

# Evaluation of ICD-9 Code Based Influenza-like Illness Surveillance



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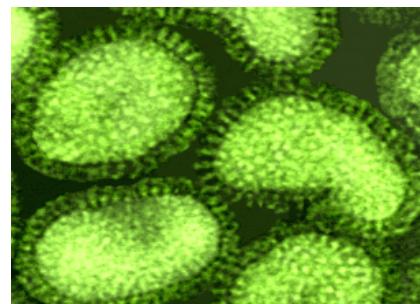
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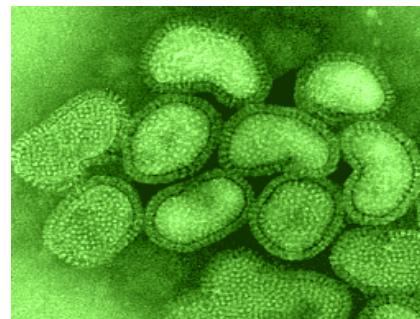
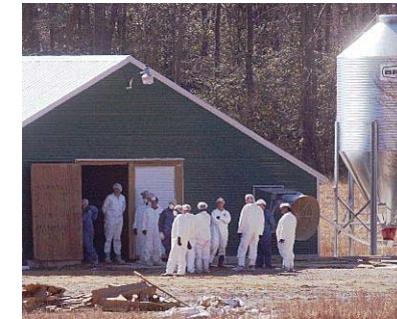
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# Annual Surveillance for Influenza



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# DOD Influenza Surveillance

- Collects respiratory pathogen specimens from military treatment facilities worldwide
  - Specimens sent to AFIOH, Brooks AFB, TX
- Collection from sentinel sites
  - Submit 6-10 specimens per week between October and March
  - Patients must meet a clinical case definition of fever  $>100.5^{\circ}\text{F}$  and either a cough or sore throat

\* Non-sentinel sites may also submit specimens but are not required
- Specimens are screened for a variety of viral respiratory pathogens including influenza A and B, respiratory syncytial virus and adenovirus



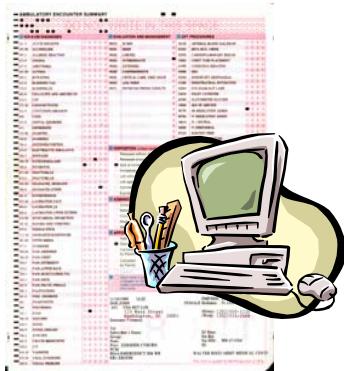
# Syndromic Surveillance Using ESSENCE

**E**lectronic  
**S**urveillance  
**S**ystem for the  
**E**arly  
**N**otification of  
**C**ommunity-based  
**E**pidemics



# ESSENCE I

## Worldwide Military Surveillance

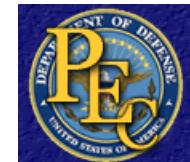


Electronic visit records  
(ICD9 codes) sent to  
central repository

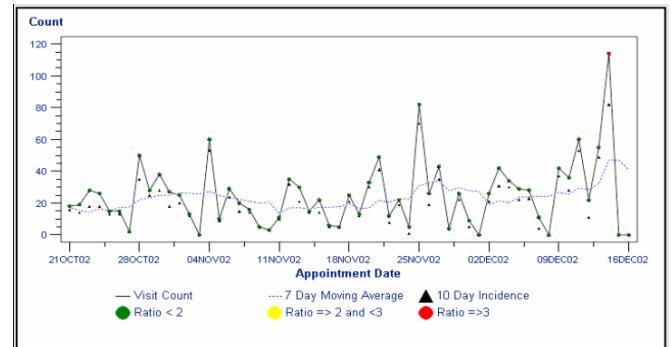
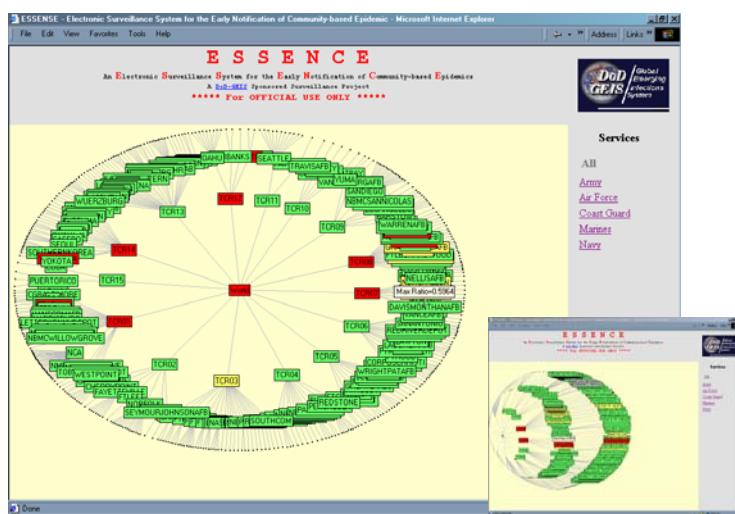
1-3  
days



Prescription data for  
DOD beneficiaries is  
captured by PDTs  
and sent to Tricare



Data updated every 8 hours.  
Analyzed by syndrome and  
organized into alerts by sites



Graphs of daily visit  
counts by syndrome

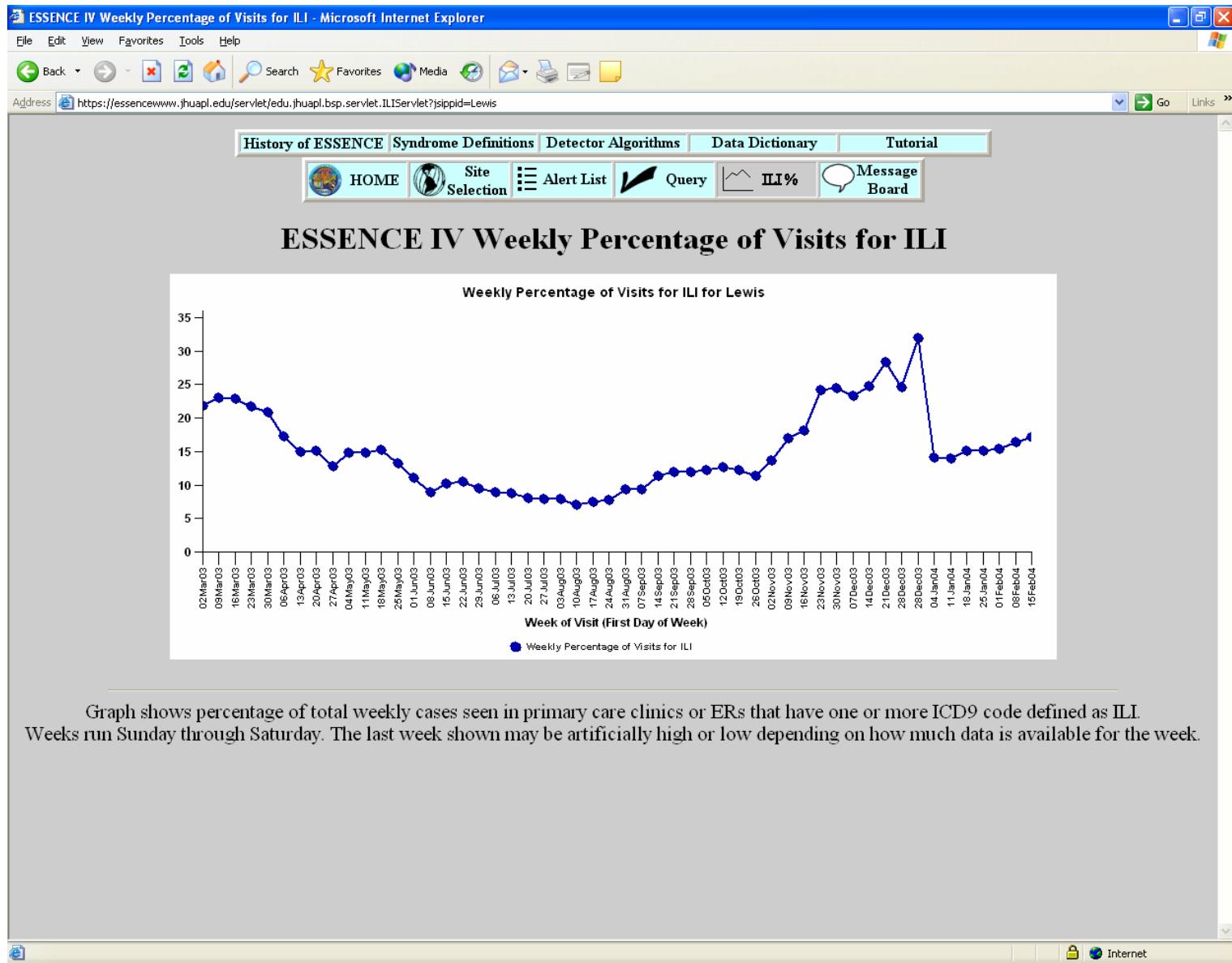


# Monitoring Influenza-like Illness (ILI) with ESSENCE

- ILI is monitored on a weekly basis as a percent of all visits
  - Based on the CDC's weekly ILI report from the U.S. Influenza Sentinel Providers Surveillance Network
  - ESSENCE calculates the number of visits for ILI as a percentage of total outpatient primary care and ER visits
- ILI is a modified syndrome group
  - Includes 29 ICD-9 codes that represent potential ILI cases
  - Visits are counted as ILI if their diagnostic code is either fever, or an included respiratory code, or unspecified viral illness



