An Enhanced Data Model for a Pharmacy Expert System Within a Telemedicine Infrastructure

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The BJC Health System utilizes two custom automated expert systems for screening drug dosing and drug interactions: DoseChecker and PharmADE. Until recently, these expert systems used the National Drug Code (NDC) as their primary key to associate drug orders with the expert system rule base. Although this data model was useful, NDCs have several shortcomings associated with their use in a clinical expert system, namely,

- NDCs are suited for billing purposes, whereas expert systems need clinical specificity.
- NDCs are difficult to maintain because they are numerous, change often, and may be reused.

This paper describes the process of converting our pharmacy expert systems from an NDC-based system to a clinically relevant, code-based system and the impact that current telecommunication technology had on its implementation.

INTRODUCTION

The pharmacy expert systems developed by the Washington University School of Medicine and in use at BJC Health System have been previously described[1,2]. DoseChecker screens orders for drug-dosing errors, and PharmADE screens orders for serious drug-drug interactions on the basis of a set of expert system rules.

NDCs in both DoseChecker and PharmADE associate drugs orders with the expert system rule base. These 10-digit codes uniquely identify every drug product sold in the United States. They are often used for billing third-party payors and use the format "xxxxx-xxx-xx"[3]. NDCs are specific to the level of drug, formulation, packaging, pricing, and manufacturer. Therefore, there is a one-to-many relationship of drug to NDC codes.

Due to this specificity of NDCs, our expert systems were subject to the following maintenance and shortcomings:

- New NDCs required that time-consuming, manual changes be made to the expert system to integrate new codes.
- Any drug orders occurring before these manual changes were made were not screened by the expert system, creating a temporary hole in the screening process.

As an enhancement, we converted our expert systems from an NDC-based to a clinically relevant code-based system. We chose Multum Information Services, Inc. (a Cerner company based in Denver, CO) and its set of tables and references as the source for our clinically relevant codes. These codes allowed clinically relevant grouping of drugs under a single code in a many-to-one relationship.

Two of the most useful Multum identifiers are the Multum Drug ID and the Main Multum Drug Code (MMDC). These two codes serve complementary functions. The MMDC is a direct link to the drug vendor and product, similar to an NDC. The specificity of the code is similar to an NDC, including packaging and pricing, and also includes the NDC. The MMDC contains all the information that a pharmacist or hospital involved with buying, selling, and stocking drugs would need to know[4]. In short, the MMDC is a link to accounting or financial information. Multum Drug IDs are a much broader, less specific category that corresponds to the generic names of drugs. They are not vendor specific and have the simple format "dxxxxx," a six-character code that uniquely identifies it and distinguishes it from any other Multum Drug ID. Unlike NDCs, Multum Drug IDs are not typically used for billing purposes[4]. It is one example of a clinically relevant code-based system. Use of the Multum Drug ID has helped resolve the administration and time delays associated with implementation and maintenance of rules based on the NDC.

METHODS

The platform for both the NDC-based system and the Multum Drug ID-based system was the same. The database is Sybase Adaptive Server Enterprise 11.5 hosted on a Sun Enterprise 250 Server with a Sun Solaris 2.6 operating system.

RESULTS

With the implementation of a Multum Drug ID-based expert system, the expert system database

increased in size. The addition of Multum tables increased the size of the database by approximately 5 megabytes. In contrast, the PharmADE Drug Code table decreased in size from 350 rows—each row corresponding to a unique NDC—to 119 rows—each row corresponding to a unique Multum Drug ID. The addition of the Multum tables to the pharmacy expert system schema also necessitated monthly downloads from the Multum Web site to keep the tables current. Multum currently has no anonymous FTP site to facilitate automatic downloads of Multum data. Although lack of an anonymous FTP site is a drawback, its impact is minimized by the fact that we only download updated Multum data once a month. This drawback is further minimized by the fact that the entire manual process of downloading and updating Multum tables typically takes less than 1 hour. The cost associated with adding a new NDC to the expert system, including manually updating the appropriate expert system tables and testing the changes, is typically 4 hours per new NDC. On average, two NDCs were added to the Pharmacy Expert System each month. This now results in an approximate savings of 1 person-day per month. In a more dynamic environment where NDCs are added on a more frequent basis, the savings would be even greater. To address the issue of NDCs used by the BJC Health System but not included in the Multum Database, four unique "append tables" were generated to append data to the Multum tables. The append tables contain hospital-specific drugs or NDCs that have no match in Multum's tables. The append tables were generated to mirror Multum's Drug ID table, the NDC Core Description table, Route table, and NDC Main Multum Drug Code table. The benefits of using append tables include allowing the user the previously addressed benefits of using Multum tables while time-tailoring the system to satisfy institution-specific needs. Append tables provide a simple, systematic method of documenting and appending non-Multum data to existing Multum tables.

CONCLUSION

A simple change to our existing Pharmacy Expert System has reduced the following drawbacks associated with using NDCs in our clinical expert system:

- Our maintenance costs have been reduced because our rules are now linked to a clinically relevant code-based system. In our specific case, we chose Multum's Drug ID, instead of NDCs. The Multum Drug ID is a better clinical categorization of drugs than NDC.
- The possibility of missing a drug-drug interaction due to changes or additions of NDCs to the hospital formulary has been reduced. Now we receive information about new drug products by downloading periodic updates to the Multum tables in a more structured, timely fashion than before.

This enhancement has been significantly aided by current Internet technology but could be further enhanced by the addition of an anonymous FTP site.

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