Facilitating Medication Reconciliation with Animation and Spatial layout

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Abstract

Our project looks at novel user interfaces to facilitate medication reconciliation. We are focusing on the user interface that physicians might use to compare and merge two separate lists of medications. Similarities and differences between the lists need to be identified; decisions need to be made as to which medications should be continued and which ones should be stopped. We describe a novel prototype called TwinList that uses animation and spatial layout to reveal similarities, and color to highlight differences in similar medications. Simple interactive controls facilitate the selection of sets of medications to be continued or stopped. We are in the early stages of user evaluation.

Introduction

Within the medical community, there has been much research highlighting the need for improved medication reconciliation [1-6]. Preventable Adverse Drug Events (PADEs) are involved in 19% of post-treatment complications. Trial implementations of medication reconciliation policies show significant improvements. In one study, 94% of patients had some medication errors, of which a medication reconciliation process eliminated nearly all [6].

The entire process of medication reconciliation is a complex collaborative process in which many things can go wrong: the patients may not recall what medications they are taking (or may even be unconscious); the information may not be recorded properly and include a lot of unreported uncertainty (e.g. about dosage); the record of past medication orders may not be complete or not even be accessible at all; not all sources of medication orders for the patient may be known (e.g. they may have consulted a specialist on their own), etc. Eventually the physician is presented with multiple lists of medications from different sources (see Figure 1) which need to be reconciled into a single list that will be signed and saved in the medical record of the patient. Our focus has been on this last step of the process: facilitating the task of reviewing and sorting the medications that need to be continued from those that need to be stopped, following a careful and often iterative decision making process. Our interviews of physicians suggest that they do not have adequate tools or a well-described workflow to perform the medication reconciliation.

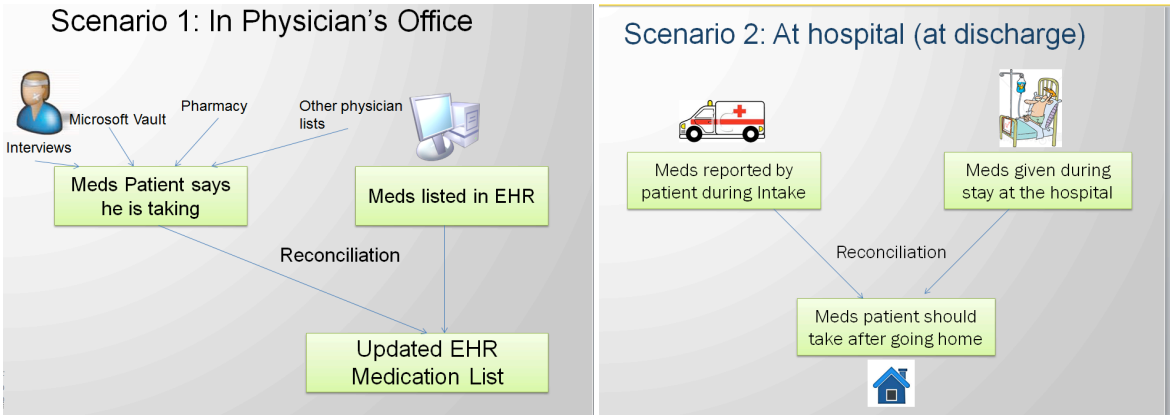


Figure 1: Example situations of medication reconciliation

Early prototypes

A first paper prototype was developed in collaboration with colleagues from the University of Texas at Houston and the University of Kentucky, and has been described in a separate paper [7]. It identified four levels of drug equivalence (Figure 1) and presents the matches between the two lists with a classic table view, using color highlighting to indicate matches (Figure 2).

Equivalence	Criteria
Form Equivalence	Identical except for brand vs. generic
Functional Equivalence	Same therapeutic intent
Partial Equivalence	Form or functional equivalence, but differ in dosage, frequency, or route
No equivalence	Unique in form and function

Figure 2. Four levels of drug equivalence – From [7].

