Bayesian Analytical Tool for ILI and Fast Detection of Intentional Release

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OBJECTIVE

This paper [4] presents a Bayesian approach to quality control through the use of sequential update technique in order built a fast detection method for influenza outbreak and potential intentional release of biological agents. The objective is to find evidence of outbreaks against a background in which markers of possible intentional release are non-stationary and serially dependent. This work takes on the US Sentinel Influenza-Like-Illnesses (ILI) data to find this evidence and to address some issues related to the control of infectious diseases. A sensitivity analysis is conducted through simulation to assess timeliness, correct alarm and missed alarm rates of our technique.

BACKGOUND

Bio-surveillance is an area providing real time or near real time data sets with a rich structure. In this area, the new wave of interest lies in incorporating medical-based data such as percentage of ILI or count of ILI observed during visits to Emergency Room as intelligence function; since many different bioterrorist agents present with flu-like symptoms [1] [2]. Developing a control technique for ILI however is a complex process which involves the unpredictability of the time of emergence of influenza, the severity of the outbreak and the effectiveness of influenza epidemic interventions. Furthermore, the need to detect the beginning of epidemic in an on-line fashion as data are received one at the time and sequentially make the problems surrounding ILI's even more challenging. Statistical tools for analyzing these data are currently well short of being able to capture all their important structural details [3]. Tools from statistical process control are on the face of it ideally suited for the task, since they address the exact problem of detecting a sudden shift against a background of random variability. Bayesian statistical methods are ideally suited to the setting of partial but imperfect information on the statistical parameters describing time series data such as are gathered in BioSense and Sentinel settings.

METHODS

In this paper [4] we present a Bayesian dynamic and sequential model for the seasonal course of ILI by using the weekly Sentinel Program %ILI data. The model takes on the %ILI, defines an initial prior and uses a recursive and sequential update technique by finding the posterior distribution at each stage and setting the posterior as a prior distribution for the next stage. Our model uses prior data to set a threshold model bound on successive differences in posterior coverage probability. The model has been tested for sensitivity and specificity.

RESULTS

We apply our dynamic and sequential Bayesian approach to the past 3 year flu seasons. Our technique is able to approximate the data by the posterior mean, is able to rely on statistical decision making to flag an epidemic at the week of outbreak with sufficiently high probability and to follow the course of ILI to the peak infectivity. The model is also used to detect simulated unusual activity (small to be seen by a naked eye but big enough to be overlooked) from the beginning of the flu season to the peak infectivity with *86.2%* correct alarm detection, *9.4%* missed alarm and *4.4%* false alarm[4].

CONCLUSION

In this era when we face threats of potential biological release, it is important that we develop surveillance techniques that can be applied to real time or near real-time observations to find statistical evidence of outbreak against imperfect baseline information, and avoid a total reliance on visual evidence that usually come one step too late. Our model, even though highly sensitive to parameter tuning, can be modified to suit daily monitoring of diseases.

REFERENCES

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