# ESSENCE ILI Graph



# Evaluation of ESSENCE ILI Surveillance

- Need to evaluate the accuracy of ICD-9 coding
  - Provider selected ICD-9 codes may reflect unconfirmed diagnoses and non-specific symptoms
  - Provider/coder variation in code selection
  - Approximately 70% of ambulatory records contain one ICD-9 code
  - Concern that ICD-9 data coded at the time of visit may not accurately reflect true illness
- Research Objectives:
  - Determine how well the ILI codes trend with respiratory specimen data collected in DOD Influenza Surveillance program
  - Determine the most parsimonious set codes from ambulatory visits for weekly ILI surveillance

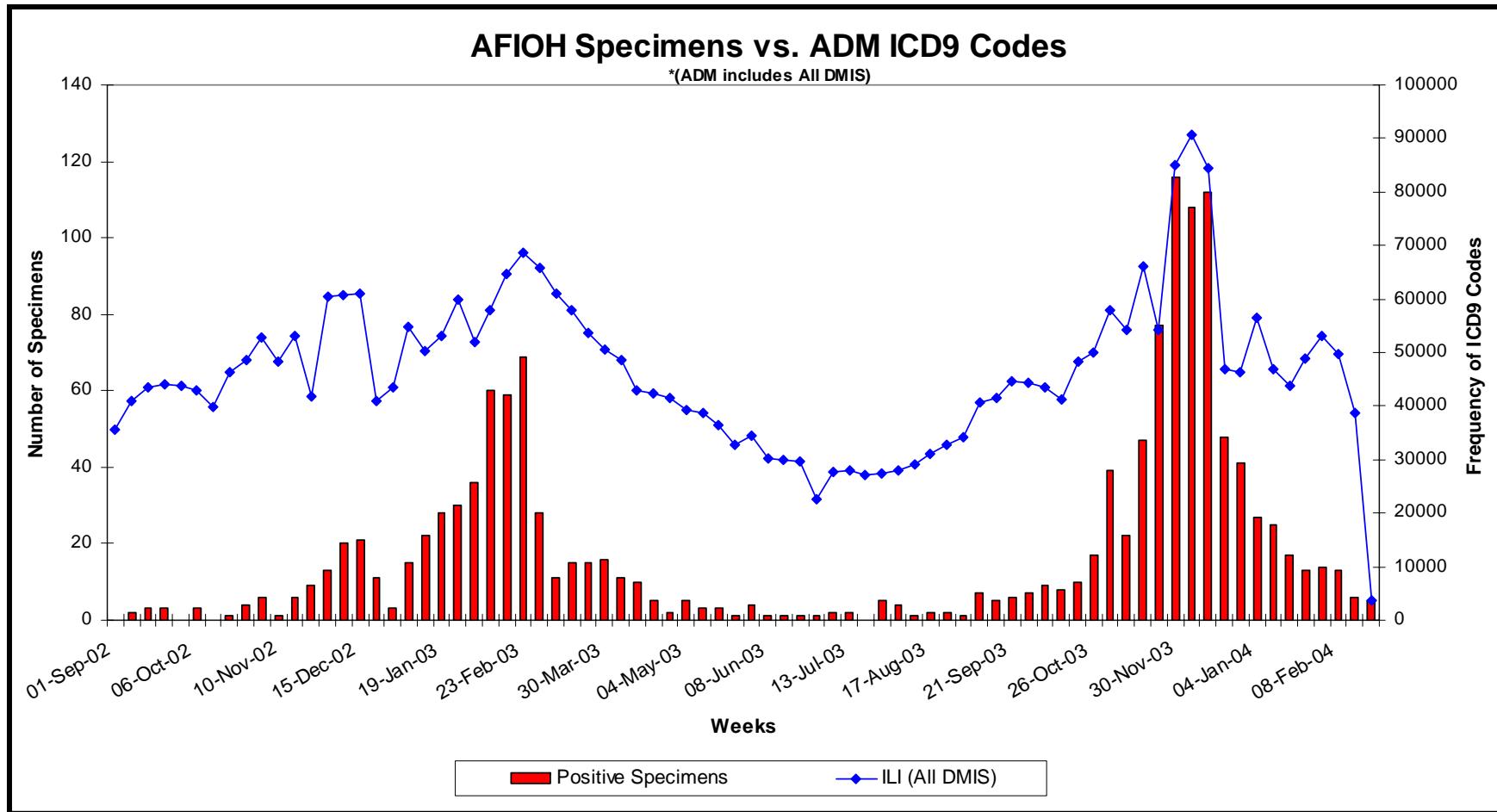


# Evaluation Design

- ILI codes were compared individually and as a group to positive respiratory specimens collected from September 2002 to February 2004
  - Codes with counts >10 per day included
- ILI codes were compared to gold standard by temporal and frequency analysis
  - Correlation matrix/lagged correlation
  - Factor analysis
  - Regression
  - Signal-to-noise



