Early Clusters of Morbidity of 2009 Influenza A/H1N1 in Texas

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Abstract

Maps of both morbidity counts and infection rates are created for the first 17 days of the 2009 Influenza A/H1N1 outbreak in Texas, at the county level. SatScan is used to identify clusters of morbidity counts. The chronological order of the clusters does not always match the original morbidity count chronological order. Most clusters began after May 8, ten days after the activation of the Multi-Agency Coordination Center and after much news coverage advised people to avoid large congregations, not to cough in their hands, and after many schools were closed. Despite the recommendation of these precautions, the disease spread rapidly. Furthermore some clusters occurred in areas with low morbidity counts.

Introduction

The Texas Department of State Health Services (DSHS) maintains the Multi-Agency Coordination Center. The MACC is an emergency operations center serving as a central point of coordination for all of the state level emergency management health matters. DSHS activated the (MACC) in April, 2009 in response the H1N1 outbreak in Texas. The Laboratory Response Network (LRN), in Texas, began testing patient samples, and for a seventeen day period the MACC tabulated the results daily, from April 29 – May 15, and from May 16 to July 31, 2009 test results were tabulated weekly. During this period the LRN received 1,000 to 1,500 specimens per day, compared to 1,500 total specimens for a typical full flu season DSHS (2009). Lian et al. (2007) used SaTScan to identify a west to east progression of equine West Nile disease in 2002 across Texas. They identified nine space-time clusters.

Methodology

MACC personnel tabulated county level laboratory test results into a spreadsheet. Using ArcMap, a table join between the spreadsheet and a shapefile was performed, and county choropleth maps were created. Statistical software was used to create graphs, and SaTScan was used to analyze clusters. Using the available data, temporal discrete Poisson, spatial discrete Poisson, space-time discrete Poisson, and space-time permutation models were run through SaTScan. Clusters obtained from SaTScan were mapped using ArcMap.

Results

The earliest confirmed cases of H1N1 in Texas were in the Dallas-Fort Worth, San Antonio, and Lower Rio Grande Valley areas. Later Houston, El Paso, and Austin also had large numbers of confirmed H1N1, as seen in Figure 1 and Figure 2. Figures 1 and 2 are maps of confirmed cases of H1N1 per county. Maps were also created showing the infection rate (cases per 100,000 population), per county. These maps, seen in Figures 3 and 4, show the first three areas mentioned above, were indeed the most impacted parts of Texas. The counties with the highest rates of infection were: Brooks, Guadalupe, Starr, Cameron, and Hamilton. In contrast Harris County with a high number of cases of infection (as seen with a darker shade of brown in Figure 2), has a low infection rate (indicated by lighter shades of blue seen in Figure 4), due to its large population. Table 1 shows the counts and rates for the counties with the highest rates of infection, as well as Harris County. On May 15, 2009 (day 17) 40 out of 254 Texas counties had confirmed cases.
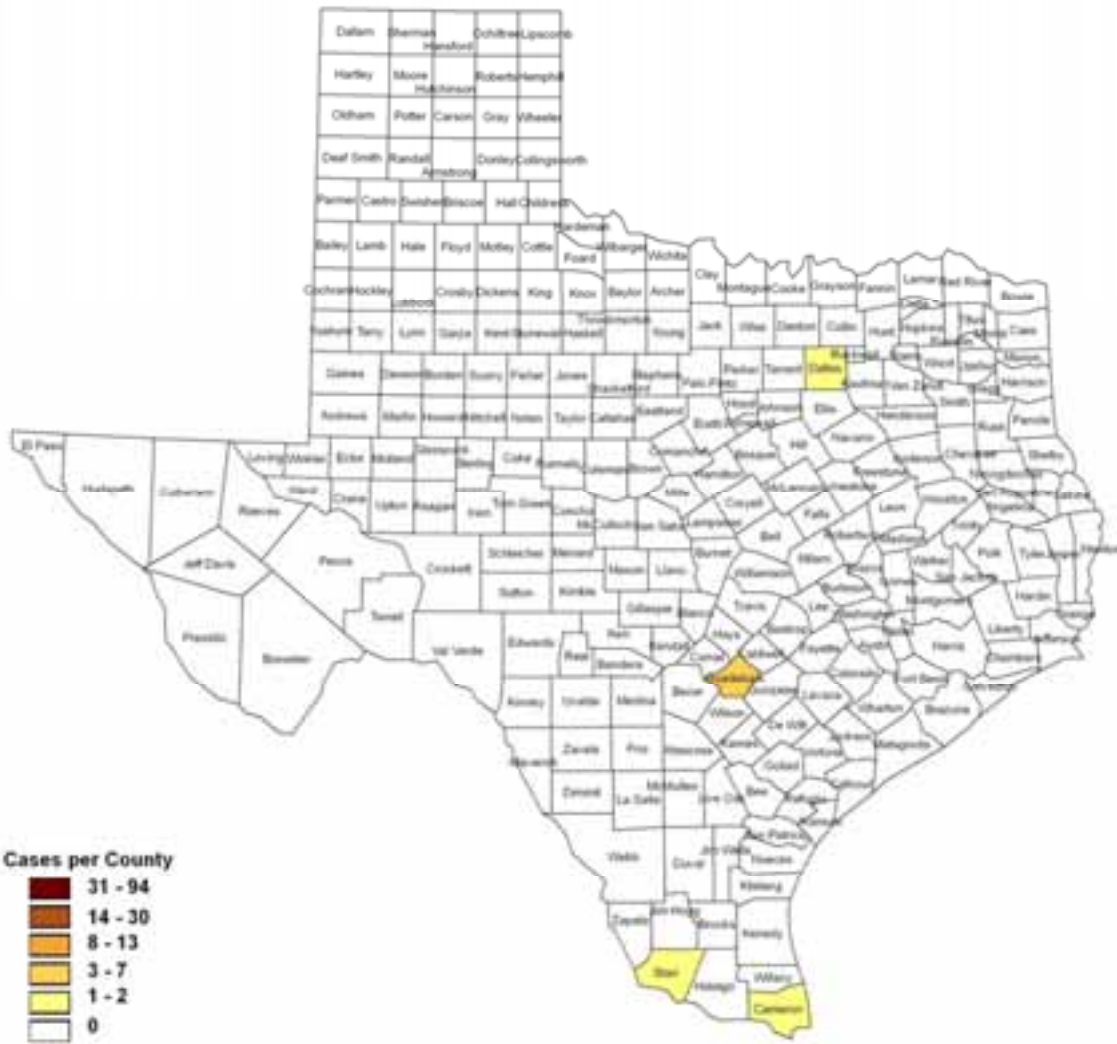
Figure 1. Day 1: Confirmed cases by county of 2009 Influenza A/H1N1 in Texas, as of April 29, 2009.

