Evaluation of the Medication Sketch Artist, a New Method of Determining Unknown Patient Medications

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Abstract

Medication errors are responsible for a significant number of hospital admissions, and significant morbidity and mortality. Many of these errors result from differences in physicians' and patients' understanding of medications. Health care providers think in terms of medication name and dose, however patients remember size, shape, and markings of their medications more frequently than the names. The Medication Sketch Artist was developed to be a graphically interfaced medication identification system to aid in physician-patient communication. This pilot study evaluated the software's ability to identify medications described from memory by volunteers. Out of 25 pills, each described 5 separate times, there were 80 correct identifications, and 9 identifications of the correct medication, but at a different dose. The Medication Sketch Artist shows promise as a tool to determine unknown medications. It could play an important role in reducing medication errors.

Background

Medication errors are responsible for an estimated 7000 deaths per year, and adverse drug reactions result in nearly 100,000 deaths per year[1]. Adverse drug reactions and medication non-compliance are linked to 14.4% of admissions of elderly patients[2]. A conservative determination of the financial burden of these errors upon the medical system was between 76 and 100 billion dollars each year. Of these adverse drug events, a significant portion may be due to differences in the way that providers and their patients understand medications. Health care providers think about medications in terms of names and doses, while patients most often do not[3]. Empiric evidence related from many clinicians indicates that patients remember their medication based on physical characteristics, such as shape and color.

Health care providers who wish to determine what medications their patients are taking have limited options when the actual medications are not available during an encounter. The most common options are the Physician's Desk Reference ® and MicroMedex ™. Both have extensive collections of medication images, but must still be accessed by pharmaceutical name, National Drug Code number (NDC), manufacturer, or specific, unique alphanumeric markings. These searches are only effective when the medications are present during the visit. These applications are of little use in the more common instances when patients do not have their medications and are unsure of their previous diagnoses.

Studies have shown that picture aids improve effectiveness in searching pharmacy records for oral contraceptive use[4] and increase the number of correctly identified topical preparations in a dermatology practice[5]. Both studies utilized static images such as charts containing photos of relevant medications and packaging. These charts were more focused than either the PDR or MicroMedex images, but all presented multiple choices that bore no resemblance to the subjects' medications. However, they still demonstrate that providing a small number of pictures of medications improve patients' recall of their home-based regimens.

Materials and methods

The Medication Sketch Artist (MSA) was developed by one of the authors (G.L.) to be a graphically interfaced medication identification system. It provides visual representations of medication templates, which are altered as the patient chooses specific attributes for a medication including shapes, colors, and markings. This provides further visual representations to enhance recognition. A relational database contains attributes for the entity 'medication', and includes pharmaceutical name, dose, manufacturer, shape, color, presence and number of scores, size, unique alphanumeric markings, illustrations, and NDC number. The database contains information on 585 tablets and 133 capsules, which represents the current formulary of the Chicago West Side VA Hospital. The query allows for searches including multiple shapes, colors, the presence of scores, and the presence of letters and numbers. These attributes may also be deselected to allow for broader searches and to increase the number of medication choices to view. Each query returns all results that match the selected terms inputted by the operator. They are presented in the order that they appear in the database. The relational database was developed in Microsoft Excel, and the

Table 1				
Medication Name	**Shape**	**Color**	**Correct response**	**Mis-identified dose**
Propranalol 40 mg	round	light green	5	0
Methocarbamol 500 mg	round	white	2	0
Fenofibrate 54 mg	ellipse	mustard	2	0
Cabergoline 1 mg	oval	light salmon	3	0
Misoprostol	hexagon	white	3	0
Pioglitazone 45 mg	round	white	4	0
Nifedipine xr 90 mg	round	salmon	4	0
Cilostazol 25 mg	triangle	white	4	0
Olanzapine 20 mg	ellipse	pink	4	1
Isosorbide Mononitrate 60 mg	oval	white	3	1
Doxazosin 8 mg	oval	aqua	4	0
Dexamethazone 2 mg	round	white	3	0
Enalapril 10 mg	4 sided	salmon	0	3
Quinadine 200 mg	round	white	0	0
Dexamethazone 1 mg	pentagon	mustard	3	0
Nilutamide 150 mg	round	white	2	0
Lovastatin 10 mg	octagon	light salmon	5	0
Lamotrigine 200 mg	shield	light blue	3	1
Refocoxib 50 mg	round	light salmon	3	1
Etidronate 200 mg	rectangle	white	4	0
Ketoconazol 200 mg	round	white	5	0
Raloxafine 50 mg	ellipse	white	5	0
Ticlopidin e 250 mg	diamond	white	3	0
Simvastatin 10 mg	shield	pink	0	2
Minoxadil 3 mg	round	white	4	0

interface and query in Java (Sun Microsystems). Pill color was determined by comparing the actual medication to the Pantone solid in RGB guide, and size was determined in decimal inches using calipers. The NDC number was obtained from the original packaging material. This attribute is unique to the medication-dose-manufacturer and functions as a secondary key or index. In the future, this code may allow for linkage with other drug information software.