# Comparison of ILI (all DoD) to Positive Respiratory Specimens

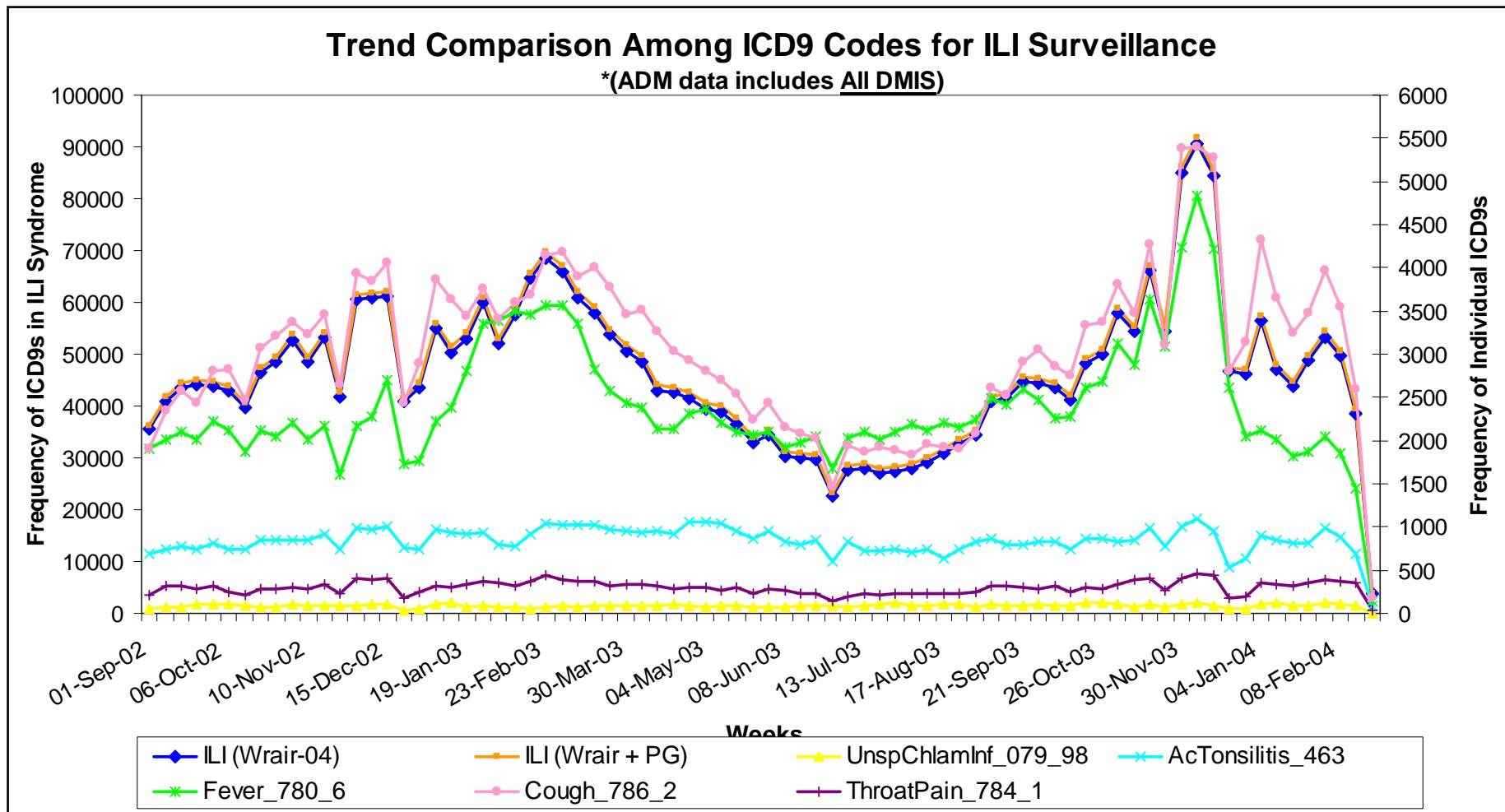


- ILI (all DoD) follows the same seasonal pattern as positive respiratory pathogen specimens

–Correlation (all DOD sites):  $r = 0.77$



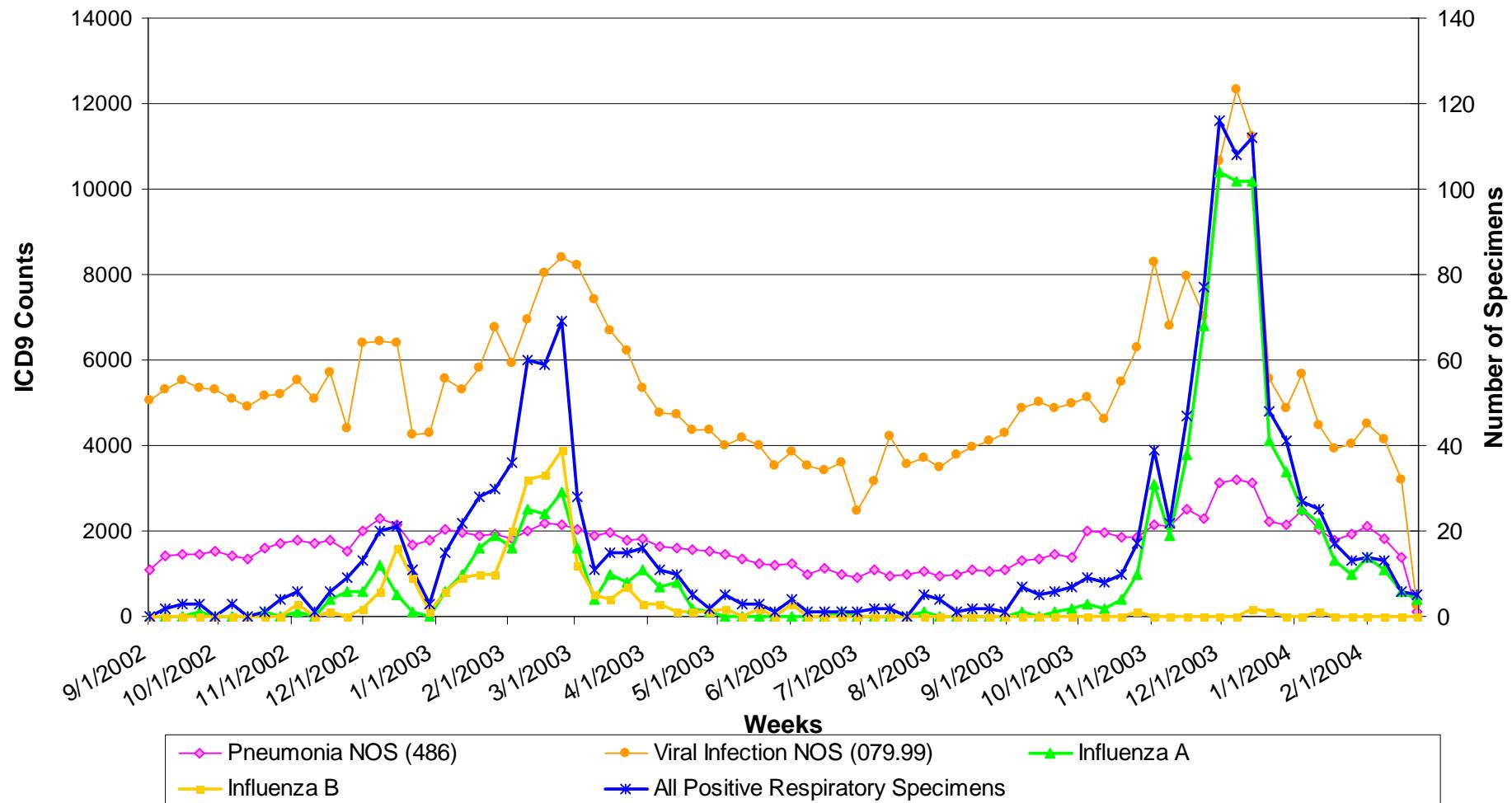
# Comparison of ILI Code Trends



- Most ILI codes follow the same seasonal pattern
- More than half of ILI codes have small counts that can be overwhelmed by larger codes like URI



# Viral Infection and Pneumonia ICD9 Codes vs. Positive Specimens



- **Viral infection (079.99):  $r = 0.82$**
- **Pneumonia (486):  $r = 0.79$**



# ILI ICD-9 Code Comparisons to Positive Respiratory Specimens

_NAME_	Positive Specimens
Flu_wOthRsp_487_1	0.924
Flu_wOthManif_487_8	0.870
Viral_Inf_NOS_079_99	0.823
Bronch_NotAC_490	0.811
Fever_780_6	0.796
Pneum_NOS_486	0.789
URI_unspsite_465_9	0.752
AcBronchitis_466_0	0.726
Flu_wPneum_487_0	0.725
URI_multsite_465_8	0.716
Cough_786_2	0.695
AcuteNasophar_460	0.621
BronchPneum_485	0.619
AcSinusUnsp_461_9	0.583
AcLryngWO_obs_464_00	0.546
AcLaryngophar_465_0	0.543
ThroatPain_784_1	0.504
AcBronc_dtOth_466_19	0.501
AcPharyngitis_462	0.458
OthUnspDsRsp_478_9	0.406
Pneum_RSV_480_1	0.397
AcTracheitis_464_10	0.375
VirPneumUnsp_480_9	0.370
Viral_Inf_NEC_079_89	0.362
AcLaryngotrac_464_20	0.342
Pneum_OthVir_480_8	0.337
Bronch_dtRSV_466_11	0.324
AcTonsilitis_463	0.266
Pneum_parainf_480_2	0.189
OthAcSinusits_461_8	0.137
UnspChlamInf_079_98	0.032
Pneum_inOthID_484_8	-0.040
Pneum_Adeno_480_0	-0.108

New code



New codes



# **Summary of Individual ILI ICD-9 Code Correlations to 486 and 079.99**

## **Large codes – High correlation**

- Viral infection NOS
- Fever
- Bronchitis, non-acute
- Bronchitis, acute
- Pneumonia NOS
- Cough
- Acute nasopharyngitis
- Flu with other resp symptoms
- Acute sinusitis, unspecified (new code)
- Acute pharyngitis\*\*