Graphs and charts were also made to show the rise of 2009 Influenza A/H1N1. Figure 5 is a bar graph and shows the total statewide confirmed cases for each of the first 17 days for which confirmed cases of 2009 Influenza A/H1N1 were tabulated, and Figure 6 is a scatter plot of the confirmed cases for the first 17 days. Regression was used to determine the rate of change. A cubic curve was found to best match the confirmed cases. The Pearson's correlation coefficient (R) for the graph is 0.992 and the coefficient of determination (R^2) is 0.984. Tables 2

and 3 summarize the regression process. Although the regression curve appears to accurately interpolate data collected, no extrapolation for days beyond the 17 day collection period should be taken. The curve equation is: $y = 10.088 + 5.446x - 0.691x^2 + 0.137x^3$.
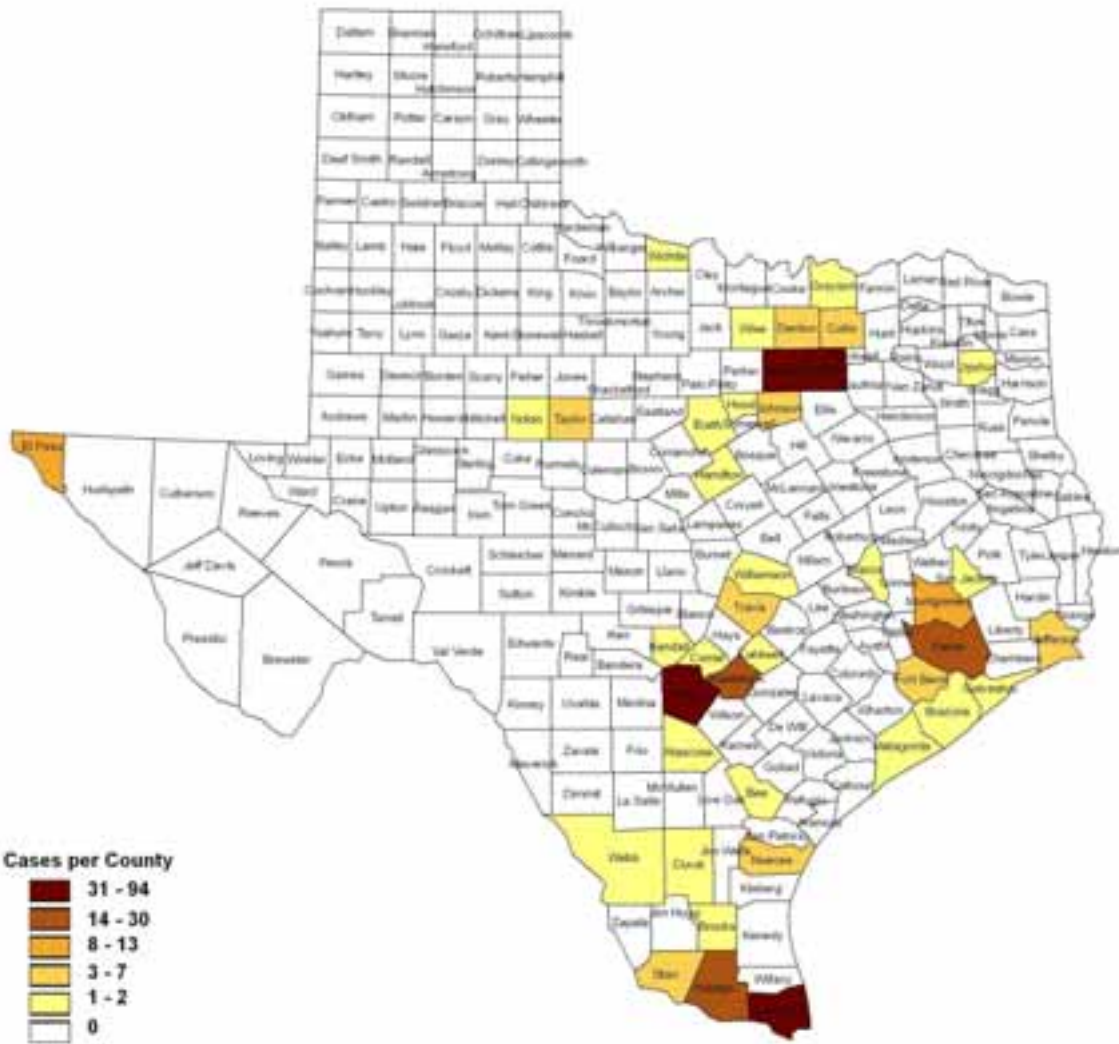
