Visual Analysis of Complex Adverse Drug Reactions in Claims Data

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Abstract

This paper describes visual analytic capabilities developed by the US Army Pharmacovigilance Center (PVC) to support pharmacovigilance safety studies, illustrated with a complex ADR example as the use case.

Introduction

The PVC developed and operates the Pharmacovigilance Defense Application System (PVDAS) to perform medication safety surveillance for the Military Health System. PVDAS is a software suite with an accompanying medical datamart that currently contains data from 2005 to the present for about 16 million patients. PVDAS also has visualization tools closely integrated with its analytic modules.

PVDAS Visualization Tools

PVDAS visualization tools include (i) EventFlow[1] developed at the University of Maryland and (ii) single and multiple-patient timeline displays developed by Commonwealth Informatics under an SBIR led by the PVC. EventFlow supports a visual query mechanism allowing the user to subset the timeline displays, and also has an innovative display in which the individual timelines are aggregated to highlight common temporal patterns. EventFlow can be configured to work with any data source. The Commonwealth single-patient timeline displays a complete patient history while the multi-patient timeline focuses on providing a visual overview of the temporal distribution of the suspected drug(s)-event(s) relationship. The interface includes capabilities to zoom to the periods of interest, to explore data at different levels of a terminology hierarchy, and in the case of multi-patient timelines, to align the data according to significant events rather than absolute time. The current version of this software has been tested with the OMOP CDM subset used by OSIM2 and will be part of an analytics package offered commercially by Commonwealth Informatics under SBIR regulations.

Case Study: Analysis of Outcome Drug Reaction Eosinophilia and Systemic Symptom (DRESS)

In December 2014, the FDA warned that ziprasidone may be associated with the serious condition Drug Reaction Eosinophilia and Systemic Symptom (DRESS). Symptoms include: rash, fever, lymphadenopathy, eosinophilia, hepatitis, nephritis, pancreatitis, and inflammation of other organs. The current diagnosis standard specifies that "simultaneous" occurrence of any three of the individual symptoms constitutes a "notification case" with medical review required for confirmation. Correctly identifying this syndrome based on claims data is extremely challenging. Our goal was to algorithmically identify "notification cases" and then visually highlight the evidence to help a medical reviewer decide whether to request a detailed chart review for final confirmation. We began by identifying 339 potential notification cases that had at least two or more of the individual DRESS criteria occurring within 60 days after exposure to ziprasidone. For initial review we loaded these cases into EventFlow and used it to identify patterns of exposure and condition onset (Figure 1). We then presented the cases for detailed review using the multi-patient timeline and single-patient timeline (Figures 2A, 2B). Using these visualizations, a medical reviewer was able to rapidly eliminate about two-thirds of the cases, and then make an initial determination on the remainder in just a few minutes per case. A full chart review will be required for final determination on the set of 30-60 "likely" cases identified through this process.

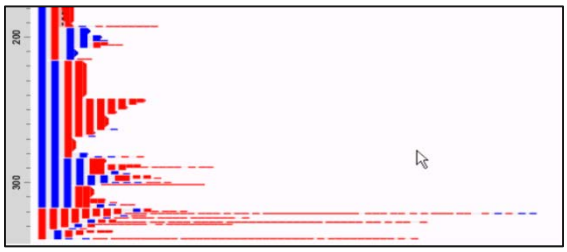

Figure 1: EventFlow aggregate view of suspected cases

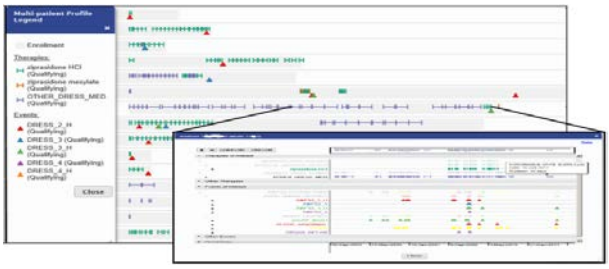

Figure 2. Multi-patient timeline (A) with single-patient drilldown (B)

Conclusion

When dealing with complex outcomes such as DRESS, "blind" algorithmic approaches are not sufficiently precise; visual analytics in the form of single- and multiple-timeline displays can greatly ease the burden of medical review

Reference

[1]http://www.cs.umd.edu/hcil/eventflow/. Accessed September 28, 2015.