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ABSTRACT

The spatial-temporal pattern of excess influenza visits at the (sub-)urban scale

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Objective

To develop a novel method to characterize the spatial-temporal pattern of seasonal influenza and then use this characterization to: (1) inform the spatial cluster detection efforts of syndromic surveillance, (2) explore the relationship of spatial-temporal patterns and covariates and (3) inform conclusions made about the burden of seasonal and pandemic influenza.

Introduction

Quantifying the spatial-temporal diffusion of diseases such as seasonal influenza is difficult at the urban scale for a variety of reasons including the low specificity of the extant data, the heterogenous nature of healthcare seeking behavior and the speed with which diseases spread throughout the city. Nevertheless, the New York City Department of Health and Mental Hygiene's syndromic surveillance system attempts to detect spatial clusters resulting from outbreaks of influenza. The success of such systems is dependent on there being a discernible spatial-temporal pattern of disease at the neighborhood (sub-urban) scale.

We explore ways to extend global methods such as serfling regression that estimate excess burdens during outbreak periods to characterize these patterns. Traditionally, these methods are aggregated at the national or regional scale and are used only to estimate the total burden of a disease outbreak period. Our extension characterizes the spatial-temporal pattern at the neighborhood scale by day. We then compare our characterizations to prospective spatial cluster detection efforts of our syndromic surveillance system and to demographic covariates.

Methods

We use the NYCDOH's syndromic surveillance emergency department system. The data includes daily data from 50 of 55 ED's in NYC representing 95% of all ED visits. An archive of prospective analyses records all significant spatial signals identified by our syndromic surveillance system for Fever/flu, influenza-like illness (ILI) and respiratory syndromes traditionally used in influenza surveillance. We define historic disease periods using WHO collaborating laboratory isolate data in New York City.

NYCDOH currently utilizes serfling regression to estimate excess visits during influenza periods. We develop a novel spatial serfling model that assigns the excess visits to dates, neighborhoods (as defined by zipcodes) and age groups. Spatial poisson regression methods were also explored for this assignment. The resulting excess patterns are consistent with the citywide excess calculations. We then compare the resulting patterns to the archive of historic spatial clusters as well as spatial demographic patterns. Finally, we notice

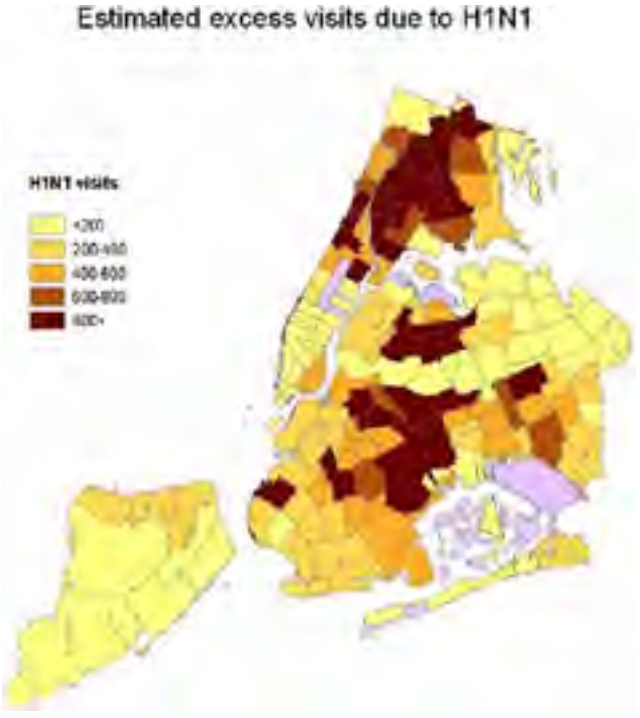

Figure 1 Spatial pattern of excess during H1N1, 2009. The resulting pattern is remarkably similar to past seasonal influenza patterns.

regularities of the patterns across flu seasons including the 2009 H1N1 season.

Results

Spatial-temporal patterns of excess ILI visits are remarkably consistent and appear to be largely driven by health-seeking behavior. Although spatial clusters are regularly detected by routine syndromic surveillance, their similarity suggests that these patterns may result from shifts in spatial pattern because of demographic characteristics and health-seeking behavior rather than the spatial diffusion of influenza. Only the May 2009 H1N1 pandemic wave shows a clear pattern of spatial diffusion emanating from Queens. However, the spatial pattern of excess for the entire 2009 H1N1 period is similar to the previous seasonal influenza seasons. Figure 1

Conclusions

The spatial serfling model developed here characterizes the spatial-temporal pattern of individual flu seasons. Unlike cluster detection systems, the resulting patterns are global and can be used to explore spatial relationships with demographic covariates. The lack of variation across flu periods suggests that spatial cluster detection for influenza may not be useful at the neighborhood scale. This may be due to the speed of diffusion at the urban scale. The spatial temporal pattern of ED visits during H1N1 was similar to all previous influenza seasons and calls into question some observations made about the uniqueness of the outbreak, most notably that the poor were more likely to be infected—this may well be a trait common to all seasonal influenza epidemics.

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