## **Small codes – High correlation**

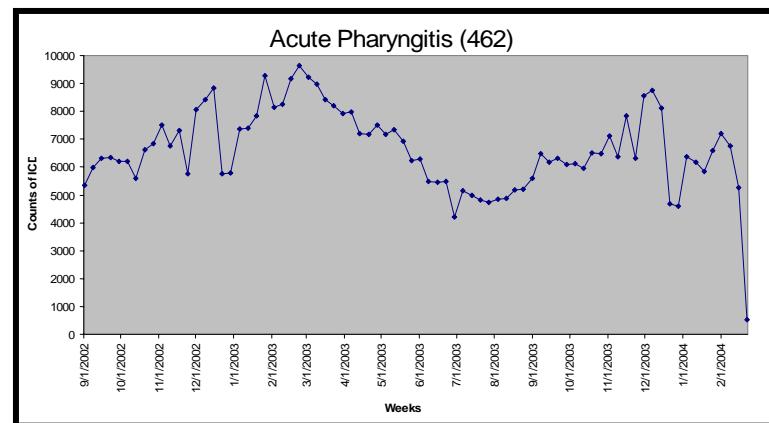
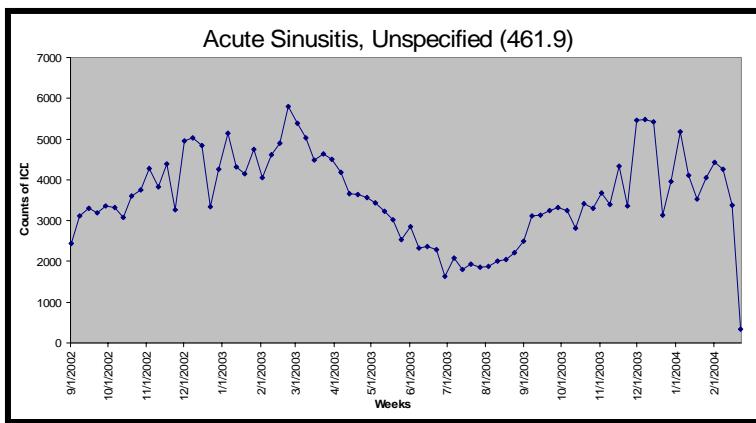
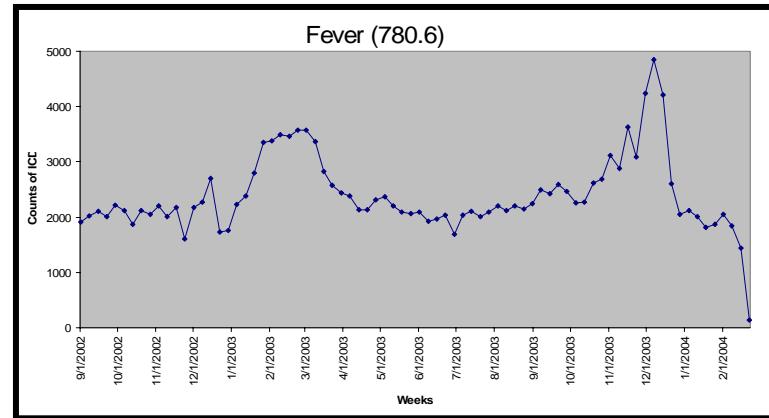
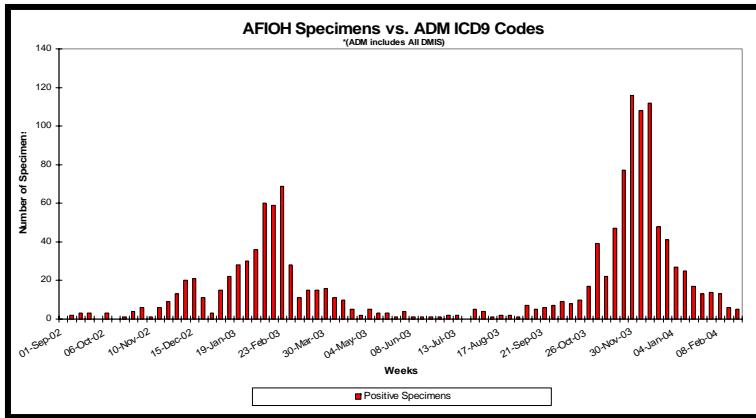
- Flu with other manifestations
- Acute laryngitis without obstruction
- Throat pain
- Flu with pneumonia

## **Medium codes – low correlation**

- Acute tonsillitis (new code)
- Other acute sinusitis (new code)
- Acute bronchitis, d/t other infectious organism
- URI, multiple sites



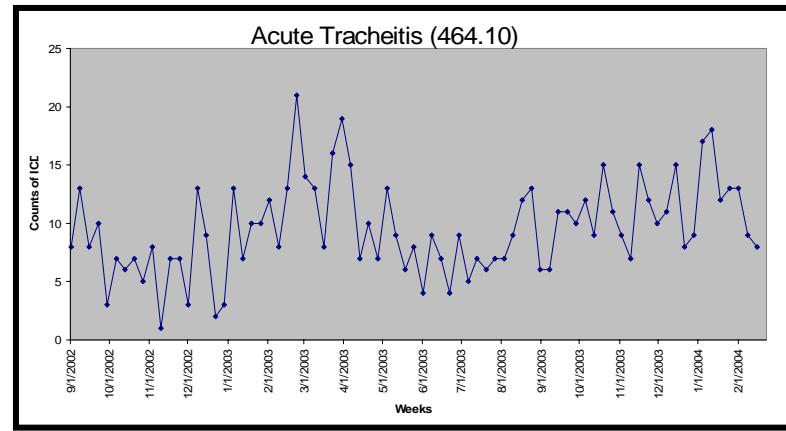
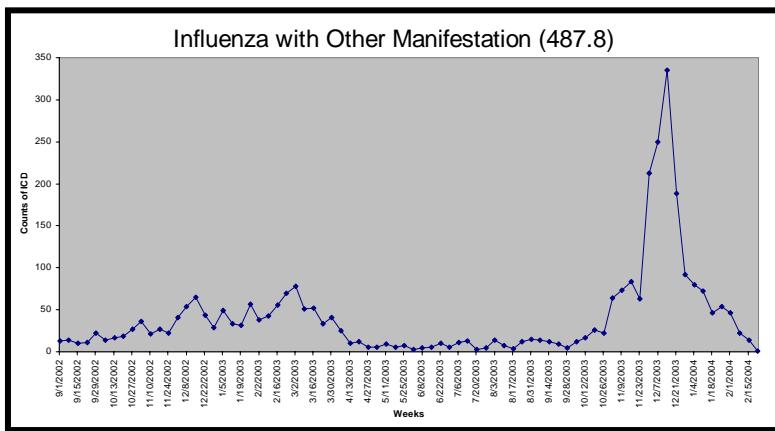
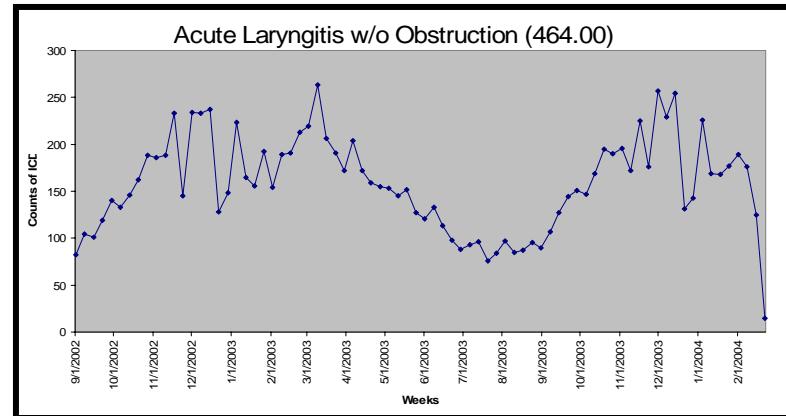
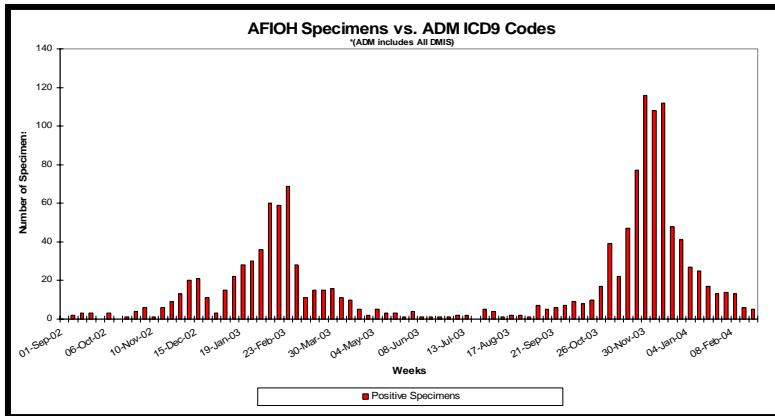
# Positive Respiratory Specimens Compared with Large Count Codes



- Most large count code temporal trends correlate well with positive respiratory specimens, but acute pharyngitis is on the low end ( $r = 0.46$ ).



