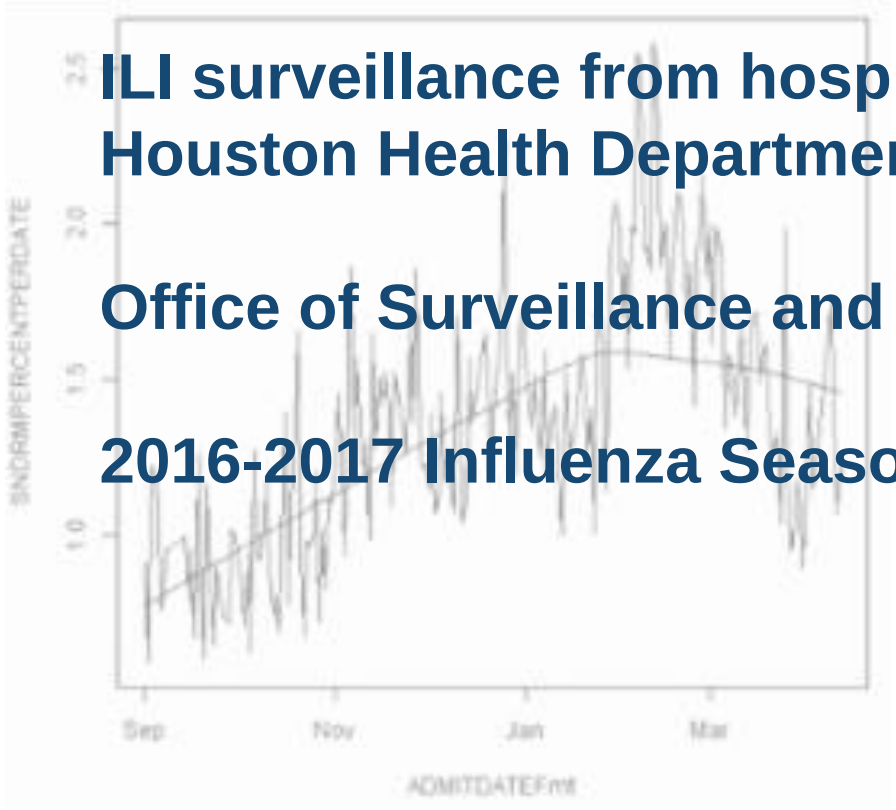
HOUSTON HEALTH DEPARTMENT

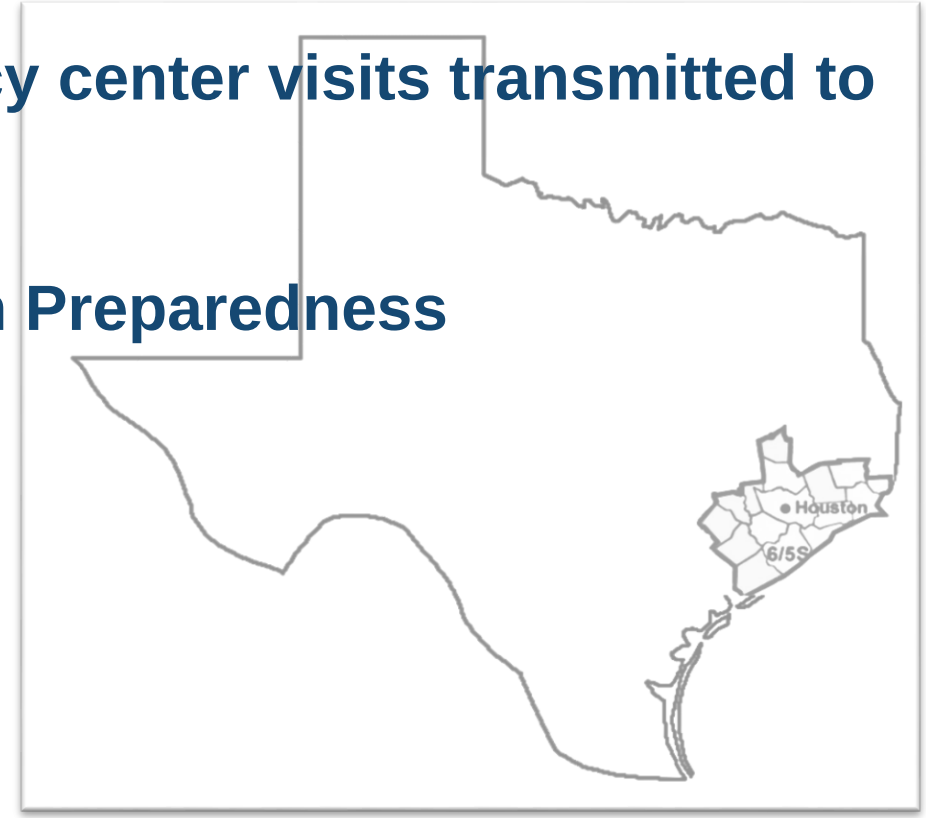
Influenza-like illness surveillance for Gulf Coast area



ILI surveillance from hospital emergency center visits transmitted to Houston Health Department

Office of Surveillance and Public Health Preparedness

2016-2017 Influenza Season



Acknowledgements

HOUSTON HEALTH DEPARTMENT

Seasonal Influenza Surveillance Collaborators

- Bureau of Epidemiology
- Bureau of Lab Services
- Houston Independent School District
- Sentinel Providers

Flu Near You Data Implementation Pilot Project Collaborators

- HHD Bureau of Immunizations
- Houston Independent School District
- City of Beaumont Public Health Department
- Susannah Paul, Emory University

