brand Generic
2	Dr. P	Vicodin 9 Acetaminophen	5/900 MG 325 MG	q.d.	05/22/2006	03/22/2007	Continuous Oral	Brand Generic
3	Dr. P	Laropin	10 MG	q.d.	02/25/2009	03/10/2009	Oral	Unique
Reconciled Record								
Entry	Origin	Medication	Dosage	Frequency	Start Date	End Date	Form	Alerts
1	Both	Quinapril	40 MG	b.i.d.	12/15/2000	Continuous	Oral	6
2	Both	Warfarin	5 MG	q.d.	09/07/2008	03/06/2009	Oral	uh, 6
3	Both	Lipitor	10 MG	q.d.	12/15/2000	Continuous	Oral	uh, 6
4	Both	Sotalol	80 MG	q.d.	12/15/2000	Continuous	Oral	6

TwinList				
<input type="button" value="Reset View"/> <input type="button" value="Separate"/> <input type="button" value="Find Identical"/> <input type="button" value="Find Unique"/> <input type="button" value="Find Similar"/>				
Patient Unique (Access:U)	Patient Similar (Access:U)	Identical (Access:U)	E.R. Similar (Access:U)	E.R. Unique (Access:U)
Aspirin daily 81 mg PO		Docusate Sodium 800 100 mg PO		Omeprazole daily 40 mg PO
		Darbeoprolin qFriday 60 mg SC		Ferrous Glconate TID 300 mg PO
		Calcitriol daily 0.25 mg PO		
		Acetaminophen q6h 325 mg PO		
	Metoprolol daily 50 mg PO		Metoprolol BID 100 mg PO	
	Calcium Carbonate TID CC 800 mg PO		Calcium Carbonate TID CC 1000 mg PO	Ciprofloxacin daily 500 mg PO
Meloxicam daily 7.5 mg PO		Ramipril daily 5 mg PO		
	Alovisatin daily 80 mg PO		Alovisatin daily 80 mg PO	

- Animation promising
- Need healthcare professionals' feedback

ACKNOWLEDGMENTS:

Strategic Health IT Advanced Research Projects Program (SHARP)

Office of the National Coordinator for Health Information Technology.

We particularly thank Drs. Zach Hettinger and Mark Goldman for their feedback, and Ran Liu for final push on Twinlist