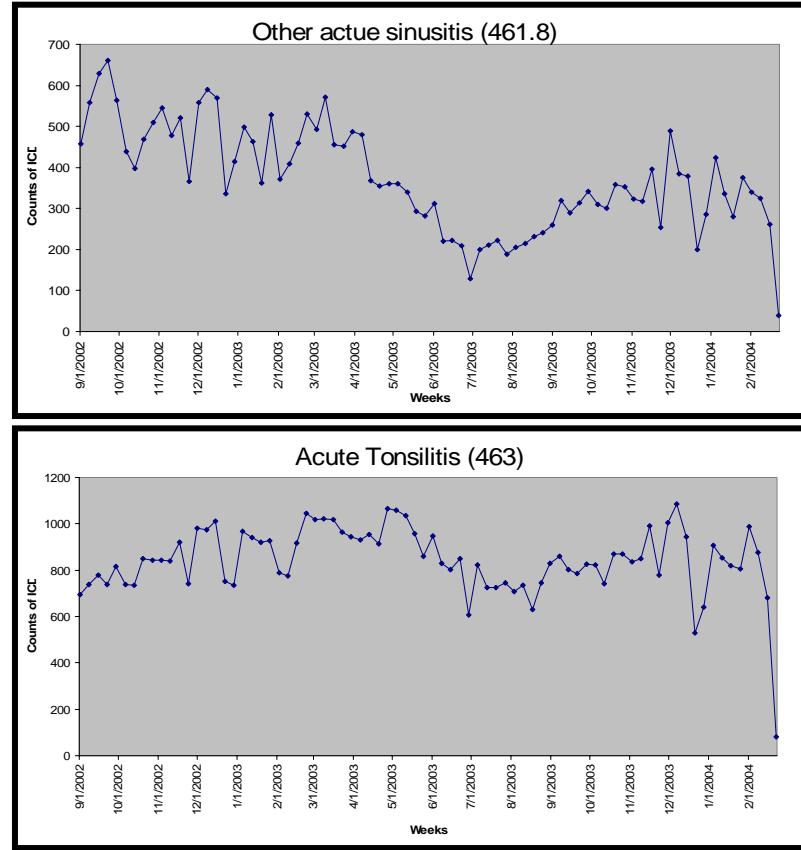
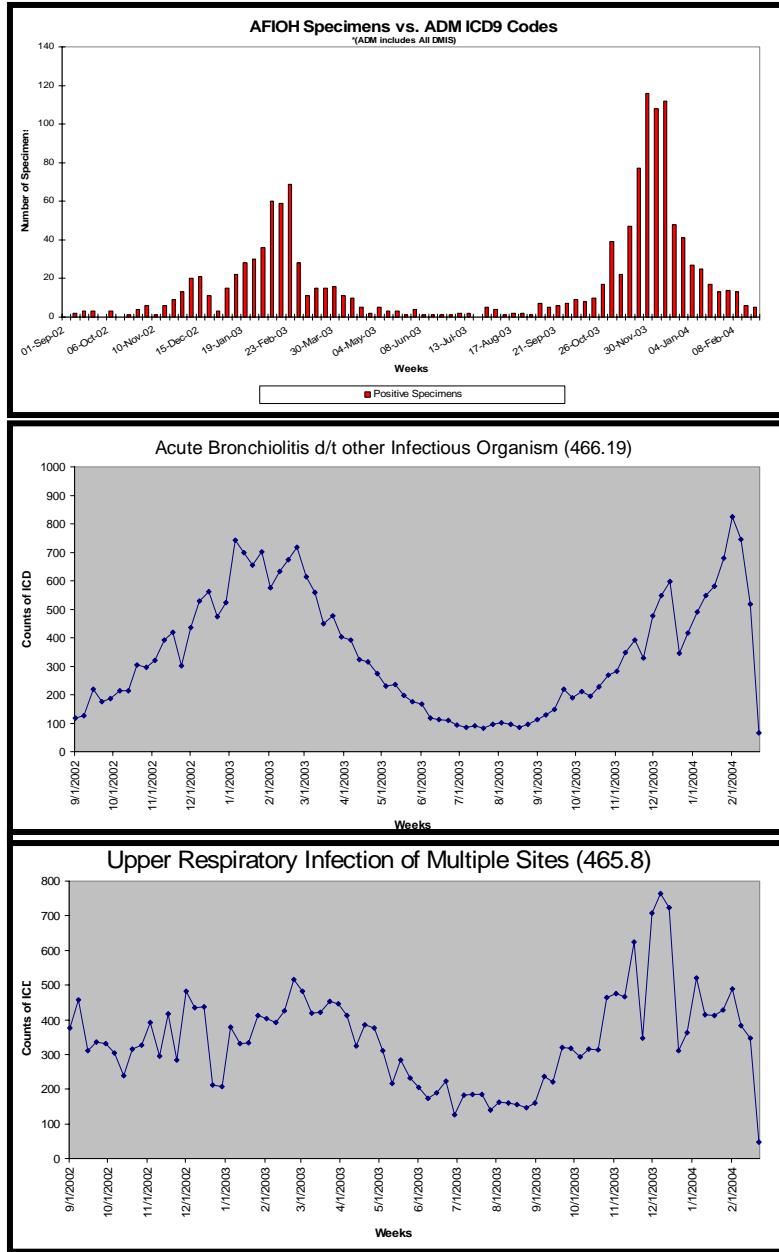
# Positive Respiratory Specimens Compared with Small Count Codes



- Temporal analysis shows that positive respiratory specimens and 487.8 have very similar trends. This trend is not quite as obvious for 464.00, and is not seen for 464.10.



# Positive Respiratory Specimens Compared with Select Medium Count Codes



- Temporal distribution of 466.19 and 465.8 correlate well with positive respiratory specimens, however 461.8 and 463 do not follow the same trend and may distort statistical signals.



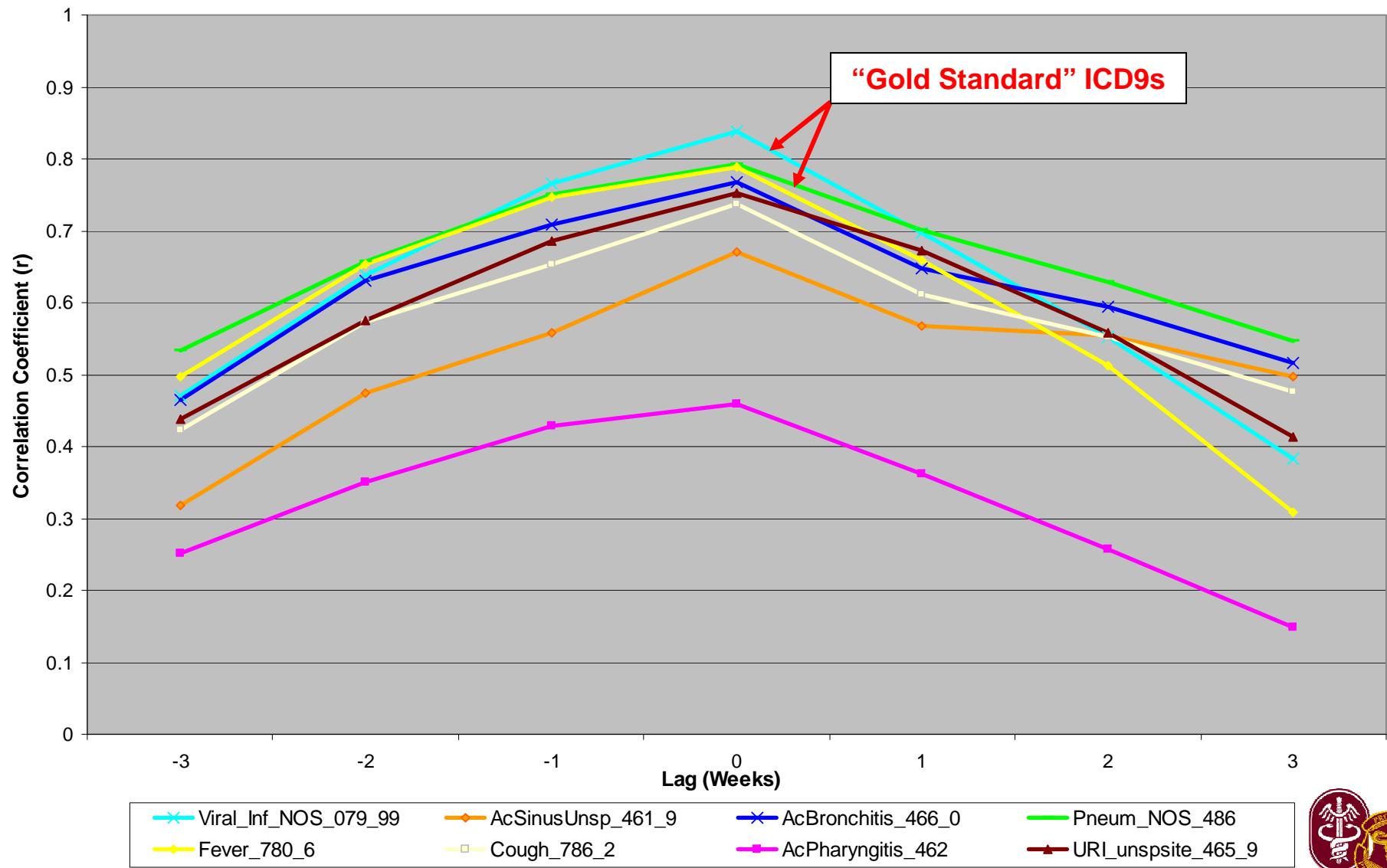
# Individual ICD-9 Code Trends

- Most large volume codes have trends similar to positive respiratory specimens
  - Pneumonia NOS and Viral Infection NOS
- Most medium and small codes did not correlate as well
  - Acute Tonsillitis, Other Acute Sinusitis, Acute Tracheitis

