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Analytic fusion of ESSENCE clinical evidence sources for routine decision support

Howard Burkom[1]*, Yevgeniy Elbert[1], Liane Ramac-Thomas[1], Richard Seagraves[1], Chong Lee[1], Wayne Loschen[1] and Kenneth Cox[2]

[1]Johns Hopkins University Applied Physics Laboratory, Laurel, MD, USA; [2]Armed Forces Health Surveillance Center, Silver Spring, MD, USA

Objective

The project objective was to develop and test a decision support module using the multiple data sources available in the U.S. Department of Defense(DoD) version of the Electronic Surveillance System for Early Notification of Community-Based Epidemics (ESSENCE).

Introduction

Block 3 of the U.S. Military ESSENCE system affords routine access to multiple sources of data. These include administrative clinical encounter records in the Comprehensive Ambulatory Patient Encounter Record (CAPER), records of filled prescription orders in the Pharmacy Data Transaction Service (PDTS), developed at the DoD Pharmacoeconomic Center, Laboratory test orders and results in HL7 format and others. CAPER records include a free-text Reason for Visit field, analogous to chief complaint text in civilian records, and entered by screening personnel rather than the treating healthcare provider. Other CAPER data fields are related to case severity. DoD ESSENCE treats the multiple, recently available data sources separately, requiring users to integrate algorithm results from the various evidence types themselves. This project used a Bayesian network (BN) approach to create an ESSENCE module for analytic integration, combining medical expertise with analysis of 4 years of data using documented outbreaks.

Methods

The strategy was to emulate a domain expert's use of ESSENCE by means of a BN whose inputs were outputs of alerting algorithms (1) applied to data streams chosen for specificity to acute illness in outpatient encounters, laboratory tests and prescribed medications in the chosen syndromes. Efforts were restricted to 5 syndrome groups seen as amenable to fusion of the ESSENCE sources: influenza-like illness, gastrointestinal, fever, rash and neurological.

Major subtasks included modifying the ESSENCE chief complaint processor (2) for CAPER syndrome classification, selection and judicious use of fields in chemistry and microbiology test data, selection of generic code number (GCN) groups of prescribed medications, development and implementation of an algorithm testbed for the various streams to be fused and elicitation of domain expertise to design BNs for practical decision support.

Results

Initial findings from fusion using severity concepts in CAPER data yielded sharp alerting reduction from pure algorithmic methods, with a timeliness loss of 1 day in 2 known outbreaks, no days in 4 others. The alert reduction was dramatic in datasets from small facilities, typically reducing the alert rate from 20 per year to below 5. In larger facilities, the reduction was less dramatic but often over 50%. Time series chosen from the laboratory test and GCN groupings were tested using additional known outbreaks. Results of fusing all algorithmic output streams will be presented.

Conclusions

This approach avoids the need to routinely examine multiple evidence sources and encourages routine investigation, not only by reducing alerting but also by directing attention to alerts that are likely connected with serious illness, with readily accessible details on which criteria were activated.

Keywords

Fusion; Bayesian network; outbreak detection; chief complaint; Department of Defense

References

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*Howard Burkom
E-mail: howard.burkom@jhuapl.edu

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