flu near you

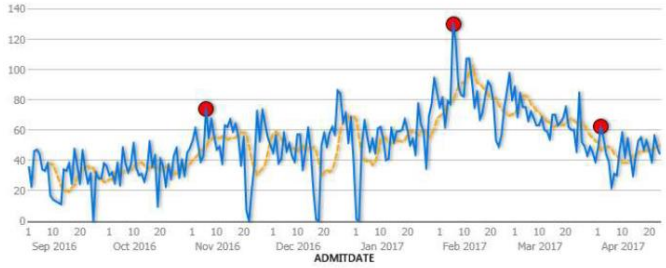
Icebreaker

Utility and awareness

HOUSTON HEALTH DEPARTMENT

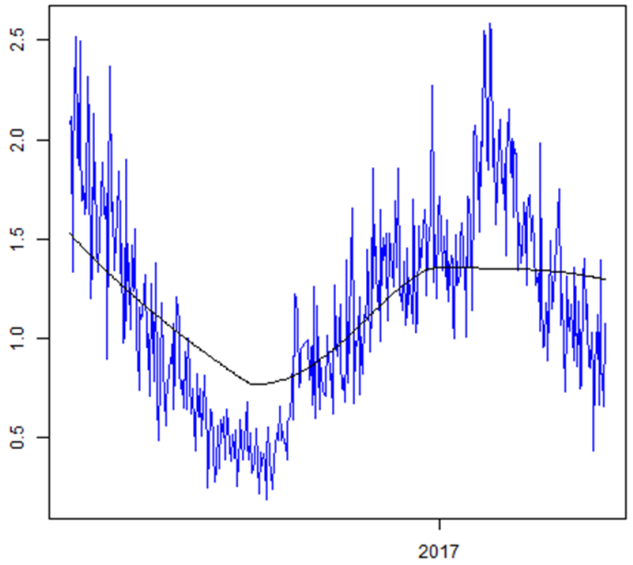
Public Health

- Analytics tools
  - Epi Info 7
  - R studio



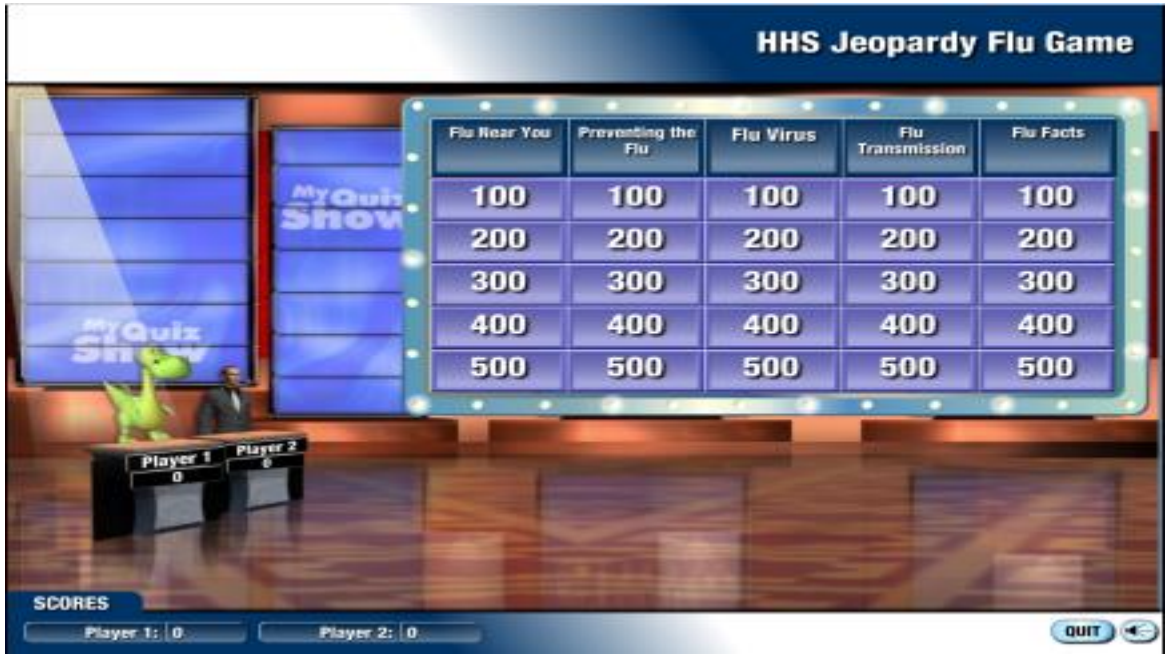
Aberrations

Date	Count	Expected	Difference
11/6/2016	74	48.57	3.51 standard deviations
2/6/2017	130	79	5.21 standard deviations
4/2/2017	62	46.43	3.55 standard deviations



School settings and Community outreach

- Toolkit
  - NACCHO website
- Game show format
  - Interactive



Presentation objectives

ILI surveillance

HOUSTON HEALTH DEPARTMENT

Review process and products

Using innovative methods and tools to streamline surveillance of influenza-like illness with Admission Discharge Transfer (ADT) Messages from Several Jurisdictions in the Texas Gulf Coast

Eunice R. Santos, MPH ; Wesley S. McNeely, MS, MPH; Biru Yang, PhD; Jeffrey Meyer, MD, MPH; Raouf R. Arafat, MD, MPH
Houston Health Department

HOUSTON HEALTH DEPARTMENT

Background

The possibility of pandemic influenza is a public health threat that requires ongoing capacity building and innovative methods to respond to the needs of public health partners and others. Influenza-Like-Illness (ILI) is used as a proxy for early detection of increased influenza activity. ILI activity can be tracked and monitored using HL7 ADT messages. In 2016 the Houston Health Department (HHD) led the effort to develop the Syndromic Surveillance Consortium of Southeast Texas (SSCSeT). The HHD syndromic surveillance team is testing technology and methodology as a proof of concept to streamline analysis and reports for multiple counties participating in the consortium. The goal is to identify the best practices to utilize health data from hospital emergency centers in a collaborative manner to inform stakeholders of ILI activity in the Texas Gulf Coast This abstract describes the technology and methods used to automate or streamline the surveillance of ILI activity.

Figure 1. Counties in syndromic surveillance consortium

Methods

Data in HL7 ADT format from hospital emergency centers (EC) is transmitted on a real-time basis to the HHD. Adhoc queries are run on a daily basis for ILI. First using SQL, a subset of records that meet the definition for ILI is created and the health data is aggregated into daily ILI percent per provider. The aggregated data is processed in RStudio to generate univariate time series plots for over 10 conditions including ILI. R Studio and EpiInfo7 are used for change point and aberration detection respectively. R Studio is used for statistical modelling while accounting for seasonality. R markdown is used to publish the results into MS Word, PDF or html. The analysis and report is designed to be run on a daily or weekly basis depending on the need for information.

Figure 2. Software

Results

The time required to process the data, perform the analysis and publish the report is 4 hours. After processing daily updates can be distributed in situations when ILI activity needs to be monitored on a daily basis, i.e during the annual influenza epidemic or in the event of an influenza pandemic. Once the technology and methods are developed it is possible to apply these methods to a variety of syndromes of interest which include Zika related symptoms and opioid related EC visits. After the proof of concept is complete a "how to guide" will be developed for the SSCSeT members.

Figure 3. Workflow from data feed to product

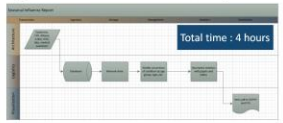


Figure 4 . HL7 message to results table

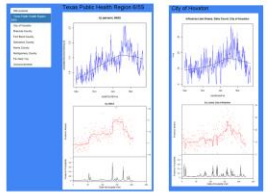
Date	Mean	Probability
1-Sep-16	1.5	75

Results

Table 1. Summary of ILI activity in Texas Gulf Coast

Begin date	Max date	Max percent	End date
27-Jan-17	11-Feb-17	2.6%	5-Mar-17

Figure 5. Website with ILI per jurisdiction



Conclusions

- Influenza epidemics occur every year.
- This proof of concept can provide timely descriptive information for situational awareness across multiple jurisdictions.
- Aggregation of data from several jurisdictions will result in enough statistical power to provide information on the begin date of ILI activity, maximum ILI activity, and end date of ILI activity to inform a public health response.

Acknowledgements: Thanks to the SScSeT Workgroup for Research and Best Practices and the collaborators who provided guidance.

The Houston Health Department provides traditional public health services and seeks to use innovative methods to meet the community's present and future needs. The HHD mission is to work in partnership with the community to promote and protect the health and social well-being of all Houstonians. HHD is now the first health department in Texas and the second of a large U.S. city to earn national accreditation.

Houston Health Department receives funding for this project through a joint organizational partnership between the Council of State and Territorial Epidemiologists (CSTE) and the Skoll Global Threats Fund (SGTF), provided by CSTE through sub-awards from the SGTF award #13-81126. The contents of this poster are solely the responsibility of the authors and do not necessarily represent the official views of SGTF or CSTE.

