Pure Spatial and Space-Time Analysis of Pertussis Infections in Houston 2005 -2015

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Background

- A total of 881 (confirmed and probable) pertussis cases in Houston jurisdiction were reported to Texas NEDSS Based System (NBS) in 2005-2015 (fig1).
- In 2009 and 2013, two peaks of pertussis cases (147 and 196) were observed.
- The main objective is to apply scan statistics to the pertussis surveillance data and determine geographic clusters.

Methods

- The case data were extracted from NBS and the census tract data were downloaded from the US Census Bureau's website.
- Eighteen pertussis cases with invalid/incomplete addresses were excluded.
- The number of pertussis cases is considered to follow a Poisson distribution, and the census tract is used as the basic geographic unit.
- Direct standardization is used to get estimated number of pertussis cases adjusted for age in each tract.
- In the analysis, first, taking the 863 cases as a whole and not adjusting for time, a pure spatial analysis is performed; then, same analysis is repeated on cases reported in 2009 and 2013; In the next step, space-time analysis are conducted to adjust the effect of time; finally a Hot Spot analysis (Geti-Ord Gi*) is done to verify the results of the Scan statistitics
- The SaTScan v9.4.2 and ArcPro v1.4 are used for this analysis

Results

- Not adjusting for time, pure spatial analysis on the 10 year data, and respectively on data from 2009 and 2013 are not able to detect statistically significant cluster of pertussis cases (fig2, the 3 clusters are not statistically significant)
- The space-time analysis on the overall data are able to generate 3 statistically significant clusters (tab1, fig3)
- Thus, we conclude time plays very important role in geographic distribution of pertussis cases; in terms of time, disease transmission is a continuous process and arbitrarily cutting time based on calendar year wouldn't help capture significant disease clusters
- The Hot Spot analysis on the overall data detects significant clusters of pertussis cases; those hot spots not overlapping with space-time analysis are considered the overall of cases in the similar geographic area over time
- A space-time cube might be helpful to clearly visualize the geographic and temporal distribution of pertussis cases in Houston

