Analysis of 5 years of multistream surveillance and weather data in Champaign County

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Objective

To examine the correlation between different types of surveillance signals and climate information obtained from a well-defined geographic area.

Introduction

INDICATOR is a multistream open source platform for biosurveillance and outbreak detection, currently focused on Champaign County in Illinois. It has been in production since 2008 and is currently receiving data from emergency department (ED), patient advisory nurse (PAN), outpatient convenient care clinic (CC), school absenteeism, animal control and weather sources. (Table 1).

Methods

We performed simple pairwise correlation between signals using the longest period of mutual data availability, e.g., between convenient care data and patient advisory nurse data, we compared the period between April 2007 and August 2011. We also offset signals by up to 14 days in each direction to investigate whether there were lag relationships between them.

Results

ILI surveillance source: Analysis of the relationships between the signals for PAN, ED and CC are heavily influenced by a strong day of the week effect in the PAN data. Considering all of the data, including periods of high and low ILI activity, the correlation between ED and PAN shows a stronger relationship when the ED signal lags the PAN by 1 day ($r = 0.653$ vs. $r = 0.617$). There is a less clear relationship between ED and CC with the strongest correlation occurring when CC lags ED by 2 days ($r = 0.669$ vs. $r = 0.659$). The relationship between CC and PAN is unclear. These relationships are also all valid when just considering the period of the 2009 H1N1 pandemic, but interestingly not the last strong seasonal influenza in 2008. For the 2008 season, for which we do not have ED data, the signal for CC clearly lags the signal for PAN with a peak correlation at a lag of 6 days ($r = 0.561$ vs. $r = 0.413$).

ILI and climate: There are significant negative correlations between all three signals and daily temperature, e.g., CC and Tmin ($r = -0.265$, $df = 2004$, $p < 0.0001$), but not precipitation, e.g., CC ($r = -0.011$) when considering all data. There are no clear relationships between temperature or precipitation and CC or PAN during the 2008 seasonal outbreak, but there is a clear negative correlation between temperature and CC, PAN and ED during the 2009 H1N1 pandemic, e.g., ED and Tmin ($r = -0.366$, $df = 119$, $p < 0.001$). There was no clear correlation with precipitation.

Zoonotic reports: There are some very strong correlations between the signals, such as the correlation between daily minimum temperature and patients seeking treatment for insect bites ($r = 0.602$, $df = 821$, $p < 0.0001$), with a less strong correlation between precipitation and insect bites peaking with a bite lag of 24 days ($r = 0.163$, $p < 0.0001$). Not as expected is the correlation between animal bites and Tmin ($r = 0.178$, $p < 0.001$).

Conclusions

There are clear indications of temporal relationships between different surveillance signals, with PAN consistently giving a 1-day lead over ED for ILI. The strong relationship between temperature and ILI cases during the 2009 H1N1 pandemic is most likely coincidental since the onset in Champaign County coincided with the change of season in September/October. The lack of a relationship between ILI and weather during the 2008 seasonal outbreak remains to be understood.

Keywords

ILI; zoonoses; correlation; multistream; weather

References

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Table 1. Data sources

Data source	Frequency	Signal contents	Start date
CC	Daily	ICD9 diagnosis	01/2006
PAN	Daily	Chief complaint	04/2007
Reportable diseases	Monthly	Reported disease count	01/2007
School attendance	Weekday	Absenteeism w or w/o illness	08/2008
Animal control	Monthly	Animal bites by species	01/2006
ED	Daily	Triage chief complaint, text Dx	04/2009
Weather	Daily	Temperature, rainfall, etc.	01/2006