Presented at the 2017 Preparedness Summit Poster Session
Email: [redacted] Visit: HOUSTONHEALTH.ORG

Forecasting (Houston level)

Identifying Change Points and Forecasting Influenza Trends Using Diverse Influenza-like Illness Surveillance Data in Houston, TX (2012-2016)

Susannah Paul BS, Eunice Santos MPH, Roberd Bostick MD, MPH
Rollins School of Public Health, Emory University, 1516 Clifton Road, Atlanta, GA 30322

AIMS

- Use influenza-like illness (ILI) data to estimate magnitude, time of peak influenza activity, and start and end of influenza season
- Use historical ILI data to forecast potential activity

BACKGROUND

- Burden of influenza in the United States (U.S.) varies based on
  - circulating strains
  - vaccine efficacy and effectiveness
  - changes in virus structure
  - onset of season
- 2015-2016: Influenza activity peaked mid-March (Rolfes, 2016)
  - One of later peaks on record
  - 25 million influenza illnesses
  - 11 million influenza-associated medical visits
  - 310,000 influenza-related hospitilizations
  - 12,000 pneumonia and influenza deaths (mortality count likely higher)
- 2013: Spot vaccine shortages in certain regions (Phyllis, 2013)
  - 29 children dead
  - 5,249 hospitalizations as of 2nd week of January
  - Public vaccine demand increased
- 2009: declaration of Public Health Emergency of International Concern due to influenza pandemic
  - Initially discovered via lab confirmations in April
  - H1N1 strain that caused pandemic is now considered a seasonally circulating strain
- ILI used as an indicator of influenza activity
  - Data gathered from sentinel providers or health care facilities via reporting or automation
  - **ILI = fever (at least100˚F/37.8˚C) + cough or sore throat without another known cause**
- How does influenza surveillance help public health?
  - Allows public health professionals time for **preparedness** and **prevention**
  - If activity identified early enough, can reduce influenza-associated mortality and morbidity
  - Advancements in technology provides **novel resources** to track health-seeking behaviors associated with influenza

METHODS: Change Point Analysis

- Use to detect multiple, subtle changes to evaluate if significant change occurred
- Graph **cumulative sum (CUSUM) charts** to monitor average influenza-like activity at a time

$S_i = S_{i-1} + (X_i - \bar{X})$,
where X_i = weekly percentage of ILI,
S_{i-1} = previous week's cumulative sum, and
$\bar{X}$ = average.

- Generate **1,000 bootstrap samples** to estimate confidence interval around point of change
  - Samples represent random data that mimic behavior of cumulative sum if no change
- Calculate **mean square error (MSE)** as estimator of change

$MSE = \sum_{i=1}^{m} (X_i - \bar{X}_1)^2 + \sum_{i=m+1}^{n} (X_i - \bar{X}_2)^2$, where

$$\bar{X}_1 = \frac{\sum_{i=1}^{m} X_i}{m} \text{ and}$$

$$\bar{X}_2 = \frac{\sum_{i=m+1}^{n} X_i}{n-m}.$$

METHODS: ARIMA Forecasting

Autoregressive integrated moving average (ARIMA) models

- describe **autocorrelations** in data
- **forecast** time series

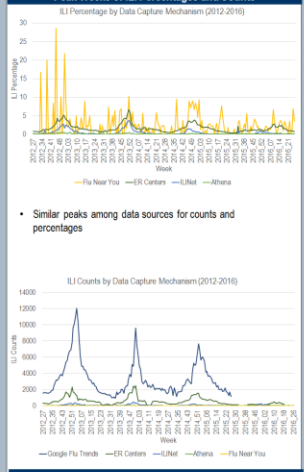
$\hat{y}_t = \mu + \varphi_1 y_{t-1} + \ldots + \varphi_p y_{t-p} - \theta_1 e_{t-1} - \ldots - \theta_q e_{t-q}$ where,
θ = moving average parameters of order q,
φ = autoregressive parameters of order p,
$\hat{y}_t$ = prediction estimates at time t,
y_{t-p} = lagged values of y, and
e = error term.

Peak Weeks per Year and ILI % by Data Source

Weeks	Data Source	Peak Week[a]	Peak ILI %[a]	Mean[a]	Mean (Oct-May)
2012-2013	Flu Near You	2012 45th	28.57	3.29	3.84[1]
	Athena	2012 50th	0.66	0.24	0.26[1]
	ER Centers	2012 51st	5.25	1.94	2.41[1]
	ILINet	51st 2012	2.62	0.72	1.01[3]
2013-2014	Flu Near You	2013 51st	10.29	2.22	2.48[1]
	Athena	2013 51st	0.48	0.15	0.17[1]
	ER Centers	2013 51st	6.59	1.87	2.35[1]
	ILINet	2013 51st	3.73	0.67	0.96[1]
2014-2015	Flu Near You	2014 37th	9.43	2.77	3.56[2]
	Athena	2014 50th	0.21	0.09	0.11[2]
	ER Centers	2014 51st	3.80	1.55	2.00[2]
	ILINet	2014 46th	1.48	0.28	0.41[2]
2015-2016	Flu Near You	2016 25th	6.9	1.90	2.12[3]
	Athena	2016 12	0.37	0.13	0.14[3]
	ER Centers	2016 9th	2.76	1.24	1.49[3]
	ILINet	51st 2015	0.96	0.18	0.23[3]

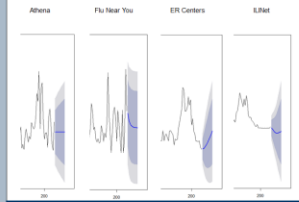
[1]Mean is calculated using weeks 40 through 22.
[2]Mean is calculated using weeks 40 through 21.
[3]Mean is calculated using weeks 39 through 21.
[4]The time interval is week 27 through week 26 of the following year.
[5]Mean is calculated using weeks 38 through 20.

Peak Weeks of ILI Percentages and Counts



- Similar peaks among data sources for counts and percentages

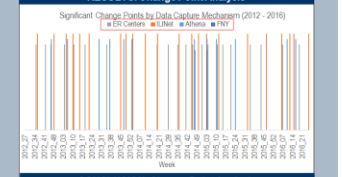
RESULTS: Forecasting



CONCLUSION: Forecasting

- All sources differ in forecasted trend
- Wide confidence interval (gray bands show 95% CIs)

RESULTS: Change Point Analysis



CONCLUSION: Change Point Analysis

- Clustered bands indicate likely time of significant change in average ILI activity
- ILINet more comprehensive in capturing start and end of season
- FNY only contains two significant change points

Future Directions

- Utilize all available data sources to fit multivariate model that forecasts one point estimate more accurately
- Include other variables that influence influenza activity (age, vaccination)
- Evaluate validity of forecasts by comparing to observed data
- Compare sources to laboratory test results

REFERENCES

Hyndman, R. J., & Athanasopoulos, G. (2014). *Forecasting: principles and practice*. Otexts.com. Retrieved from https://www.otexts.org/fpp/8

Kass-Hout, T. a, Xu, Z., McMurray, P., Park, S., Buckeridge, D. L., Brownstein, J. S., … Groseclose, S. L. (2012). Application of change point analysis to daily influenza-like illness emergency department visits. *Journal of the American Medical Informatics Association : JAMIA*, *19*(6), 1075–1081. https://doi.org/10.1136/amiajnl-2011-000793

Rolfes MA, Foppa IM, Garg S, Flannery B, Brammer L, Singleton JA, et al. Estimated Influenza Illnesses, Medical Visits, Hospitalizations, and Deaths Averted by Vaccination in the United States. 2016 Dec 9, https://www.cdc.gov/flu/about/disease/2015-16.htm

Taylor, W. A. (2000). Change-Point Analysis: A Powerful New Tool For Detecting Changes. Retrieved from http://www.variation.com/cpa/tech/changepoint.html

All analysis was completed using R 3.2, Microsoft Excel, and Change-Point Analyzer 2.3.