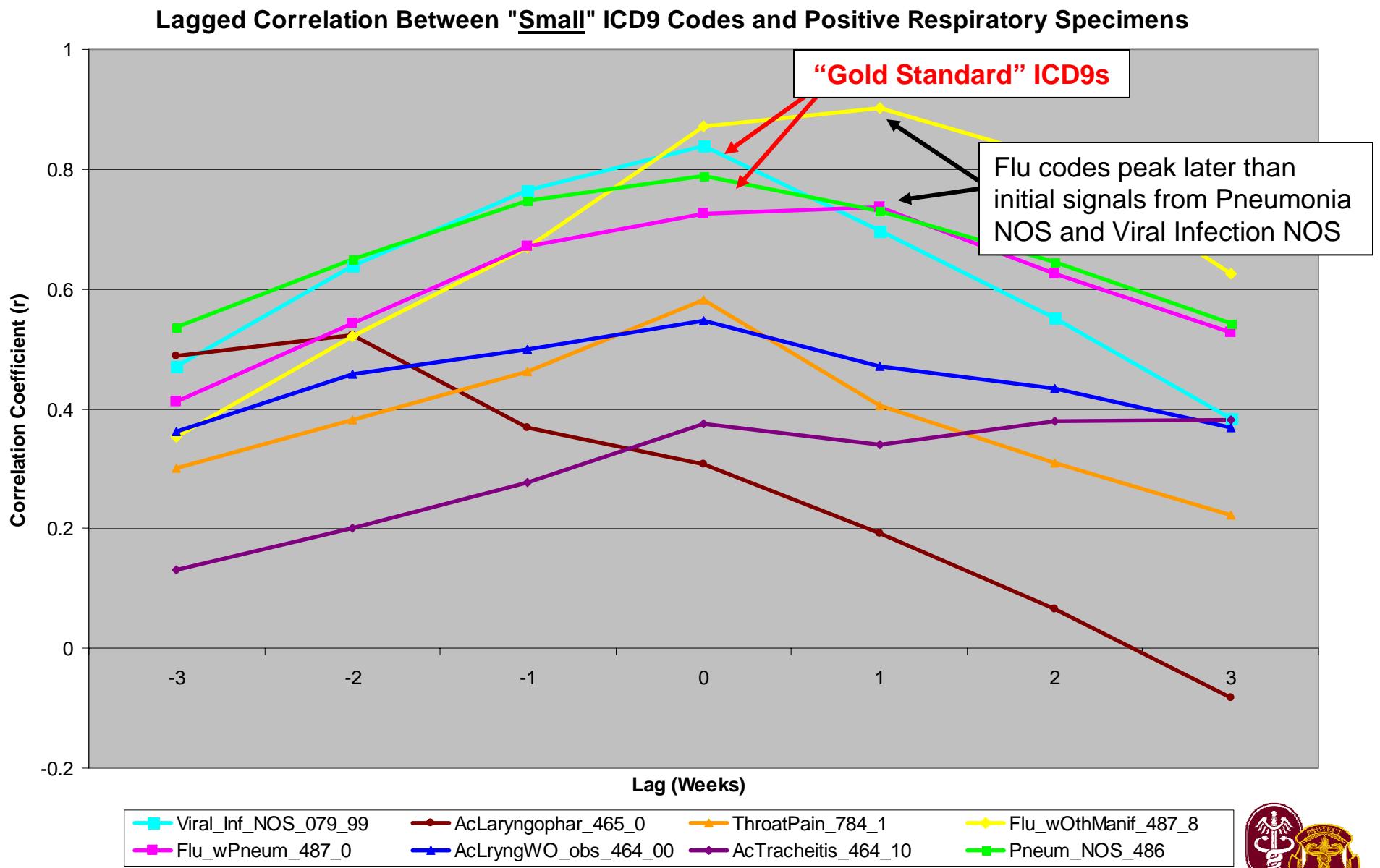


# Lagged Correlation

Lagged Correlation Between "Large" ICD9 Codes and Positive Respiratory Specimens

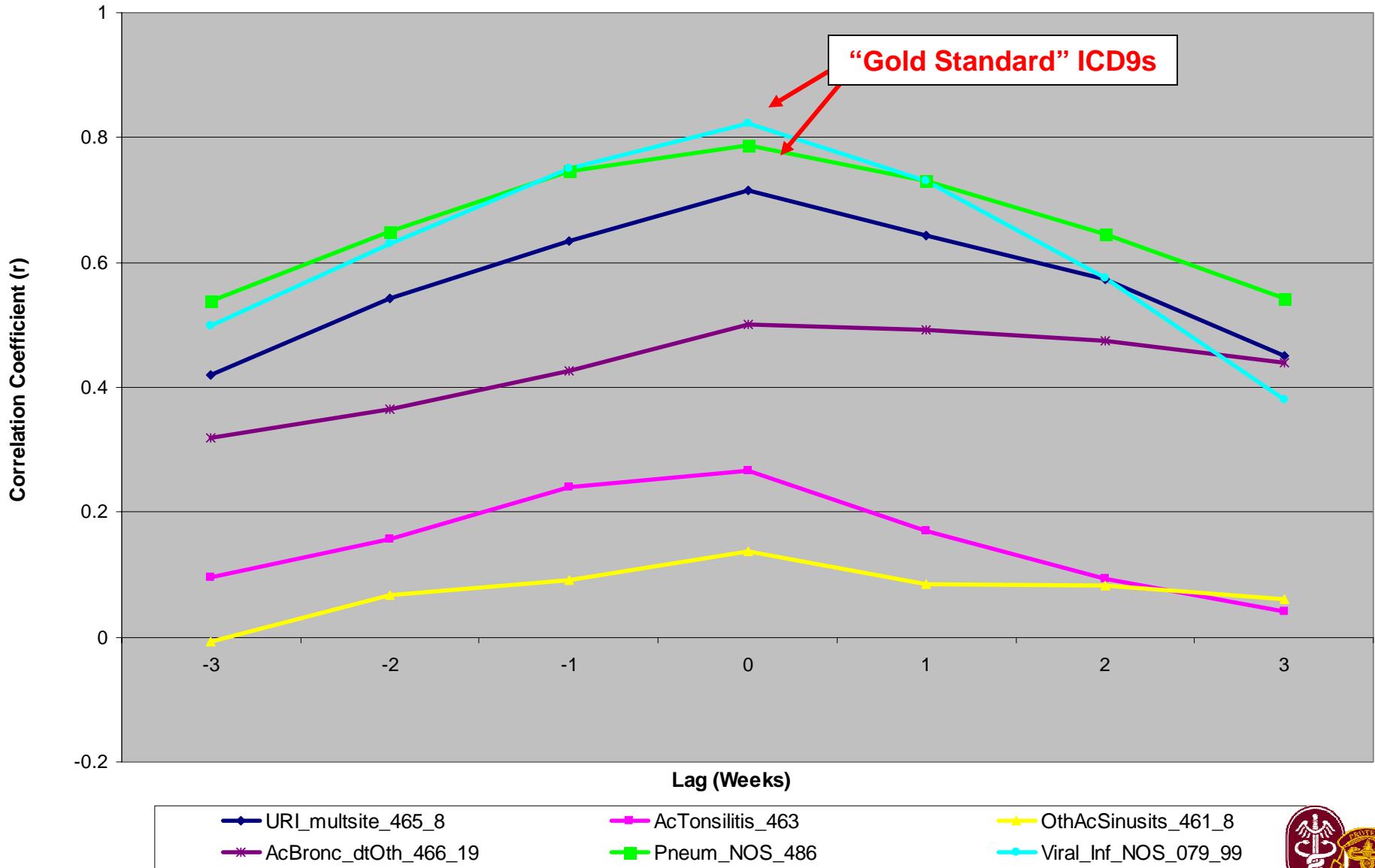


# Lagged Correlation



# Lagged Correlation

Lagged Correlation Between "Medium" ICD9 Codes and Positive Respiratory Specimens



