Pattern Detection in Clinical Laboratory Data for Patient Identification and Quality Assurance

Andrew R. Post, M.D., James H. Harrison, Jr., M.D., Ph.D.
Center for Biomedical Informatics, University of Pittsburgh, Pittsburgh, PA

BACKGROUND
Therapeutic drug monitoring (TDM) is a useful tool for preventing Adverse Drug Events related to patient variability or inappropriate dosing. Typical physicians find proper interpretation of monitoring data difficult, however.1

Patient follow-up by TDM experts is an effective method of improving TDM utilization, but the cost of having such a service track all patient visits across an entire medical center is prohibitive. Therefore, we have developed a rule-based expert system called LabScanner that analyzes clinical laboratory drug concentration data from a laboratory information system (LIS) to identify a population of patients enriched in those who could benefit from expert follow-up.

METHODS
LabScanner was implemented in Java using the Java Development Kit (JDK) version 1.3 (Sun Microsystems, Inc.). It is an extension of a prototype system that was previously described.2 Our target user population is individuals who have a working knowledge of drug therapy and pharmacokinetics, but minimal technical background in computing and expert systems (e.g. clinical laboratory personnel, pharmacists, and clinical pharmacologists). A GUI is provided for creating rules, importing data, visualizing pattern matches, creating summary reports, and comparing data sets.

LabScanner identifies patients for follow-up based on four basic rule categories: (1) a sequence of drug concentrations outside the target range for that drug; (2) a sequence of increasing or decreasing drug concentrations with specified slope and projected values; (3) excess variability between sequential drug concentrations; and (4) inappropriate frequency of drug monitoring. Data adequate for application of these rules can be supplied by LIS’s of most medical centers.

A sliding window algorithm is used to scan the data. The inference engine determines whether or not a sequence of values within a window completely satisfies a rule. If consecutive windows match the same rule, a single pattern match is recorded and the number of additional days over which the pattern extends is called the persistence of the pattern.

EVALUATION
To quantify the incidence of patterns in a selected patient population, a set of rules was developed for detecting patients treated with phenytoin who have problem drug concentration patterns. LabScanner was then used to conduct a retrospective review of 412 inpatients and outpatients at the University of Pittsburgh Medical Center from May to August, 2000 who had two or more phenytoin levels drawn. One half of patients (208) were found to have patterns of interest, which corresponded to an average of 1.7 new patients detected per day. Nearly half of those patients (99) had persistent patterns. Average persistence time was 4.1 days.

DISCUSSION
These data may indicate drug concentration problems and/or inappropriate use of TDM. Detailed follow-up of this patient population may allow improvement of their care and may also produce more useful information for medical process improvement than analysis of a subset of TDM patients chosen at random.

The patient selection framework we have implemented provides a method of improving the effectiveness of TDM that may be deployed with the current resources of most medical centers. Note that our framework is not intended for automated diagnosis or data interpretation, but to focus the attention of relatively scarce resources where it would be most beneficial.

References