ACKNOWLEDGEMENTS

- Houston Health Department Office of Surveillance and Public Health Preparedness
- Harvard, Boston Children's Hospital, and Skoll Global Threats Fund
- Texas Department of State Health Services

Introduction

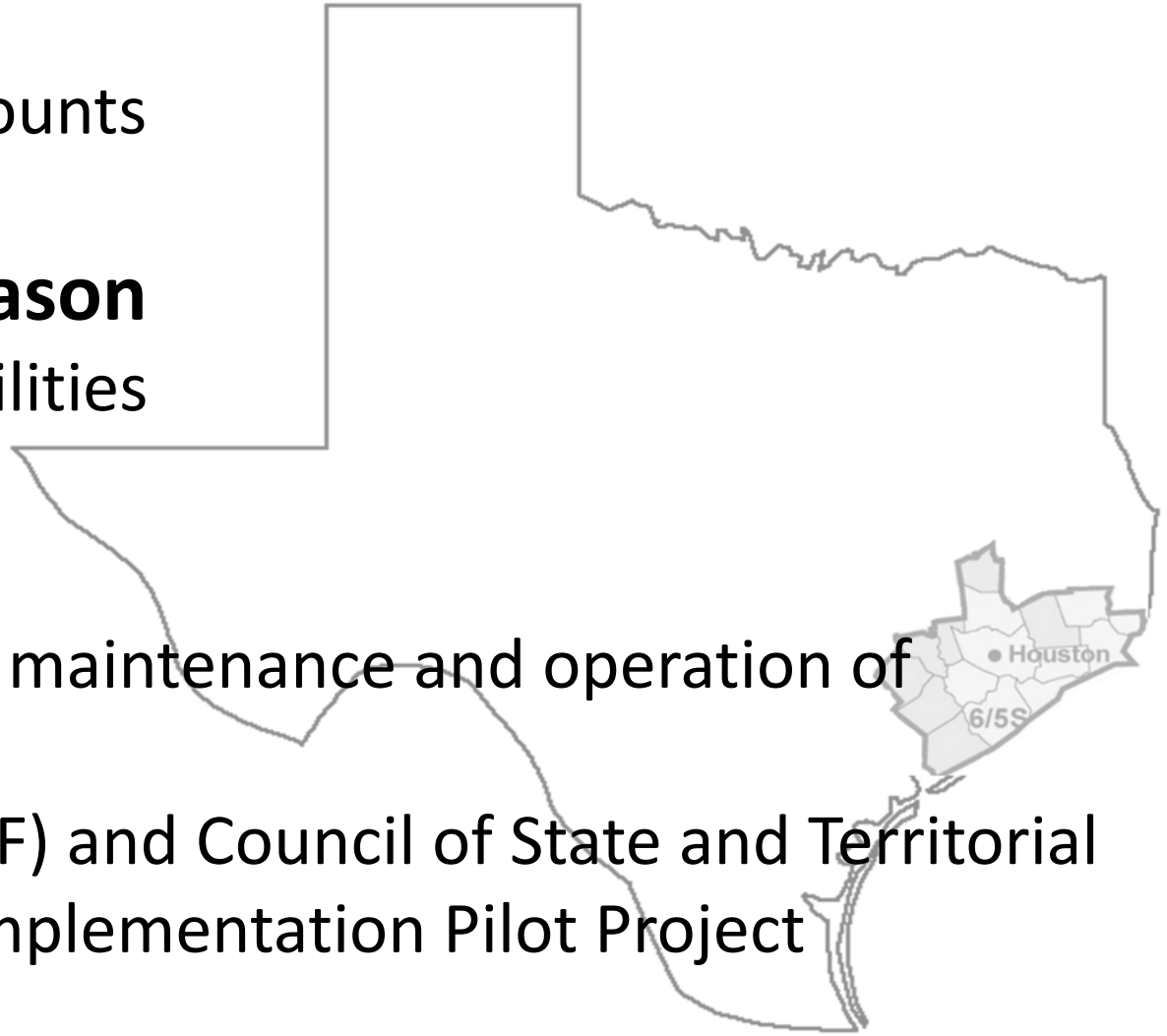
HOUSTON HEALTH DEPARTMENT

Purpose of ILI surveillance

- Monitor ILI activity with aggregated counts

Coverage during the 2016-2017 season

- Six jurisdictions and 32 healthcare facilities



Funding

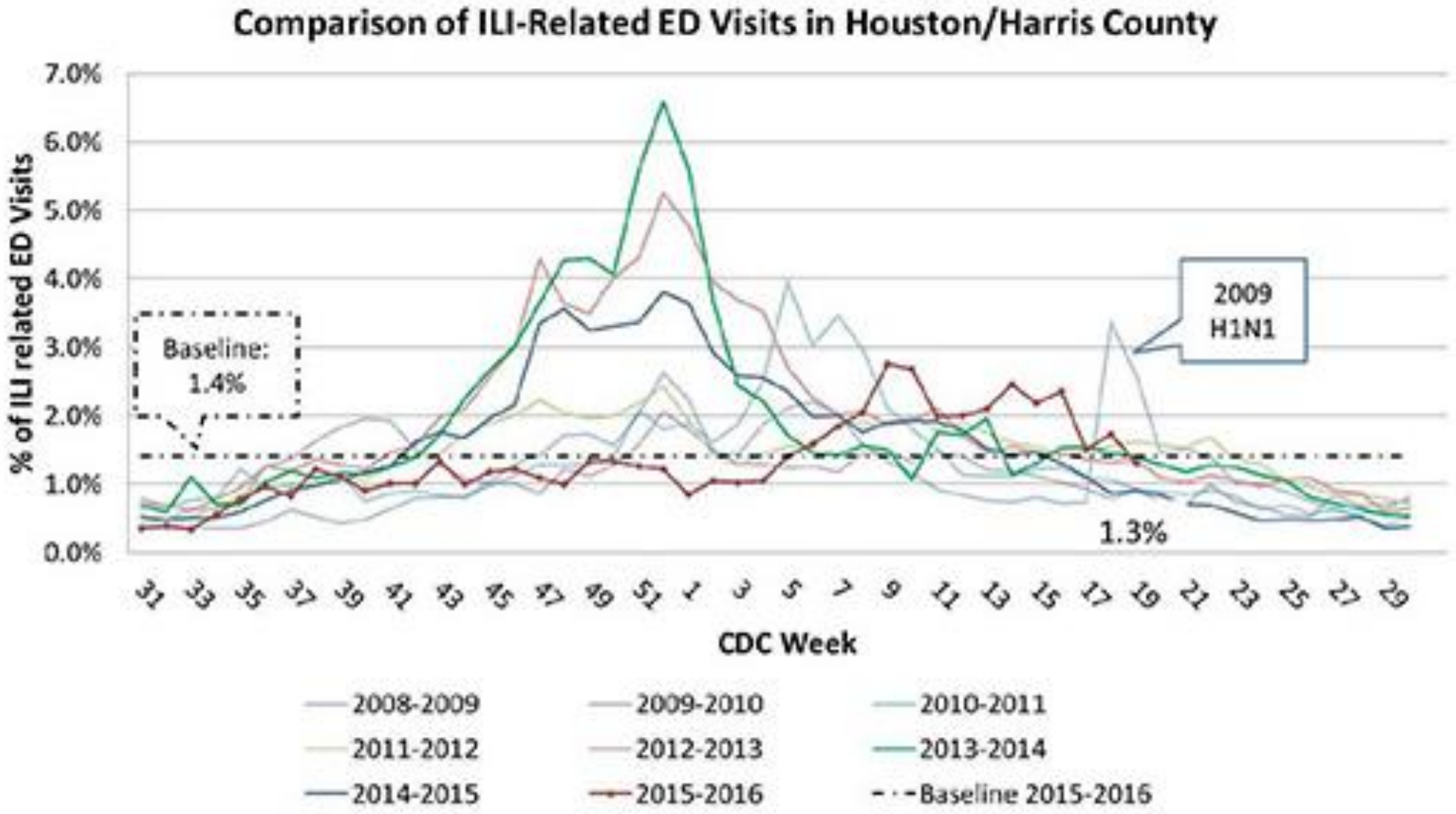
- Urban Area Security Initiative (UASI): maintenance and operation of syndromic surveillance activities
- Skoll Global Threats Foundation (SGTF) and Council of State and Territorial Epidemiologists: Flu Near You Data Implementation Pilot Project

flu near you

Historical review

Hospital emergency center visits in Houston, 2008 to 2016

HOUSTON HEALTH DEPARTMENT



ILI surveillance overview

Sources of data for ILI surveillance

HOUSTON HEALTH DEPARTMENT

Gulf Coast area

- Hospital emergency center visits from participating counties

Houston level

- Hospital emergency center visits
- Athena
- ILINet
- Flu Near You
- School surveillance