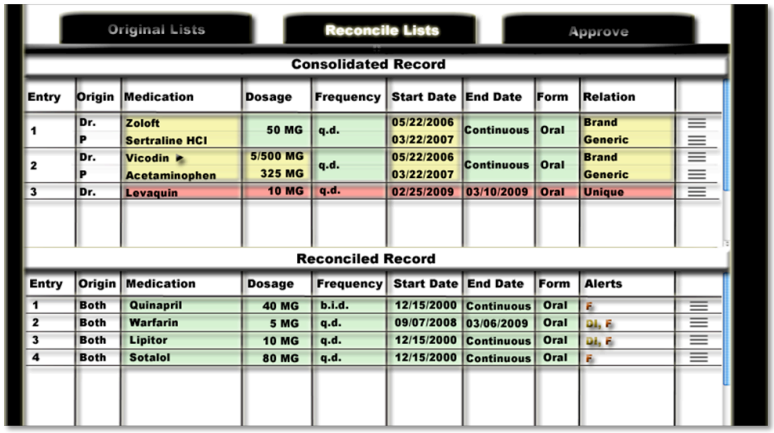


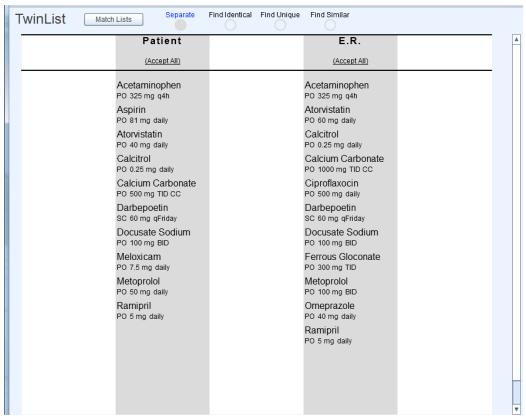
Figure 3: Example of a tabular interface used for presenting two medication lists combined in one table, from an earlier prototype [7]. After the two lists have been processed the drugs that are exactly the same in both lists (color coded in green) are automatically moved to the reconciled list (at the bottom). The remaining drugs are color coded. The drugs that appear only in one list are highlighted in red. The drugs that are similar but not an exact match between the two lists are grouped together in one large row and highlighted in yellow.

TwinList: a new prototype using animation and layout to show similarity

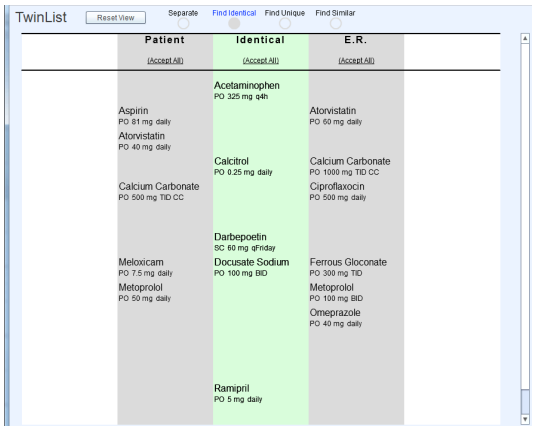
Here our goal was to investigate alternative ways of presenting the similarity information data. We developed TwinList, a prototype that uses spatial layout, color coding and animation to convey the similarity and differences between the lists (Figure 4 and 5). This prototype was developed by a team of students of the University of Maryland Computer Science department as a project for the Information Visualization class [8].

Using a spatial organization of data, we provide an intuitive way for users to quickly differentiate items that are the same from those that differ between the two lists. We used 3 categories: drugs are "identical" when they appear in both lists, "unique" when they appear in one list only, and others are "similar" when the drug has some level of equivalence with another drug in the other list (either form equivalence, functional equivalence or partial equivalence). We use animation to help users understand each step of the list comparison process; see Figure 4 (and video http://www.cs.umd.edu/hcil/sharp/slides/twinlist-v2-symposium-1024by768.mp4 . In addition, Twinlist provides grouping of the drugs by therapeutic use, which may be useful when the lists are very long.

After the medications have been reorganized to show similarities and differences users need to decide which medications will remain in the final reconciled list by accepting or rejecting drugs individually or as a group. Clicking on a drug brings a popup menu with the option to "Accept" or "Reject" it. Once the user has selected "Accept" or "Reject", the item is added to the top of either the Accepted or Rejected lists (Figure 5); the corresponding List Viewer item is either removed or grayed-out, according to the user-configurable option (which can be set in the Options Panel). Actions can be reversed if needed. More importantly physicians can accept or reject an entire column of drugs for example all the identical drugs, or all unique drugs from one list or the other.

