Emerging Health Threats Journal 2011, **4**:s10. **doi:** 10.3134/ehtj.10.010

www.eht-journal.org

ABSTRACT

Analytic disease surveillance methodology based on emulation of experienced human monitors

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Objective
This presentation gives a method of monitoring surveillance time series on the basis of the human expert preference. The method does not require detailed history for the current series, modeling expertize, or a well-defined data signal. It is designed for application to many data types and without need for a sophisticated environment or historical data analysis.

Introduction
Recently published studies evaluate statistical alerting methods for disease surveillance based on detection of modeled signals in a data background of either authentic historical data or randomized samples. Differences in regional and jurisdictional data, collection and filtering methods, investigation resources, monitoring objectives, and system requirements have hindered acceptance of standard monitoring methodology. The signature of a disease outbreak and the baseline data behavior depend on various factors, including population coverage, quality and timeliness of data, symptomatology, and the care-seeking behavior of the monitored population. For this reason, statistical process control methods based on standard data distributions or stylized signals may not alert as desired. Practical algorithm evaluation and adjustment may be possible by judging algorithm performance according to the preferences of experienced human monitors.

Methods
In this approach, introduced at the 2009 ISDS Conference, consensus alerting preferences of human monitors based on historic data time series were used as a gold standard. The study data were highly aggregated, unlabeled time series from the National Notifiable Disease Surveillance System approved for public release by the US Centers for Disease Control and Prevention. Multiple unmarked time series with known outbreak effects were given to 18 experienced epidemiologist raters in an EXCEL tool. Raters were asked to mark dates of desired alerts for possible outbreaks on 18-weekly time series each spanning 2–3 years. Individual response sets and derived consensus sets were used as 'truth data' for calculation of sensitivities and false alarm rates for the purpose of comparing candidate algorithms. These 136 algorithms included 45 CUSUM variants at each of three threshold levels and the standard CDC Historical Limits method.

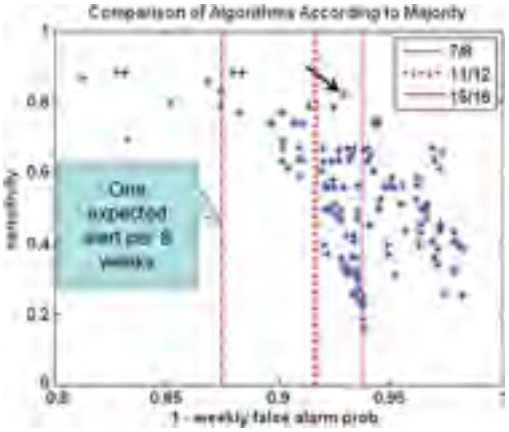

Figure 1 Sensitivity comparison among 136 algorithm variations based on rater majority. Subsequent applications to weekly time series of reportable disease data will also be discussed from (a) a state health department and (b) a resource-limited setting.

Results
An adaptive CUSUM variant with $k = 0.5$ and an 8-week sliding baseline yielded the best sensitivity/false-alarm-rate combination according to the consensus set and to multiple individual sets, as indicated by the arrow in the Figure 1.

Conclusions
On the basis of agreement analysis and the stability of algorithm performance comparisons, the approach is viable and worthy of comparison to conventional approaches based on known data distributions and signal types.

Acknowledgements
This paper was presented as an oral presentation at the 2010 International Society for Disease Surveillance Conference, held in Park City, UT, USA, on 1–2 December 2010.