# Lagged Correlation - Summary

- Large count codes are highly correlated and tend to peak during same times as the positive specimens
- Only a few small and medium count codes are correlated with positive respiratory specimens
  - Flu codes are slightly later than initial indication of respiratory illnesses but seem to be the best “Small” codes
  - URI (multiple sites) is best “Medium” code



# Factor Analysis - Weekly

## WEEKLY COUNTS

ICD9 Code	The FACTOR Procedure					
	Initial Factor Method: Principal Components					> 0.7
						> 0.6
Factor Pattern						< 0.6
ICD9 Code	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
AcBronc_dtOth_466_19	0.770	0.196	0.207	-0.480	-0.007	0.098
AcBronchitis_466_0	0.965	-0.049	-0.074	-0.017	0.051	-0.045
AcLaryngophar_465_0	0.781	0.180	-0.420	-0.236	0.134	0.004
AcLaryngotrac_464_20	0.396	-0.222	-0.050	0.350	0.433	-0.281
AcLryngWO_obs_464_00	0.905	0.079	0.212	0.047	0.095	-0.068
AcPharyngitis_462	0.825	0.187	0.357	0.175	-0.246	-0.090
AcSinusUnsp_461_9	0.947	0.169	0.154	-0.090	-0.037	-0.001
AcTonsilitis_463	0.609	0.106	0.535	0.297	-0.285	0.041
AcTracheitis_464_10	0.412	-0.247	0.466	-0.018	0.085	0.327
AcuteNasophar_460	0.961	0.147	-0.070	0.023	0.126	0.000
Bronch_dtRSV_466_11	0.631	0.369	0.128	-0.570	0.043	0.090
Bronch_NotAC_490	0.919	-0.295	0.008	-0.072	0.043	-0.061
BronchPneum_485	0.735	-0.165	-0.084	-0.242	0.286	0.095
Cough_786_2	0.970	-0.084	0.128	0.000	0.057	0.036
Fever_780_6	0.722	-0.469	0.053	0.216	-0.212	-0.148
Flu_wOthManif_487_8	0.718	-0.534	-0.289	-0.145	-0.044	0.021
Flu_wOthRsp_487_1	0.725	-0.579	-0.271	-0.106	-0.091	-0.018
Flu_wPneum_487_0	0.715	-0.311	-0.040	-0.087	-0.414	-0.010
OthAcSinusits_461_8	0.636	0.589	-0.090	0.275	-0.067	0.023
OthUnspDsRsp_478_9	0.703	0.281	-0.333	0.265	-0.007	-0.055
Pneum_Adeno_480_0	0.035	0.253	0.347	-0.201	0.311	-0.518
Pneum_inOthID_484_8	0.344	0.596	-0.335	0.239	-0.061	0.076
Pneum_NOS_486	0.933	-0.221	-0.073	-0.100	0.092	0.022
Pneum_OthVir_480_8	0.742	0.388	-0.102	0.080	0.162	-0.122
Pneum_parainf_480_2	0.325	0.181	-0.241	0.004	-0.331	0.438
Pneum_RSV_480_1	0.694	0.344	-0.021	-0.326	-0.039	0.086
ThroatPain_784_1	0.826	0.025	0.334	0.109	0.048	0.027
UnspChlamInf_079_98	0.129	-0.105	0.246	0.373	0.520	0.591
URI_multsite_465_8	0.912	-0.166	0.030	0.052	0.052	0.086
URI_unspsite_465_9	0.982	-0.073	-0.040	0.038	0.079	-0.049
Viral_Inf_NEU_079_89	0.636	0.213	-0.480	0.220	0.085	0.031
Viral_Inf_NOS_079_99	0.871	-0.296	-0.123	0.210	-0.085	-0.123
VirPneumUnsp_480_9	0.669	0.199	0.250	0.152	-0.242	-0.147



# Signal-to-Noise Method

- Define respiratory outbreak periods using positive specimen data
- Calculate difference in means between respiratory illness season and non-season (signal)
- Calculate standard error (SE) during non-season (noise)
- Calculation signal/noise ratio



# Signal-to-Noise Results

_NAME_	signal	noise	stn
Flu_wOthRsp_487_1	171.79	44.38	3.87
Flu_wOthManif_487_8	15.43	6.20	2.49
Viral_Inf_NOS_079_99	610.83	333.68	1.83
Fever_780_6	224.06	127.13	1.76
Bronch_NotAC_490	163.37	117.21	1.39
Pneum_NOS_486	138.56	110.63	1.25
URL_unspsite_465_9	1719.78	1477.79	1.16
Flu_wPneum_487_0	2.67	2.60	1.03
AcBronchitis_466_0	230.06	231.52	0.99
URL_multsite_465_8	33.77	34.71	0.97
AcLaryngophar_465_0	13.67	15.21	0.90
AcBronc_dtOth_466_19	34.14	40.28	0.85
AcuteNasophar_460	124.10	152.55	0.81
Cough_786_2	202.66	271.66	0.75
AcSinusUnsp_461_9	218.91	305.47	0.72
AcLryngWO_obs_464_00	8.82	12.89	0.68
AcPharyngitis_462	269.53	434.99	0.62
BronchPneum_485	2.11	3.79	0.56
ThroatPain_784_1	13.06	25.07	0.52
VirPneumUnsp_480_9	1.95	4.65	0.42
Bronch_dtRSV_466_11	5.17	12.73	0.41
AcLaryngotrac_464_20	0.91	2.27	0.40
OthUnspDsRsp_478_9	1.41	3.55	0.40
Pneum_OthVir_480_8	2.14	5.77	0.37
Viral_Inf_NE_079_89	1.71	5.63	0.30
AcTonsilitis_463	13.57	48.77	0.28
Pneum_Adeno_480_0	0.24	0.91	0.27
AcTracheitis_464_10	0.34	1.32	0.26
OthAcSinusits_461_8	6.17	37.69	0.16
Pneum_RSV_480_1	0.15	1.47	0.10
Pneum_parainf_480_2	0.00	0.53	0.01
Pneum_inOthID_484_8	-0.08	2.68	-0.03
UnspChlamInf_079_98	-0.96	8.15	-0.12



# Results and Conclusions

- These results confirm the accuracy of using a subset of military ambulatory ICD-9 codes for ILI surveillance and allow for refinement of the code group by identifying codes that do not track well with others in ILI
- Different analyses yield similar results
  - Regression difficult because the variables are highly correlated
  - Visual examination of trends may be most helpful
  - Some of the small count codes with no seasonal trend, low correlation and low signal/noise ratio may be removed



# Further Analysis

- Smaller codes may still be of interest, but their signals may be “drowned out” amongst the high volume codes
  - May be best to retain a secondary group of smaller codes to run separately from the larger codes
  - Will evaluate signal detection in large group versus small group
- Look at smaller geographic regions to determine if results hold true while coding practices may differ between localities



