Radiographic Surveillance in Children: A System for Monitoring Epidemics Associated with Prominent Respiratory Symptoms

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OBJECTIVE

Create a tool for monitoring respiratory epidemics based on chest radiograph ordering patterns.

BACKGROUND

Yearly epidemics of respiratory diseases occur in children. Early recognition of these and of unexpected epidemics due to new agents or as acts of biological/chemical terrorism is desirable. In this study, we evaluate the ordering of chest radiographs as a proxy for early identification of epidemics of lower respiratory tract disease. This has the potential to act as a sensitive real-time surveillance tool during such outbreaks.

DESIGN/METHODS

Our study was a review of children presenting to the emergency department (ED) of an academic children's hospital from January 1993 to November 2003. ARIMA time series models that provided forecasts of daily visits and chest radiographs were specified. Disease outbreaks sustained for 7-days were simulated and sensitivity values for models at a target specificity of 97% were compared using one- vs. multi-day (moving-average, linear and exponential) detection filters. Selection of an optimal model was based on the performance characteristics and complexity of competing models.

RESULTS

There were an average of 129 visits and 21 chest radiographs per day for 3,962 days studied. After examining time plots of data, we chose from competing models a multivariate ARMA (2,1) model of daily chest radiographs with daily visits as a covariate. This model for the degree of complexity had the best fit and signal-to-noise discrimination. Sensitivity and timeliness of signal detection were related to the size of simulated outbreaks and the type of detection filter. Multi-day filters attained a sensitivity of 100% at a threshold of 10 extra chest radiographs/day vs. 15/day for the one-day filter. The median lag to detection of 10 excess radiographs/day was 2, 4, 3 and 2 days for one-day, moving average, linear and exponential filters. The exponential filter provided the best balance between sensitivity and timeliness.

CONCLUSIONS

A time-series model based on ordering patterns of chest radiographs and controlled for daily visits among children evaluated in the ED may assist in real-time surveillance of epidemics characterized by prominent respiratory symptoms.

REFERENCES

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