ILI surveillance for 2016-2017

Hospital emergency center visits

HOUSTON HEALTH DEPARTMENT

Challenge

- Data structure changed

Solution

- Data mining approach used HL7 message to code each hospital visit into ILI

ILI definition

- Fever and cough
- Fever and sore throat
- Fever and cough and sore throat
- Flu or Influenza

Process

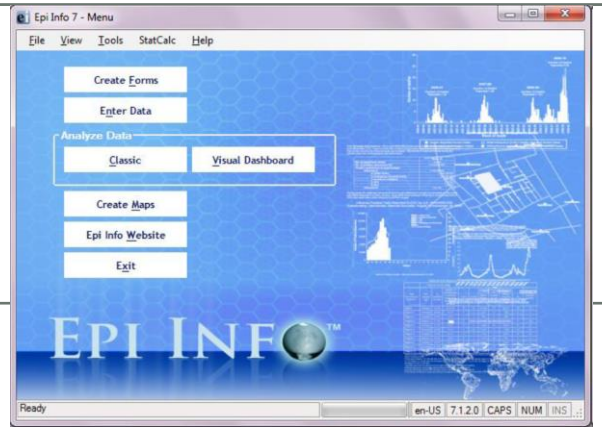
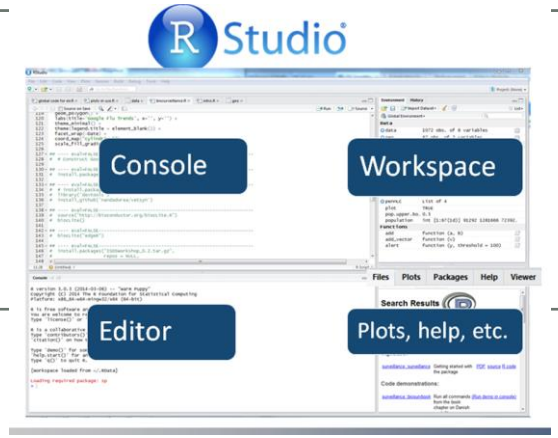
- Aggregate data per jurisdiction, hospital, and Gulf Coast area (regional)

Distribution format

- Csv file with aggregated counts made available to jurisdictions
- Html file with ILI per jurisdiction in Texas Public Health Service Region 6/5S

Methods

HOUSTON HEALTH DEPARTMENT

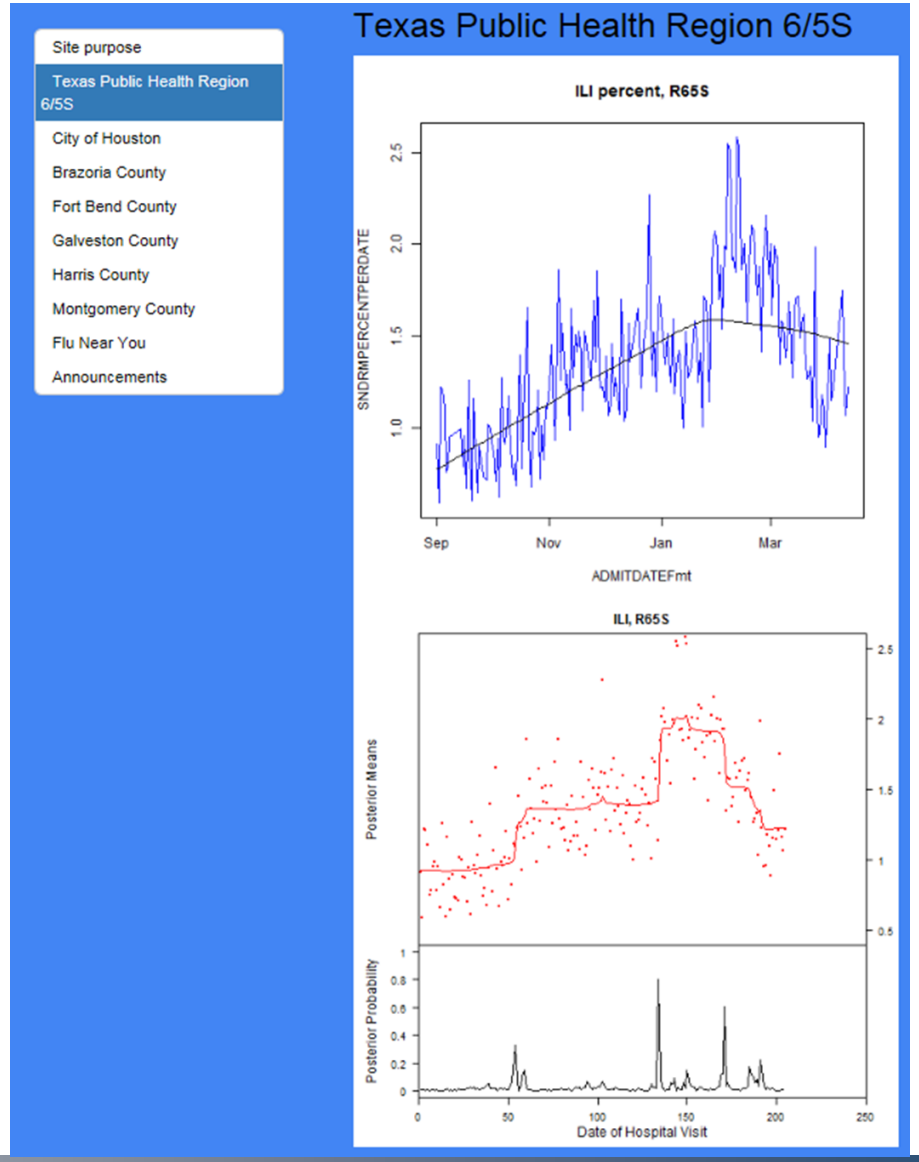
	Transmission	Ingestion	Storage	Management	Analytics	Distribution
Architecture	Syndromic, FNY, Athena, ILINet, HISD, labs, medical examiners					
Logistics		Databases	Network drive	Weekly occurrence of condition by age group, type, etc.	Descriptive statistics with graphs and tables	
Visualization						Html, pdf to OSPHP and PIO