Figure 2. Day 17: Confirmed cases by county of 2009 Influenza A/H1N1 in Texas, as of May 15, 2009.
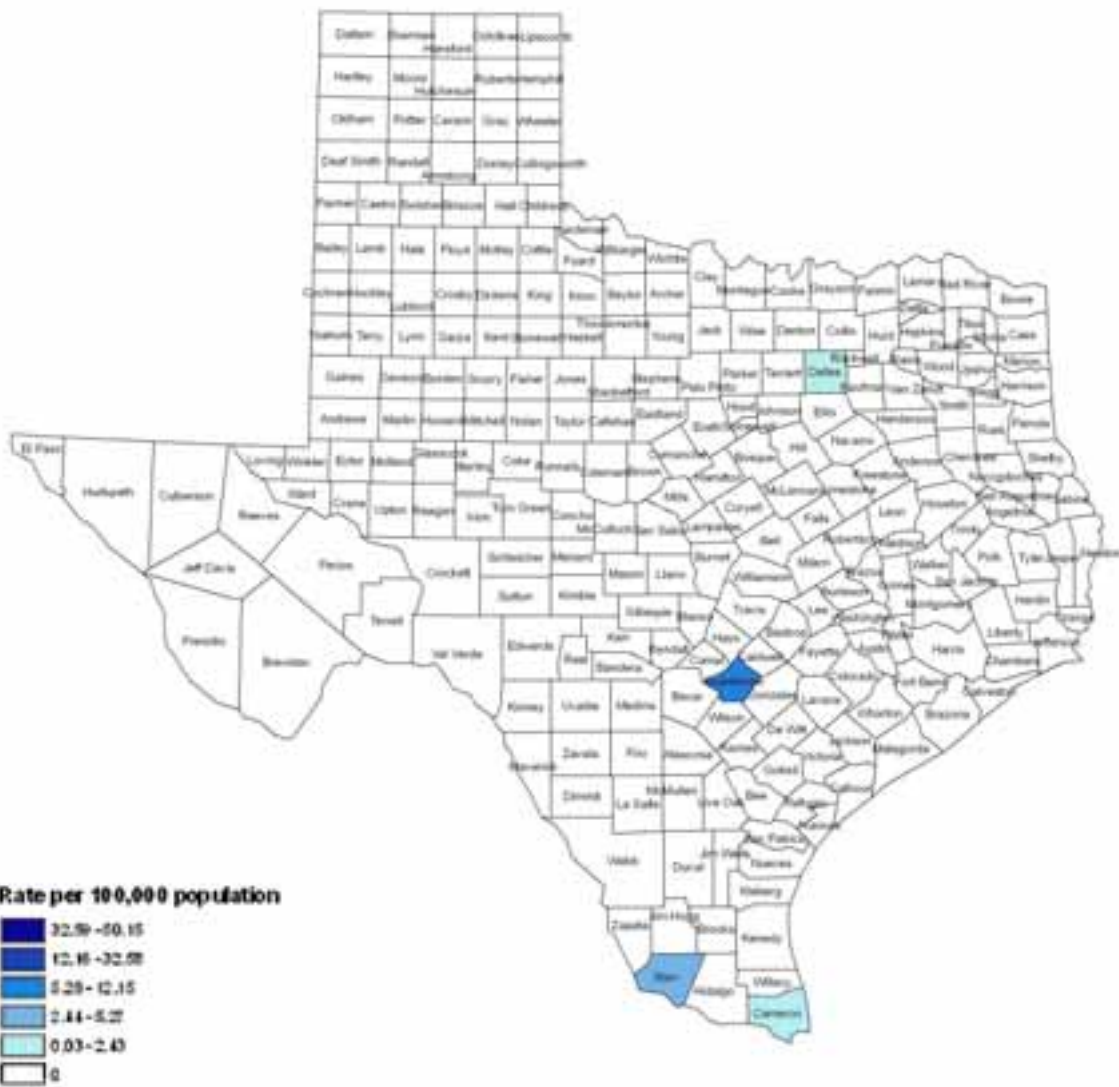
Figure 3. Day 1: Rate per 100,000 population by county of 2009 Influenza A/H1N1 in Texas, as of April 29, 2009.
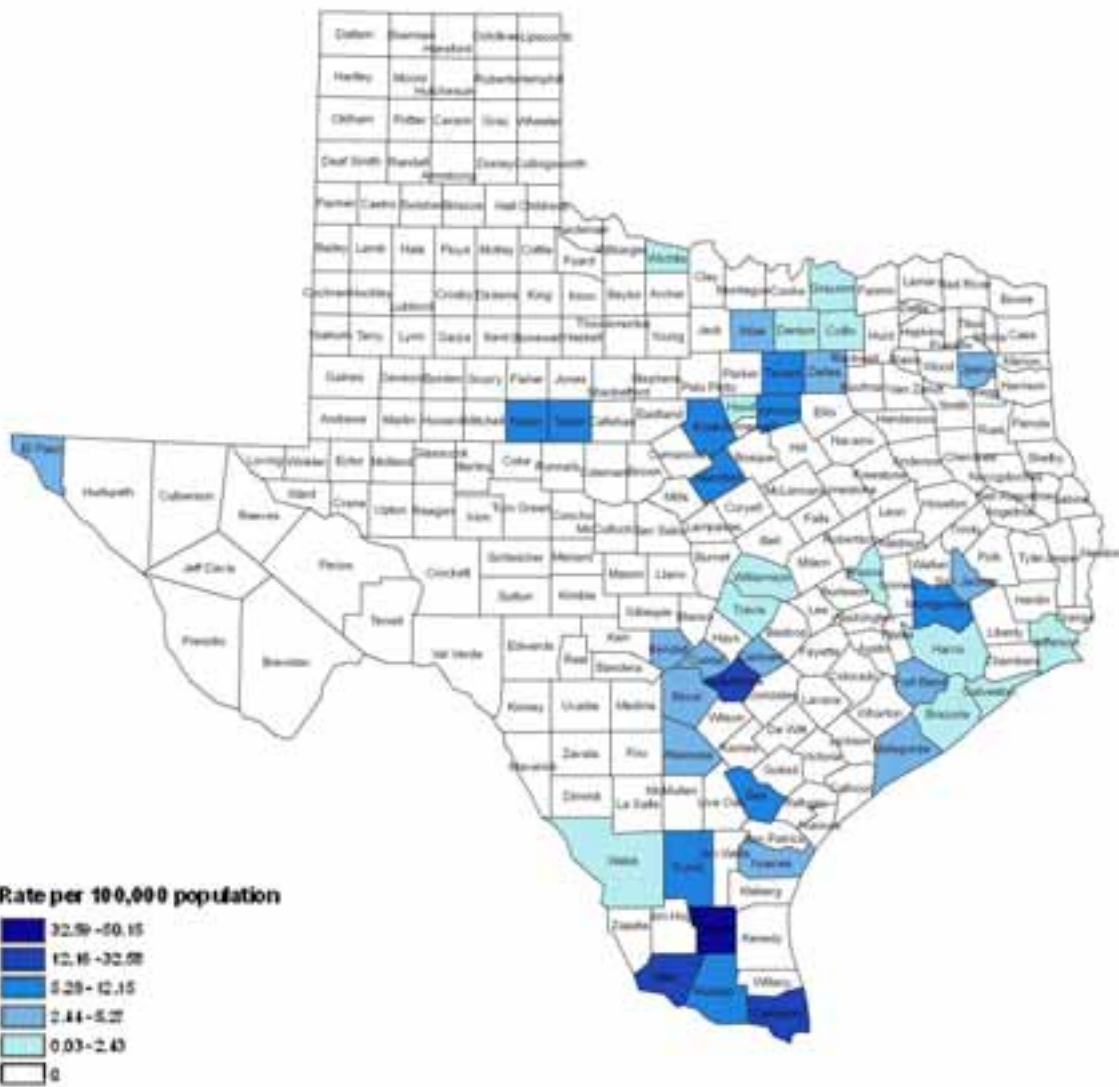
Figure 4. Day 17: Rate per 100,000 population by county of 2009 Influenza A/H1N1 in Texas, as of May 15, 2009.

