ROC Curves in Public Health Surveillance: A First Step in Cost-Benefit Analysis

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OBJECTIVE

Our purpose was to develop an ROC curve for public health surveillance similar to those used in diagnostic testing. We developed syndrome surveillance algorithms with differing sensitivity and specificity in detecting the seasonal influenza (ILI) outbreak. For each algorithm we plotted: days to detect the event against the numbers of false positive alarms during the non-ILI season.

BACKGROUND

ROC curves are used to measure the loss of specificity with increases in detection sensitivity. These curves are used to determine the ideal test "cut-off" points for disease detection that benefits the largest numbers of patients. Surveillance for public health events is a priority, but balance must be struck between early detection and conservation of scare public health resources. There may be ideal "outbreak cut-offs" for different public health events. We postulate that ROC curves might provide a first step in future cost-benefit analysis of public health surveillance activities.

METHODS

Our clinical data warehouse includes dates of service, demographics, chief complaints, vital signs and diagnoses. We tested several methods of varying the outbreak sensitivity: 1.) Generate ratio rather than absolute case counts by altering the denominator using different age-groups. Rationale: adults with influenza might delay seeking emergency case for themselves but rush in early with a febrile infant. 2.) Enhanced case definitions. 3.) Alter the absolute number of cases signifying an outbreak.

RESULTS

There were over 500,000 patient emergency visits available for analysis in years 2000-2004. Age-Group Ratios: Pediatric patients presented with ILI earlier than adults in all years and the 2003 ILI season would not have been detectable if pediatric rates had been excluded. Enhanced case definitions: Expanding ILI definitions resulted in early outbreak detection, but more false alarms in non-ILI seasons. Combining complaints of fever with measured temperature > 100 F resulted in significantly earlier detection. Sore throat alone without cough was more specific for the ILI season. See Figure 1. We constructed an ROC curve using increasing daily counts for ILI as an outbreak cut-off point; the area under the curve was 0.77 when days to detect the outbreak was plotted against the number of false alarms over the rest of the year.

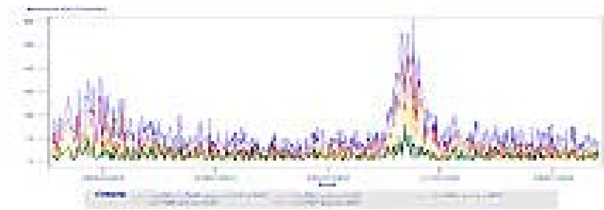

Figure 1 – Daily plot of case counts using 5 different disease definitions.

CONCLUSIONS

Decomposing patients by demographic groups, especially age, may result in earlier detection of outbreaks and more precision in differentiating outbreaks from seasonal norms. Expanded case definitions have higher sensitivity but do suffer corresponding increases in false positives. The ideal outbreak cut-offs will therefore depend on the benefits of early disease detection and prevention versus the costs of public health epidemiologic and management responses to false-alarms. This will vary on the type of public health emergency. The daily counts in Figure 1 and the relatively large area under the ROC curve demonstrate the potential for developing public health ROC curves that could be used to perform cost-benefit analyses. In the future, this information could be combined with more precise cost—benefit comparisons to balance the need for early disease detection with conserving public health resources.

REFERENCES

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