2016-2017

Region 6/5S, ILI percent

HOUSTON HEALTH DEPARTMENT

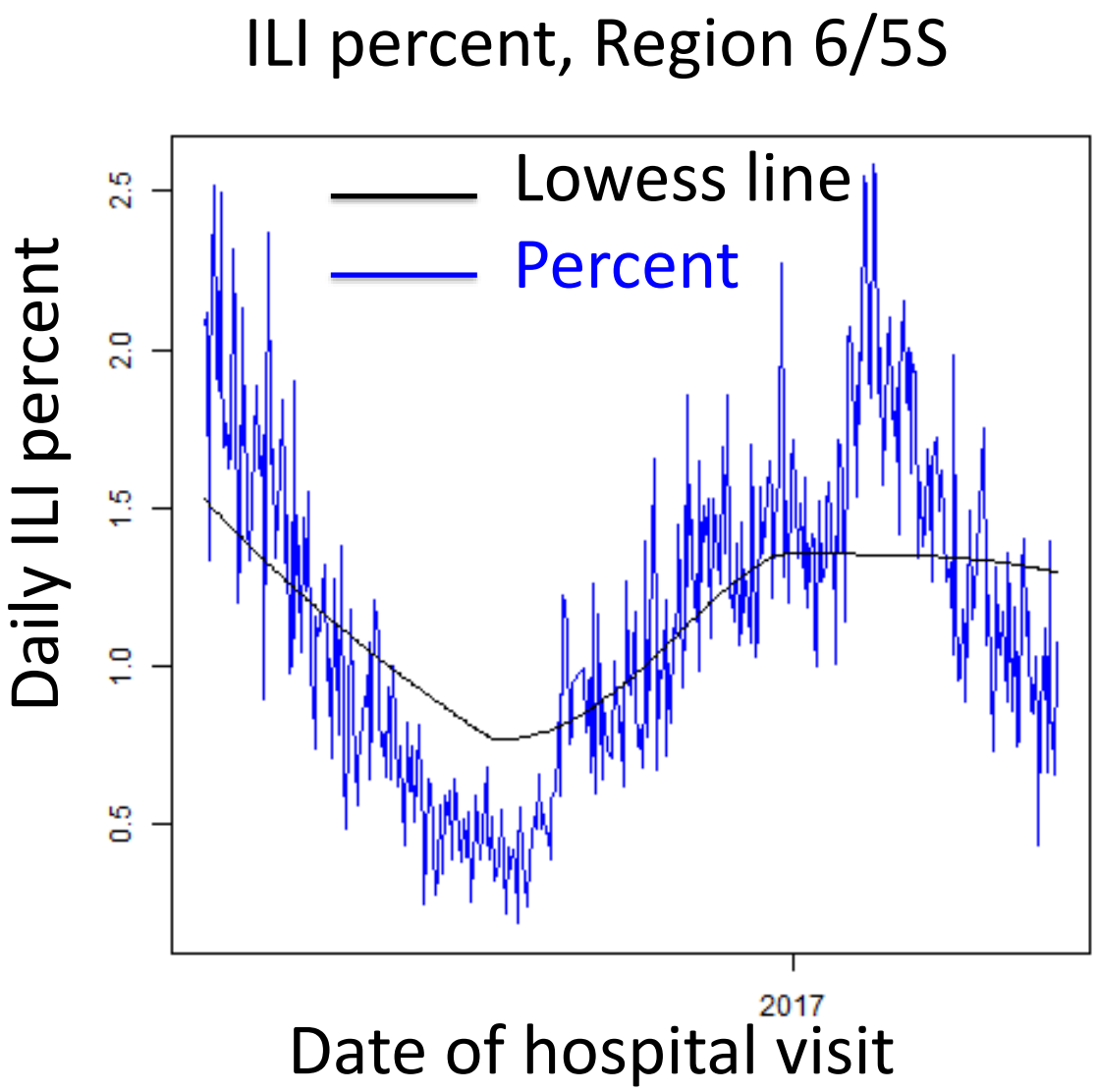
Begin date	Max date	Max percent	End date
27-Jan-17	11-Feb-17	2.6%	5-Mar-17