The MSA is designed to be eventually platform independent. For this pilot study, a Compaq Presario 2100 laptop computer (1.9 GHz) served as database storage and executed the main application.

25 students and faculty at the University of Illinois at Chicago were consecutively recruited as a convenience sample. Exclusion criteria included age less than 18 years, color blindness, as well as being a member of the medical profession (physician, nurse, pharmacist, home health aid, or students in training for health professions.) Research was approved through an expedited process by the UIC Institutional Review Board. Mean subject age was 25.0 (SD = 11.0), 64% were men, 84% wore glasses, and 16% regularly took medications.

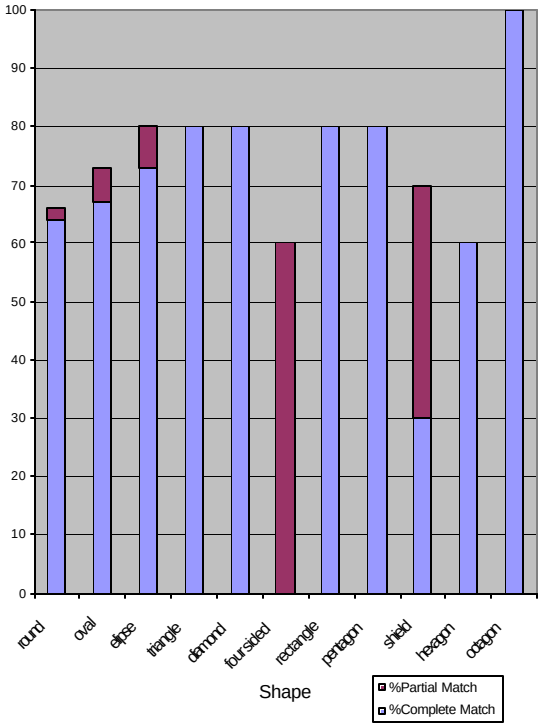
The tablets for the experiment (Table 1) were selected to ensure a variety of shapes, sizes and colors, but were weighted towards more common formulations (Table 2).

Table 2	
Round	10
Ellipse	3
Oval	3
Triangular	1
Shield	2
4-sided	1
Rectangle	1
Diamond	1
Pentagon	1
Hexagon	1
Octagon	1

A physician acted as user of the MSA with cooperation from the subject. The subject was formally consented through a written consent form. The physician was blinded to the contents of the study envelopes. To familiarize the subject to the experiment, a “tryout” envelope was provided. The subjects could examine the medications in this envelope in full view of the investigator, who could provide advice on features to take note of. When the subject was comfortable with the software, they were issued a test envelope containing 5 pills and were instructed to look at the pills one at a time, out of the sight of the investigator. They were requested to note the shape, color, and markings, and were given up to one minute to examine each pill. Once they finished examining a pill, they placed it in a second envelope, and did not look at it again. The subject then described the medication to the operator from memory, as both viewed the computer monitor. When the subject was satisfied with the search terms, the query was submitted, and results displayed. The subject then chose the pill they believed was the closest match by indicating its position on the screen. The selected pill, and the other potential choices were recorded. This process was repeated for each pill in the envelope. For our preliminary study, 25 subjects examined envelopes.

Time spent using the program was recorded, as well as a rating from 1-10 on ease of use (1 = Very Hard, 10 = Very Easy). Data elements were entered and analyzed using Microsoft Excel ® and SPSS (Version 11.0; Chicago, IL).

Figure 1



Results

Subjects' responses were considered to be of four types for each pill evaluated: a correct response; a misidentified dose of correct medication; a complete misidentification; and an unsuccessful query. Responses were considered correct if the subject identified the correct medication and dose. Responses were considered misidentified doses of correct medications if the subject's choices were of the same medications by the same manufacturer as the study pills, but of a different dosage. Responses were termed complete misidentifications if the medications did not match the study medications. Unsuccessful queries were those when the queries returned no responses, or the subject stated that the correct medication was not presented as a choice after three attempts. There were a total of 80 correct responses (64%), 9 misidentified dose of the correct medication (7.2%), 12 complete misidentifications (9.6%), and 24 unsuccessful queries (19.2%) (Table 1) shows the frequency of correct responses and misidentified doses (partial correct matches) by pill. (Figure 1) shows the frequency of completely correct matches, and partial correct matches stratified by pill shape. (Figure 2) shows the number of correct responses per subject.