Table 1. H1N1 Cases and Rates		
County	Confirmed Cases	Rate per 100,000 population
Brooks	4	50.15045
Guadalupe	29	32.57585
Starr	11	20.52354
Cameron	61	18.19662
Hamilton	1	12.15214
Johnson	12	9.46290
Taylor	10	7.90170
Duval	1	7.62195
Montgomery	22	7.48890
Tarrant	94	6.49971
Nolan	1	6.32831
Bee	2	6.18066
Erath	2	6.06042
Hidalgo	30	5.26812
Harris	34	0.99983
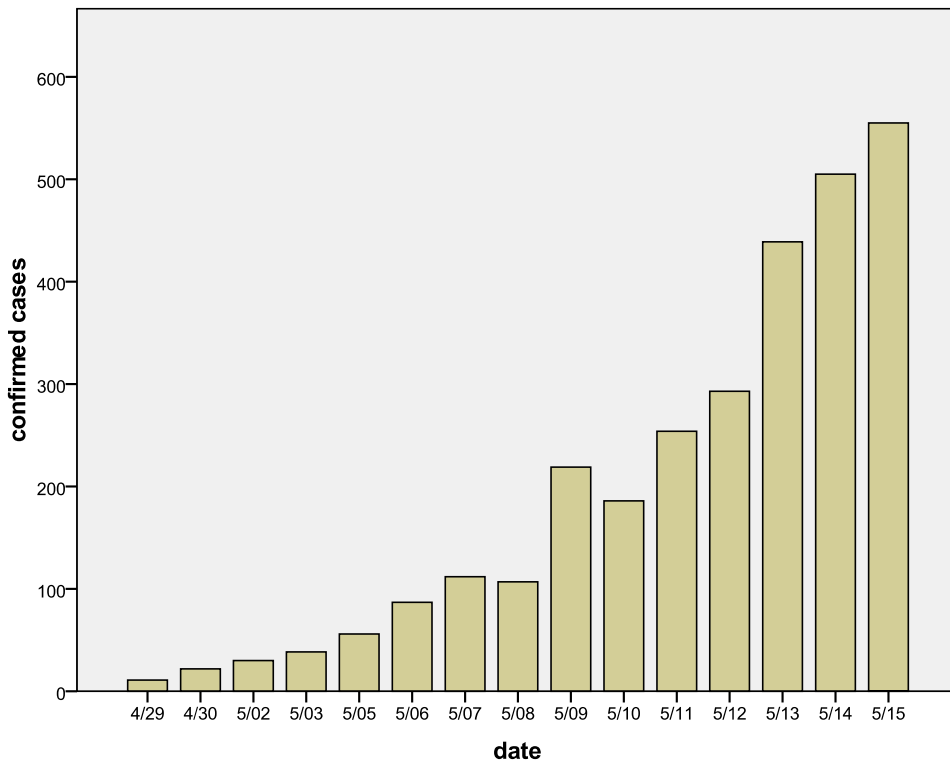
Figure 5. Texas statewide 2009 Influenza A/H1N1 confirmed cases per day for April 29-May15, 2009.
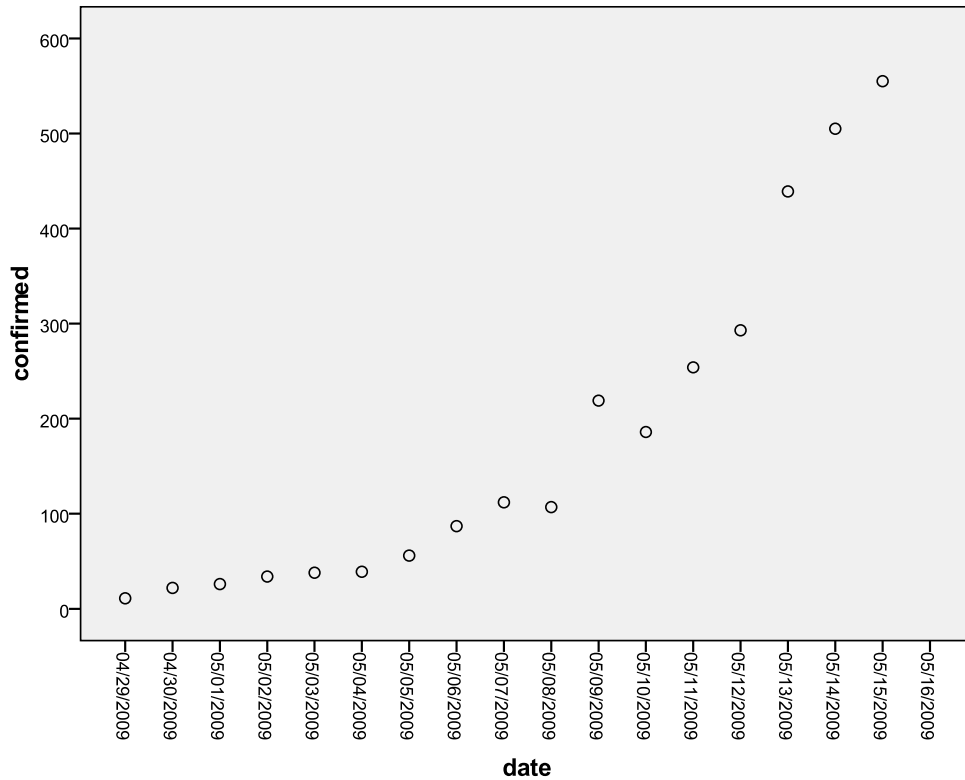
Figure 6. Texas statewide 2009 Influenza A/H1N1 confirmed cases per day for April 29-May15, 2009.