Results

Figure 1: Number of Pertussis Cases in Houston, 2005-2015

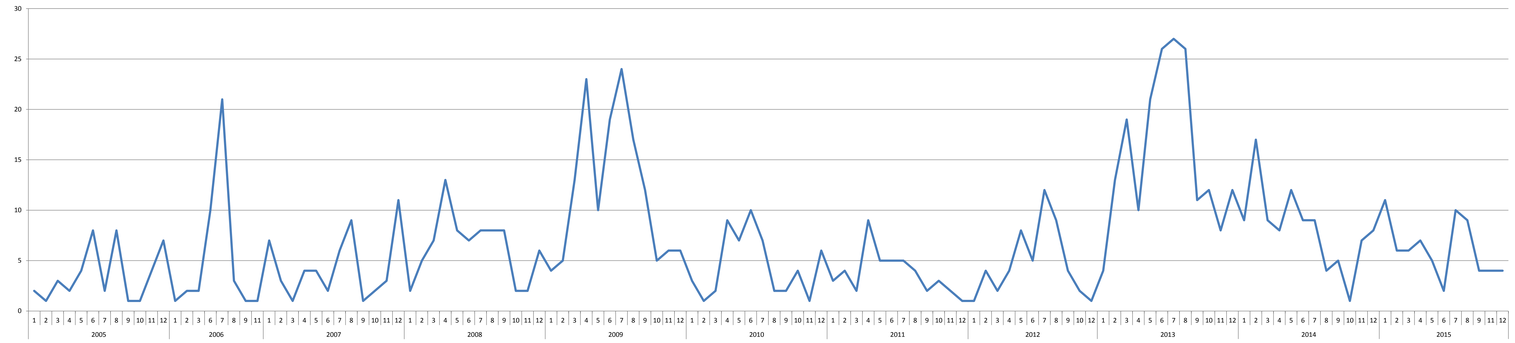


Figure 2: Spatial Analysis on Overall, 2009 and 2013 Cases

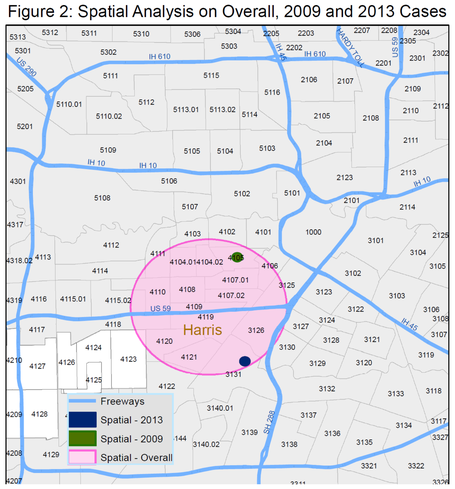


Figure 3: Spatial - Time Analysis on Overal data

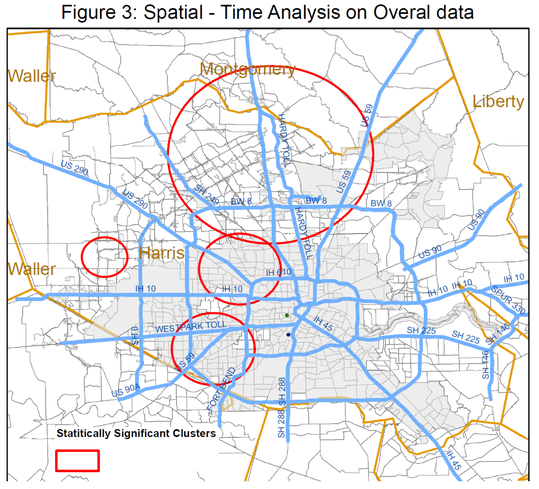
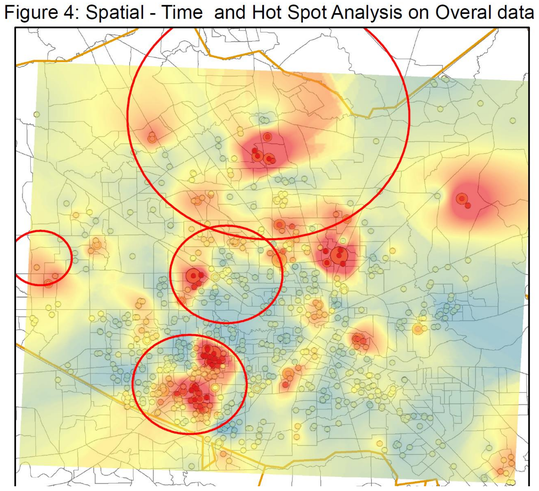


Figure 4: Spatial - Time and Hot Spot Analysis on Overal data



Conclusion

- Spatial distribution of pertussis cases shows strong (significant) variation over time
- In the first half of the 10 year period, evidence of geographic clusters of pertussis infections are detected; whereas since 2010 we haven't found pertussis infections in Houston are geographically clustered.
- Different method of scaling and aggregation on the study question might produce slightly different outputs; therefore, it is not appropriate directly compare findings from different models
- The SatScan space-time analysis adjusts for the effect of time; ArcGIS space-time cube would also test the space-time distribution of events

Table 1: Space-time analysis on the overall data

Cluster	Radius (km)	Time frame	Observed	Expected	Test statistics	P-value
1	17.3	01/01/2005 - 12/31/2006	36	8.08	26.33	<0.0001
2	7.0	01/01/2005 - 12/31/2006	2	20.07	14.44	0.0002
3	3.9	01/01/2005 - 12/31/2005	6	0.3	12.31	0.0029
4	6.9	01/01/2009-12/31/2009	31	13.02	9.11	0.119

Acknowledgments

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