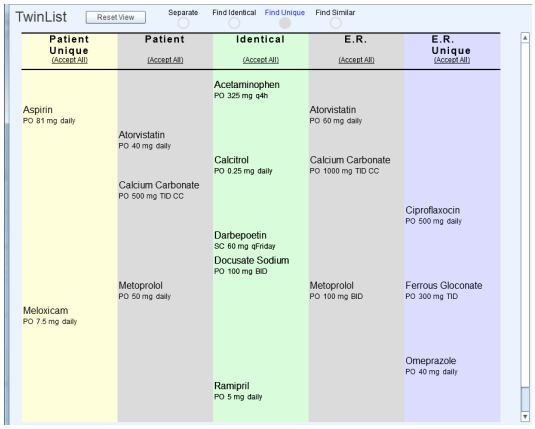


Original layout: two separate lists



Step 1: The identical drugs move to the middle

→ ←



Step 2: The Unique drugs move to the outside

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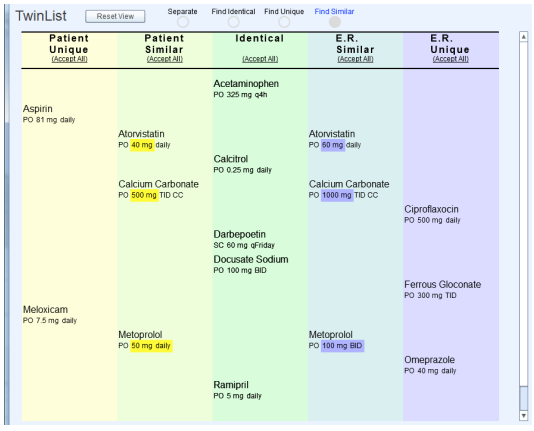

Step 3: The similar drugs are aligned, with their differences highlighted (here dosage differences

Figure 4: The 4 steps of the animation sequence sorting two lists of medications. We highly recommend that you watch the video demonstration at: http://www.cs.umd.edu/hcil/sharp/slides/twinlist-v2-symposium-1024by768.mp4.

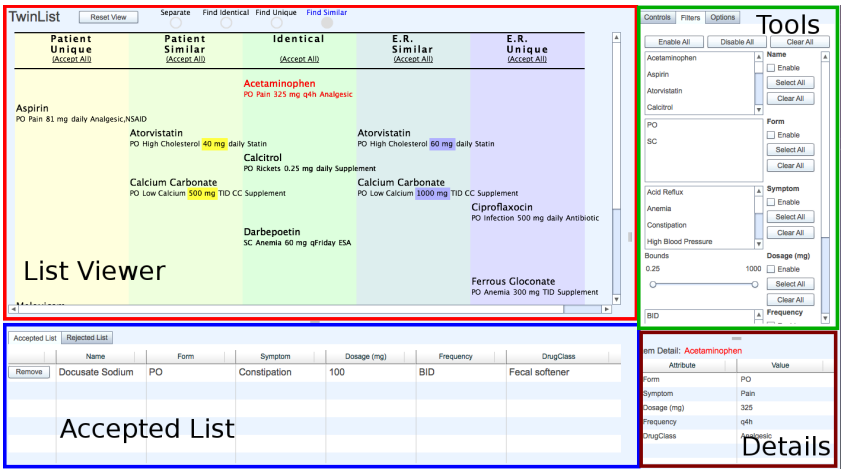

Figure 5. The TwinList interface: In the list viewer identical items appear in the center column, unique items in the outer columns and similar items in between. Color highlighting is used to indicate the differing attribute values. In the bottom left panel is the Accepted list; in the upper right panel, the Filter Panel; and in the lower right, the Details Panel, which displays all attributes for the selected item. In normal operation only the list viewer would be shown, until all the medications have been reconciled and the final accepted list can be approved.

Conclusions

We described a novel interface for medication reconciliation that uses animation and layout to indicate similarities and differences in pairs of medication lists and assist physicians enter their decisions regarding what to keep and what to discontinue. We are starting to gather feedback from representative users (physicians who do medication reconciliation in their daily practices). We are receiving positive feedback and continue refining our prototype. While the many issues that arise during the information gathering stages of medication reconciliation remain, we believe that Twinlist demonstrates that improved interface designs can facilitate the later stages of the reconciliation process.

Acknowledgments

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For more information see: http://www.cs.umd.edu/hcil/sharp

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