Table 2. Model Summary For Cubic Regression			
R	R Square	Adjusted R Square	Std. Error of the Estimate
0.992	0.984	0.98	24.895
The independent variable is day.			

| Table 3. Coefficients For Cubic Regression					
	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
day	5.446	14.321	0.155	0.38	0.71
day ** 2	-0.691	1.821	-0.364	-0.379	0.71
day ** 3	0.137	0.067	1.208	2.059	0.06
(Constant)	10.088	30.639		0.329	0.747

Four SaTScan models were run: Purely Temporal Discrete Poisson, Purely Spatial Discrete Poisson, Spatial-Temporal Discrete Poisson, and Spatial-Temporal Space-Time Permutation. The purely temporal model found one cluster from May 12 – May 15, 2009. This cluster had 349 confirmed cases versus 131 expected cases. The other three models were mapped based upon their spatial component. Because the data for this study was county level the whole counties indicated in the clusters were mapped using ArcMap. Figures 7 – 9 show these results. Only clusters with p values less than 0.05 were mapped. Several counties repeatedly are found in clusters of the various models. Guadalupe County northeast of San Antonio appears in clusters in all three of the above cluster maps, including cluster 3 in Figure 8 and cluster 1 in Figure 9. Three regions: Montgomery County (clusters D in Figure 7, cluster 6 in Figure 8 and 9 in Figure 9), Tarrant County (clusters C, 4, 6 respectively) and five counties in the Lower Rio Grande Valley (clusters A, 5, 7 respectively) appear in all three maps although temporally late. Guadalupe County (clusters B, 3, 1 respectively) also appears in all three maps and temporally early. El Paso appears in cluster 1 of Figure 8 and cluster 3 of Figure 9.