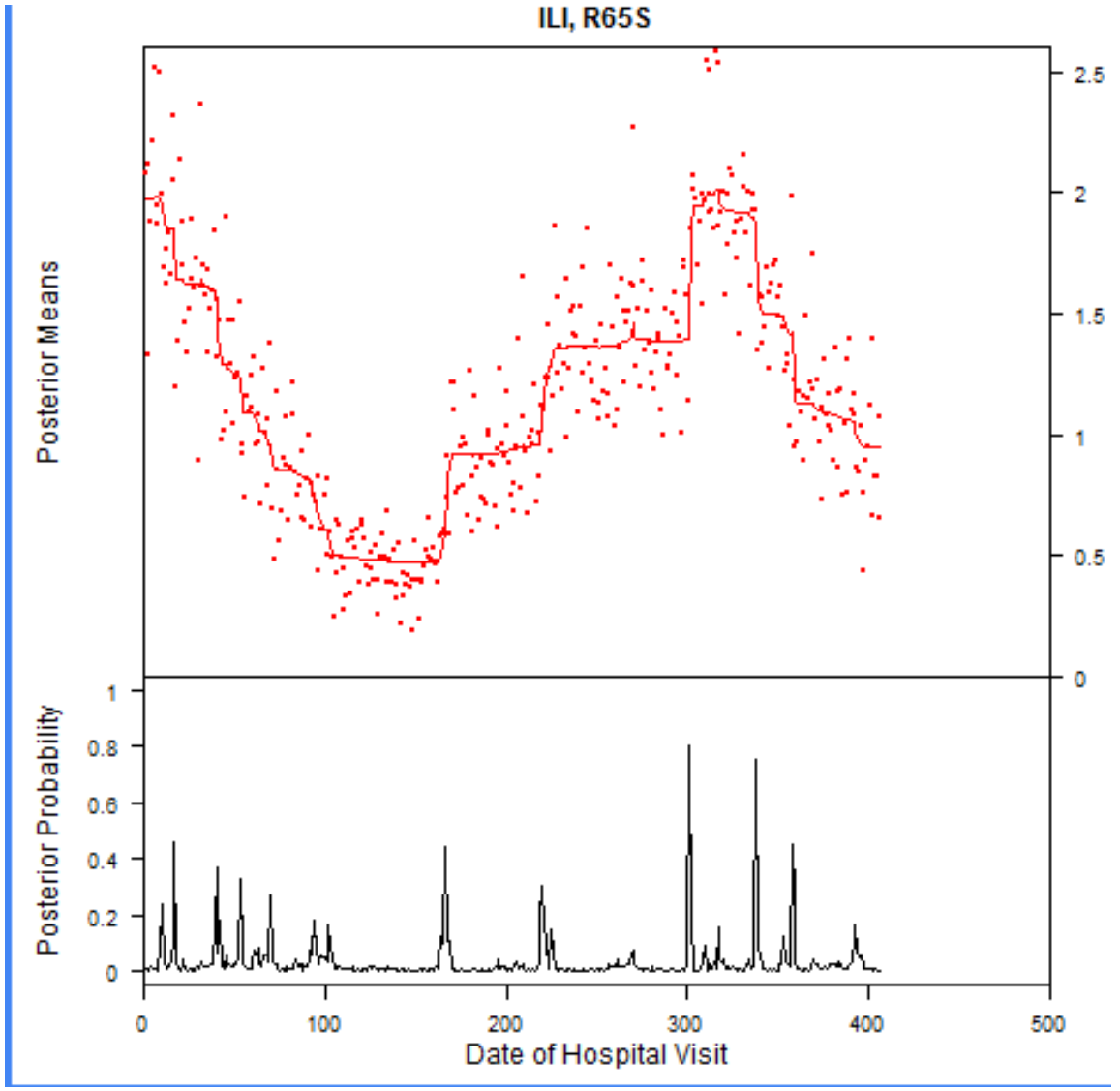


2016-2017 ILI activity

Region 6/5S, ILI percent

HOUSTON HEALTH DEPARTMENT

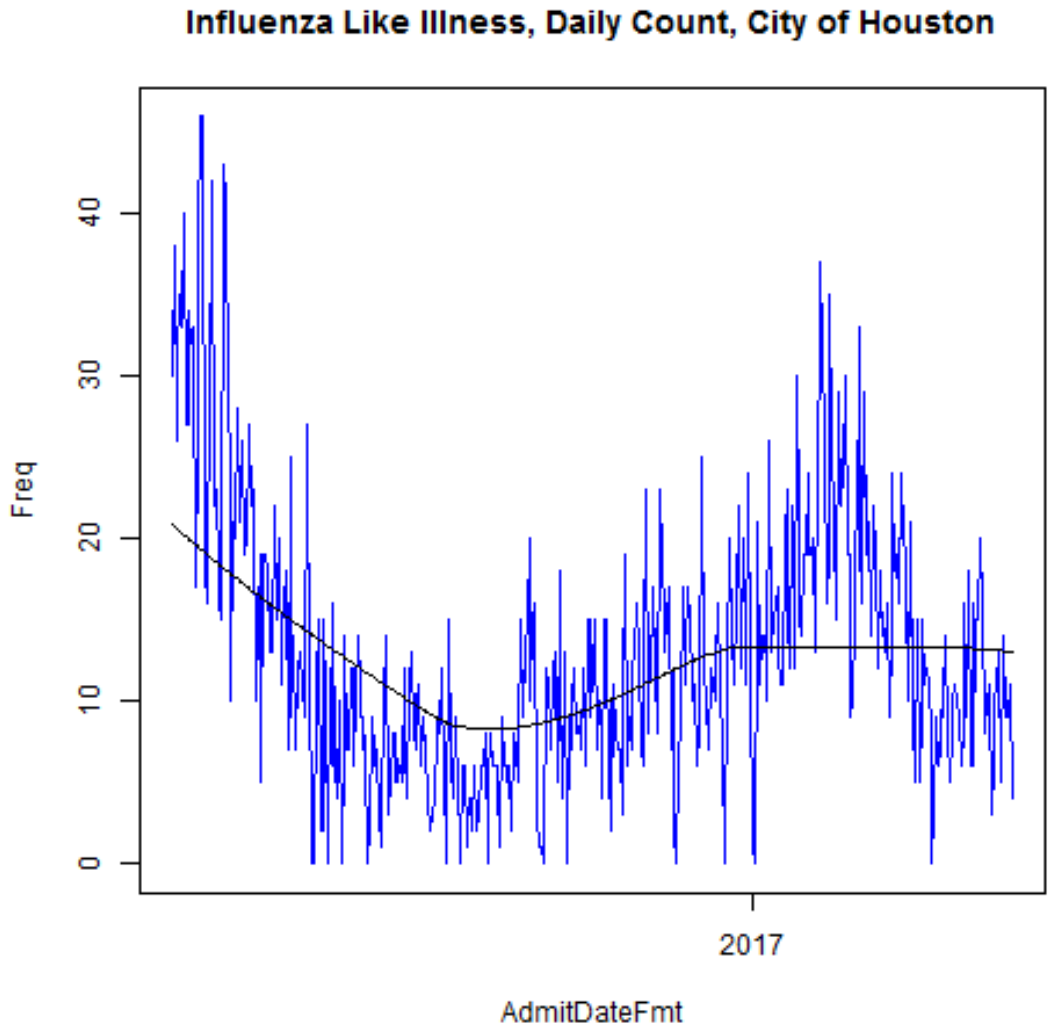


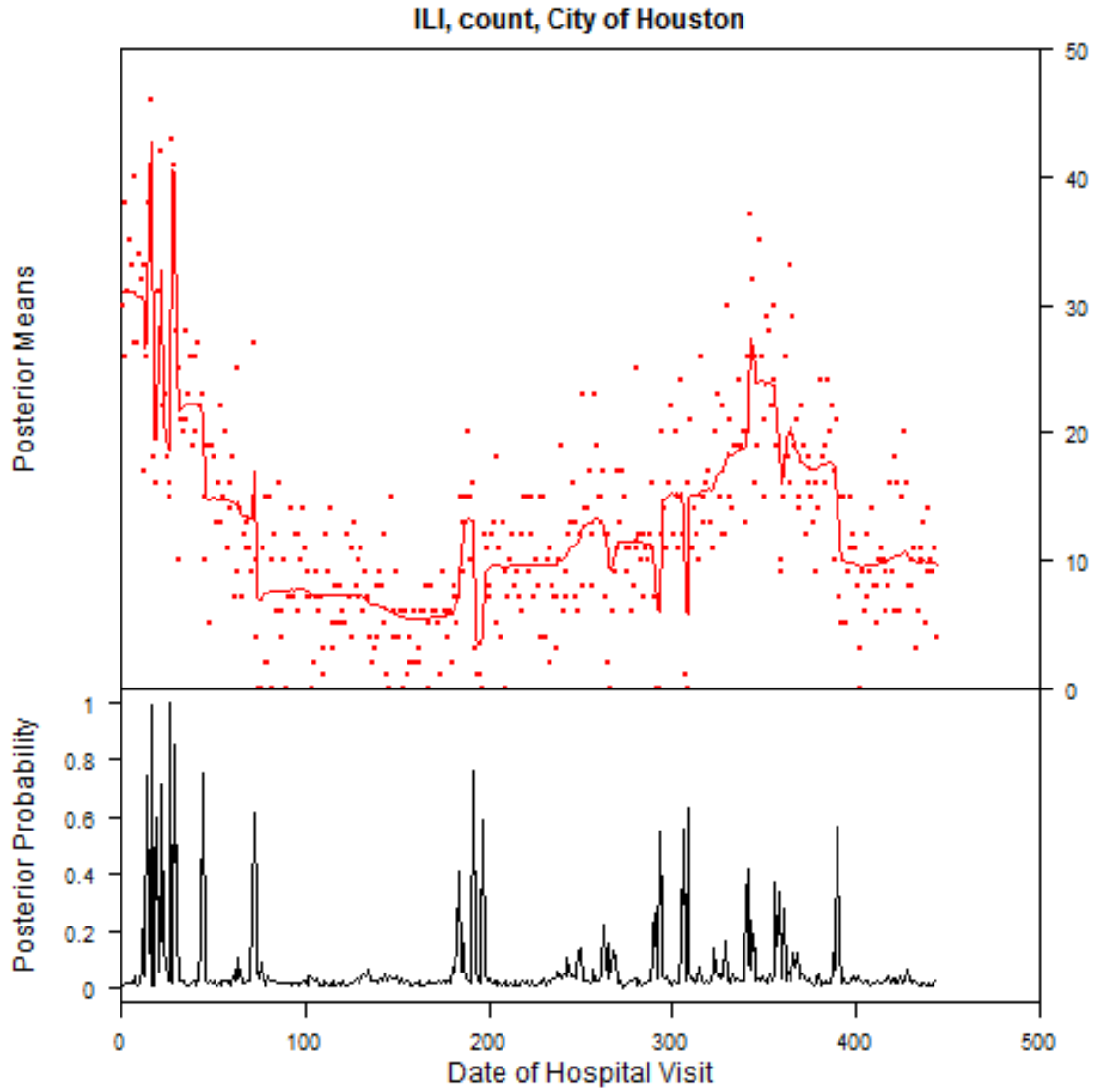


2016-2017 ILI activity

ILI count from hospitals in City of Houston jurisdiction

HOUSTON HEALTH DEPARTMENT

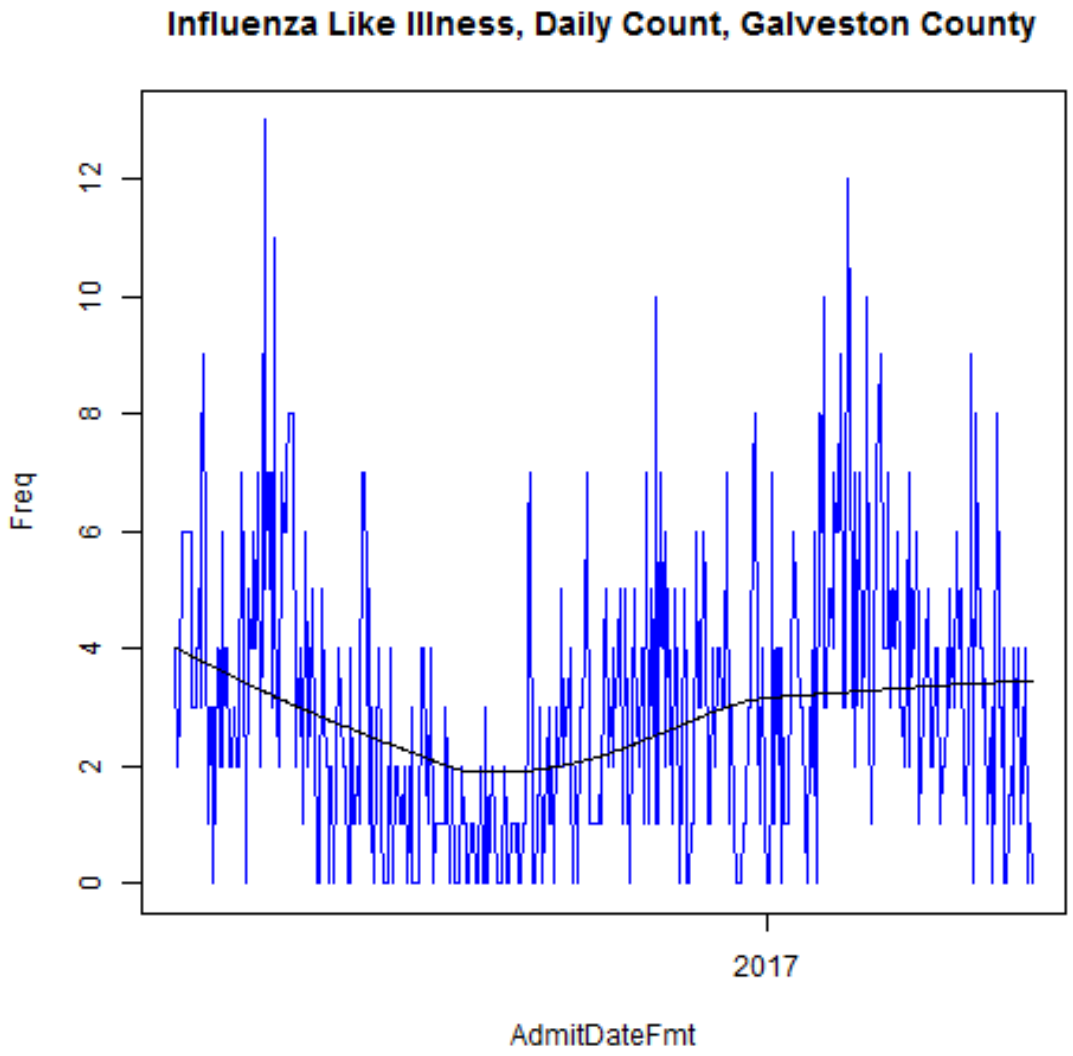


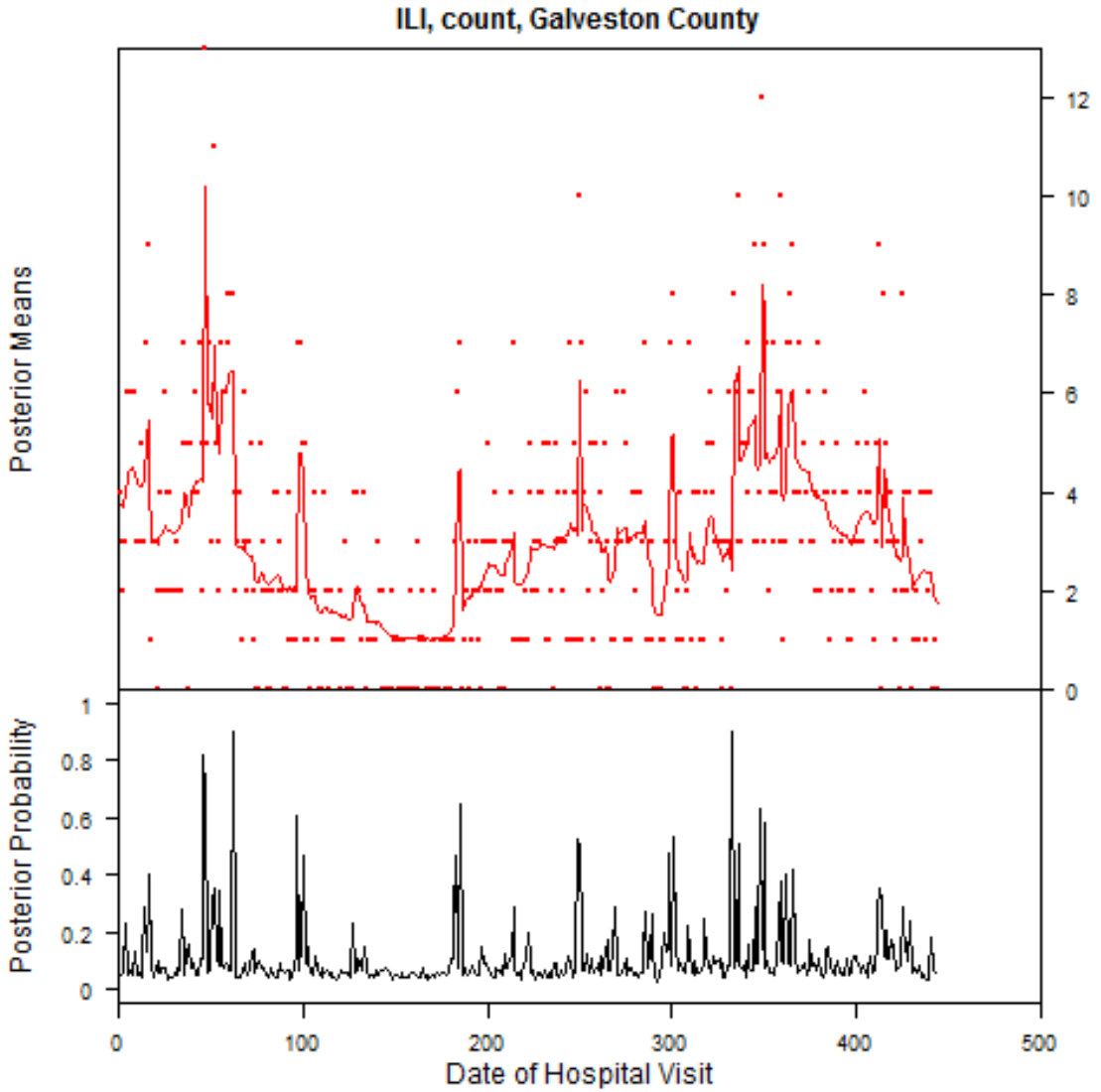


2016-2017 ILI activity

ILI count from hospitals in Galveston County

HOUSTON HEALTH DEPARTMENT





Next steps

HOUSTON HEALTH DEPARTMENT

- Test methods on new syndromic surveillance system (ESSENCE)

Questions

HOUSTON HEALTH DEPARTMENT

Questions?

Contact information:

Eunice Santos, MPH
Eunice.santos@houstontx.gov

@HoustonHealth

Houston Health Department

houstontxdotgov

Website Houstonhealth.gov

Thank You!

HOUSTON HEALTH DEPARTMENT