

Improving Outpatient Medication Lists Using Temporal Reasoning and Clinical Texts

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Summary: An accurate and complete medication list in a patient's electronic health record (EHR) is critical to prevent medication prescribing and administration errors. Most software systems aggregate structured medication data from the EHR to generate and maintain a reconciled list. However, certain critical information for medication reconciliation and decision support exists in free-text clinical notes that may be unavailable in structured data. Structured data in a standard, predictable form can be processed easily by a computer, but narrative data are not codified and thus pose challenges. Natural language processing (NLP) is any system that manipulates free-form text or speech. NLP applications have been developed to identify and extract medical information from non-structured sources, but few projects have examined the use of NLP as a method for improving the accuracy of medication lists and facilitating medication reconciliation.

One challenge for medication reconciliation is that the drug names from various EHR applications and NLP systems are usually coded using different terminologies (e.g., a local terminology for a specific organization or a commercial terminology) and therefore not interoperable. This study investigated the feasibility of extracting medication information from non-structured electronic clinical sources within the Longitudinal Medical Record (LMR) system, the ambulatory care EHR at Partners HealthCare System. The extracted information can be used by clinicians at the point of care to reduce prescription and administrative errors. This project: 1) designed and developed an NLP application that identifies medication names and drug signatures (e.g., dose amount) and other contextual information (e.g., status) from free-text clinical notes; 2) encoded medication names using RxNorm and local terminology in the LMR; 3) conducted terminology mapping simultaneously; 4) structured the extracted information; 5) evaluated the tool by verifying the NLP output against manual review; and 6) identified requirements for a user interface to use NLP output for efficient medication reconciliation.

Specific Aims:

- Extract and encode medication information from clinical texts available in an ambulatory electronic medical record system. **(Achieved)**
- Apply temporal information (a controlled terminology, domain knowledge, and linguistic knowledge) to develop a mechanism to represent the timing of medication use, detect the changes, and then to organize medications in a chronological order and classify them into appropriate groups. **(Achieved)**

- Measure the feasibility and efficiency of the proposed methods and tools for improving the process of medication reconciliation. **(Achieved)**

2011 Activities: Dr. Zhou and her project team completed the development of the NLP system at the beginning of the year. The system, called the Medical Text Extraction, Reasoning and Mapping System (MTERMS), applies a modular, pipeline approach flowing from a preprocessor to a semantic tagger, a terminology mapper, and a context analyzer to a parser. It extracts free-text medication information (e.g., drug name, dose, and frequency), encodes drug names using different terminologies, and establishes dynamic mappings between them to improve data interoperability.

Thereafter, the project team evaluated the performance of MTERMS in processing medication information from clinical free-text documents. They focused on free-text outpatient clinical notes created mainly by patients' primary care physicians and medical specialists. Evaluators manually reviewed and compared 30 free-text and 10 structured outpatient notes with MTERMS output. The mapping between RxNorm and a local medication terminology in the LMR was also assessed, and requirements for integrating NLP output to the medication reconciliation process were studied.

Dr. Zhou and her team disseminated the results of the project in [Using Medical Text Extraction, Reasoning and Mapping System \(MTERMS\) to Process Medication Information in Outpatient Clinical Notes](#), an article in the Proceedings of 2011 Annual Symposium of the American Medical Informatics Association, and in [Mapping Partners Master Drug Dictionary to RxNorm using an NLP-based Approach](#), which was published in the *Journal of Biomedical Informatics*.

As last self-reported in the AHRQ Research Reporting System, project progress and activities were on track and project budget spending was on target. The project was completed in September 2011.

Preliminary Impact and Findings: Dr. Zhou and her team found that real-time clinical use of NLP in assembling the medication reconciliation list is feasible. However, a real-life application will require change management. For example, a terminology management process to review how updates to terminologies will affect the mappings and to track retired concepts is needed. A common occurrence in electronic order entry systems is free-text medication entries, which represent something of a 'black box' to the systems that process them. NLP could be used to extract coded medications from these entries and allow duplication alerts or a drug interaction system to catch potential medication errors.

Target Population: General

Strategic Goal: Develop and disseminate health IT evidence and evidence-based tools to improve the quality and safety of medication management via the integration and utilization of medication management systems and technologies.

Business Goal: Knowledge Creation