Figure 7. Purely Spatial Discrete Poisson Model. Brightly colored counties form clusters. Letters A-D are purely arbitrary and for identification purposes only. Cluster A comprises the Lower Rio Grande Valley; Cluster B is Guadalupe County northeast of San Antonio; Cluster C comprises Dallas and Fort Worth; Cluster D is Montgomery County north of Houston.
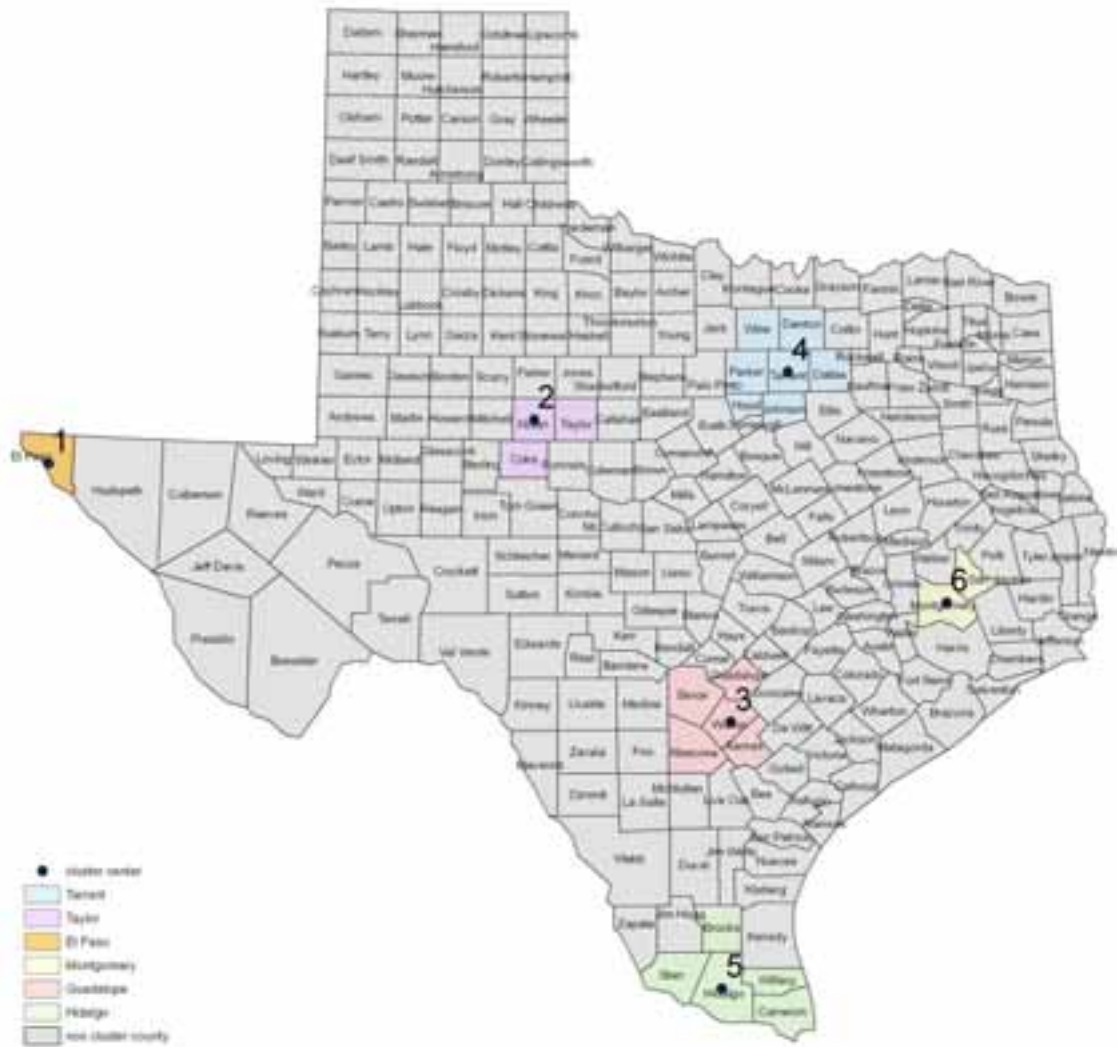
Figure 8. Spatial-Temporal Discrete Poisson Model. Brightly colored counties form clusters. Number labels indicate the chronological order of the cluster formations. Cluster 1 occurred May 9, cluster 2 May 9-12, cluster 3 May 9-13, cluster 4 May 11-14, cluster 5 May 13-15, and cluster 6 May 13-15.
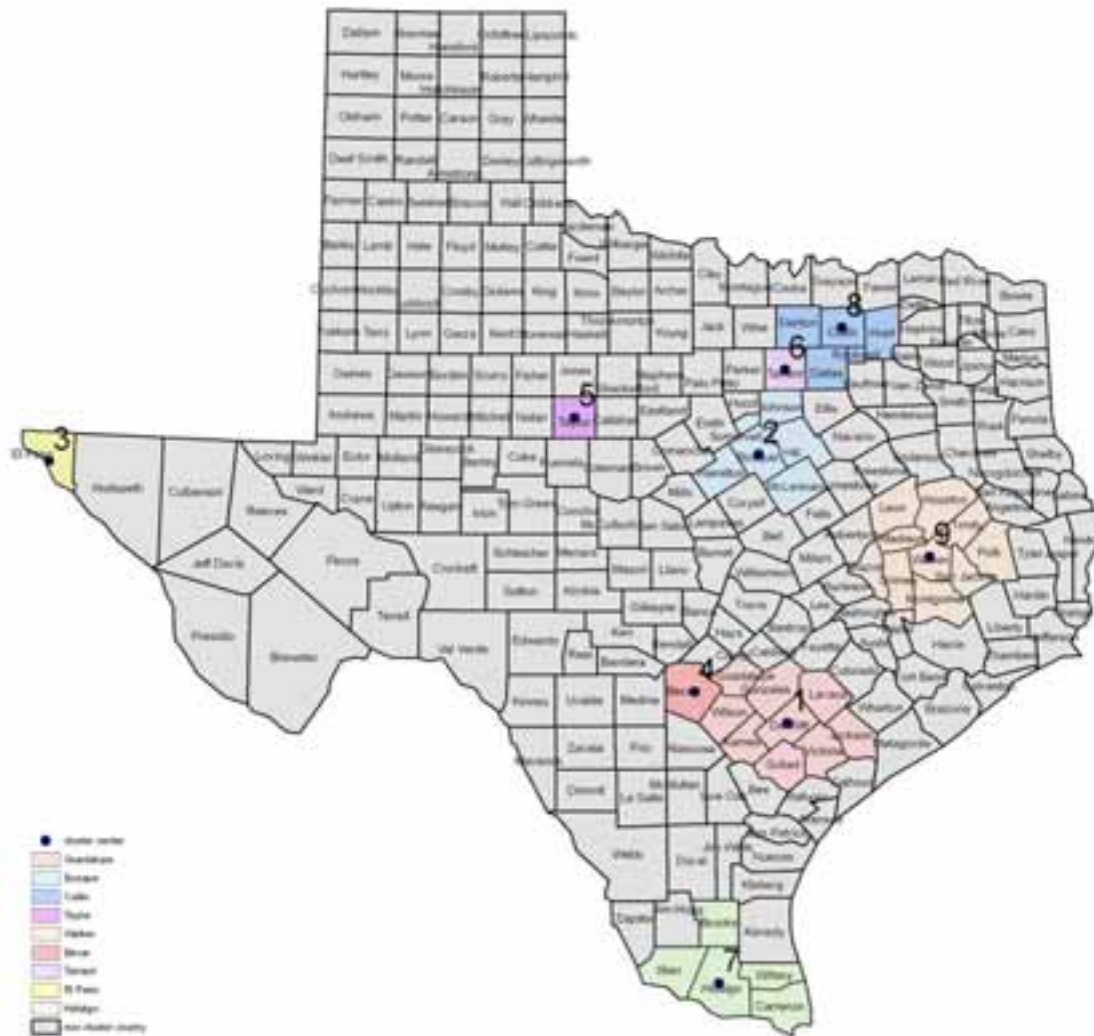
Figure 9. Spatial-Temporal Space-Time Permutation Model. Brightly colored counties form clusters. Number labels indicate the chronological order of the cluster formations. Cluster 1 occurred April 29-30, cluster 2 May 2, cluster 3 May 5, cluster 4 May 9, cluster 5 May 10, cluster 6 May 11, cluster 7 May 13-14, cluster 8 May 14, and cluster 9 May 15.

In conclusion, in Texas, the earliest morbidity cases of 2009 Influenza A/H1N1 appear to have risen in the Dallas-Fort Worth, San Antonio, and Lower Rio Grande areas. Other high population areas such as Houston, Austin, and El Paso did have high counts of morbidity, but not at the rates as high as the three areas mentioned above. The rate of growth statewide during these early days was cubic. Temporally early clusters did not originate in the Lower Rio Grande

Valley, Dallas-Fort Worth, and San Antonio areas. Many of the earliest clusters originated southeast of San Antonio, southwest of Fort Worth, and near Abilene. Several later clusters originated near Montgomery County, Nolan County, and Guadalupe County. Most clusters began after May 8, ten days after the activation of the MACC and after much news coverage advised people to avoid large congregations, not to cough in their hands, and after many schools were closed. Despite the recommendation of these precautions the disease spread rapidly. So did people follow precautions?

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