The average time spent using the program; not including time spent using the "tryout" envelope was 15.3 minutes. The average rating of the programs ease of use was 8.12 out of 10.

Discussion

The MSA was used by subjects to help in identifying medications. A majority of medications were successfully identified. This preliminary research has provided information for review that will provide focus for further development in use as a tool. An additional study in the form of a randomized controlled trial will determine its efficacy by comparing use by pharmacists with and without the program. These will include patients recruited from the clinical environment, rather than volunteers.

Certain medications were more difficult to identify. Seven of the twelve complete misidentifications were from two pills. Both were round and white. One- Quinidine 200mg- had the letters "DAN" on both sides of the score on one side; and a four digit number on the reverse. This is a common set of markings, requiring subjects to recognize the exact number presented on the tablet. None of the 5 subjects who looked at the pill could do so. In addition, 2 pills - Simvastatin 10mg, and Enalapril 10mg - represented 5 of the 9 "misidentified dose of the correct medication" responses. The first was a shield shape, and the second a 4-sided pill. This illustrates the subjects' ability to identify the correct shapes, but indicates difficulty consistently defining pill color.

There were a number of limitations in this pilot study. This study involved a small number of subjects, and a limited number of medications. Most importantly, this study was not completed in a clinical setting. Patients who have taken multiple medications for many years may think of them differently than a healthy volunteer. Recall is significantly different between viewing pills daily before ingestion, versus the short-term interval before attempted identification.

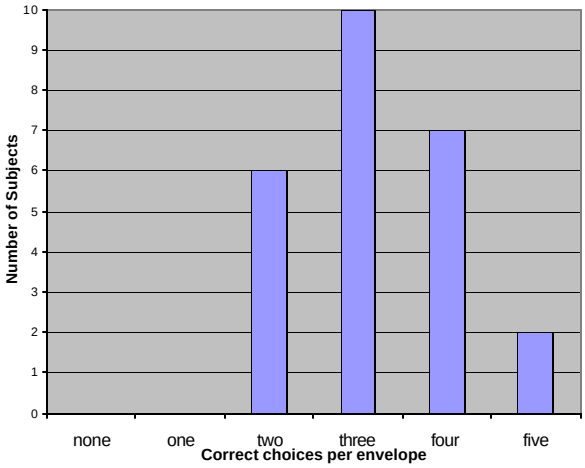
Furthermore, the database is small relative to the total number of medications on the market, which number near 10,000 (including parenteral, topical, and inhaled medications).[6] It is quite possible that additions to the database will increase the number of query results making it more difficult for patients to find their medication.

Therefore, improvements in the interface and query allowing for searching based on a range of sizes, and on presence of specific logos or images on the medications are planned for the future. Queries for capsules are also being added. As a Java-based application, the MSA is currently a "stand alone" application that requires both the interface and the database to be loaded on the same computer. It is

being converted to a HTML application allowing for potential access via the World Wide Web. This modification would also allow for database updates, and new query parameters to be implemented by all users without upgrading their copies of the software. Web accessibility would also allow providers with PDA devices with the proper wireless connectivity hardware to utilize the MSA at other points such as the emergency department, in an ambulance, a clinic waiting room, or a pharmacy.

It would be feasible to add an attribute for medication function, mechanism, or class. For example, patients could search for a "heart pill" or "diabetes pill." However, a concern remains for patients with multiple diagnoses who may not remember the function of individual medications. A query incorporating the wrong function could lead to further errors.

Figure 2



Conclusion

The Medication Sketch Artist may help in correctly identifying medications based on recalled physical characteristics. The MSA shows promise as a tool to determine unknown medications. It is likely to be useful in an emergency/urgent care setting to evaluate for possible toxic ingestion, medication interaction, and as a guide to previous diagnoses that patients do not divulge. One major requirement for success is that a capable patient is available to describe and identify prescribed medications. In the longitudinal clinic, the program may aid in evaluating whether patients are continuing to take discontinued medication, or if there have been changes in their regimen instituted by other providers. In all cases, it has the capability of reducing prescriptions of inappropriate medications with harmful interactions, and may thereby reduce medication errors. Further refinements of the interface and query may allow for improved functionality even with a larger database.

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