# Acknowledgements

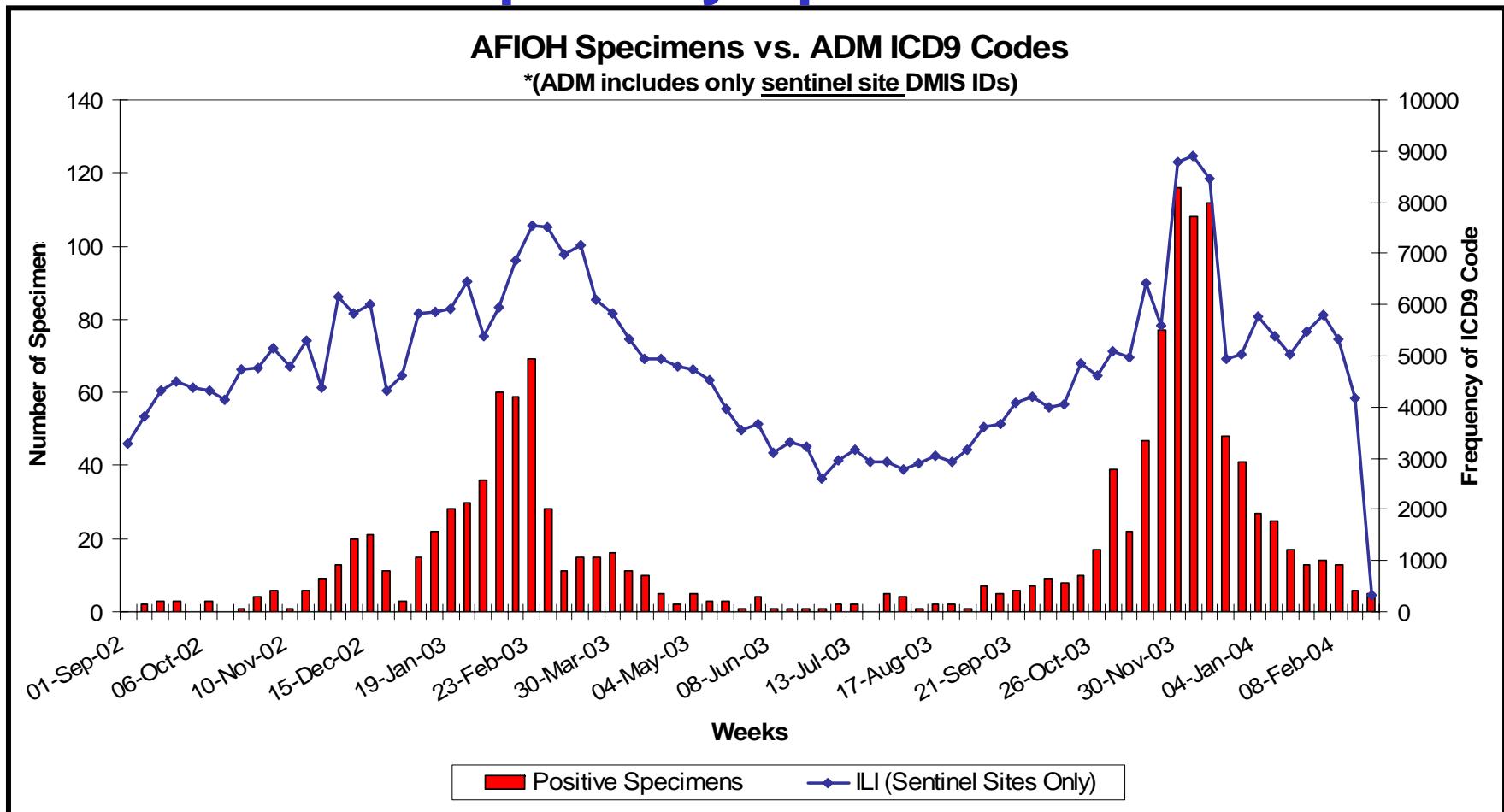
- Farzad Mostashari, MD, MS  
New York City Department of Health and Mental Hygiene
- Eugene (Yevgeniy) Elbert, MS  
Walter Reed Army Institute of Research



# Questions?



# Comparison of ILI (Sentinel) to Positive Respiratory Specimens



- ILI (Sentinel Sites) follows the same seasonal pattern as positive respiratory pathogen specimens
  - Correlation (Sentinel):  $r = 0.73$



# Factor Analysis - Daily

DAILY COUNTS								
	The FACTOR Procedure Initial Factor Method: Principal Components							
	Factor Pattern							
ICD9 Code	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8
URI_unspsite_465_9	0.975	0.088	0.020	0.099	0.034	0.124	0.016	0.090
Cough_786_2	0.967	-0.135	0.002	-0.068	-0.067	-0.023	0.096	0.128
Pneum_NOS_486	0.949	-0.130	-0.063	-0.086	-0.039	0.012	0.009	0.023
AcBronchitis_466_0	0.947	-0.012	-0.105	0.194	0.052	0.099	0.040	0.038
ThroatPain_784_1	0.930	0.111	-0.052	0.063	-0.064	-0.117	0.084	0.110
AcSinusUnsp_461_9	0.927	0.018	0.321	-0.075	0.048	-0.005	0.024	0.048
Viral_Inf_NOS_079_99	0.894	0.214	-0.230	0.029	0.190	0.025	-0.051	-0.116
Bronch_NotAC_490	0.884	-0.247	-0.280	0.046	-0.052	0.135	0.095	0.027
AcuteNasophar_460	0.882	0.077	0.282	0.028	0.175	0.111	-0.136	0.008
AcPharyngitis_462	0.859	0.265	0.005	-0.242	0.124	-0.105	0.130	0.063
VirPneumUnsp_480_9	0.845	0.078	-0.101	0.059	-0.239	0.062	-0.204	-0.243
URI_multsite_465_8	0.831	-0.273	0.043	0.336	-0.143	-0.038	0.017	0.029
Flu_wOthRsp_487_1	0.818	-0.254	-0.318	-0.110	-0.050	-0.092	0.042	-0.106
AcLryngWO_obs_464_00	0.781	-0.256	0.003	-0.132	0.309	0.133	-0.127	-0.275
AcBronc_dtOth_466_19	0.733	-0.108	0.311	-0.439	-0.203	-0.035	0.201	0.169
Fever_780_6	0.727	0.145	-0.573	-0.228	0.027	-0.088	0.043	0.068
AcLaryngophar_465_0	0.692	0.488	0.303	-0.020	0.072	0.019	-0.004	-0.144
Flu_wOthManif_487_8	0.688	-0.427	-0.016	0.108	0.409	-0.297	-0.054	0.047
Pneum_OthVir_480_8	0.678	-0.356	0.121	0.195	-0.183	0.057	-0.402	-0.309
AcTonsilitis_463	0.654	-0.020	-0.365	-0.115	-0.251	-0.411	0.117	0.216
AcLaryngotrac_464_20	0.631	0.106	-0.475	0.194	-0.301	0.182	-0.158	-0.105
Pneum_RSV_480_1	0.587	0.248	0.098	-0.494	-0.263	0.108	0.387	-0.109
Bronch_dtRSV_466_11	0.571	-0.331	0.649	-0.238	-0.117	0.034	-0.058	0.072
Viral_Inf_NEV_079_89	0.480	0.561	0.185	0.335	-0.402	0.067	-0.234	-0.063
OthAcSinusits_461_8	0.474	0.616	0.321	0.312	0.196	-0.174	-0.095	-0.103
BronchPneum_485	0.324	-0.651	0.185	0.172	0.046	-0.043	-0.266	0.540
OthUnspDsRsp_478_9	0.241	0.487	-0.250	0.431	0.384	0.188	-0.228	0.389
UnspChlamInf_079_98	0.223	-0.494	0.411	0.356	-0.089	0.079	0.296	-0.207
Pneum_parainf_480_2	0.223	-0.065	0.196	-0.419	0.788	0.027	-0.158	-0.128
Flu_wPneum_487_0	0.220	0.047	-0.227	0.373	0.464	-0.179	0.538	-0.193
Pneum_inOthID_484_8	0.205	0.719	0.476	0.119	-0.058	-0.246	0.138	0.190
Pneum_Adeno_480_0	0.117	0.036	0.000	0.066	0.104	0.891	0.333	0.196
AcTracheitis_464_10	-0.048	-0.308	0.166	0.785	-0.030	-0.127	0.339	-0.045



# Regression

The REG Procedure  
 Dependent Variable: Positive\_Specimens  
 Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	39704	5672.00854	41.46	<.0001
Error	69	9440.01813	136.81186		
Corrected Total	76	49144			

Root MSE	11.69666	R-Square	0.8079
Dependent Mean	17.80519	Adj R-Sq	0.7884
Coeff Var	65.69240		

## Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr >  t
Intercept	Intercept	1	-25.71797	8.10017	-3.17	0.0022
<b>Viral_Inf_NOS_079_99</b>	<b>Viral_Inf_NOS_079_99</b>	<b>1</b>	<b>0.01292</b>	<b>0.00094524</b>	<b>13.67</b>	<b>&lt;.0001</b>
AcTracheitis_464_10	AcTracheitis_464_10	1	0.50020	0.38189	1.31	0.1946
AcLaryngotrac_464_20	AcLaryngotrac_464_20	1	-0.13298	0.15064	-0.88	0.3805
<b>Pneum_inOthID_484_8</b>	<b>Pneum_inOthID_484_8</b>	<b>1</b>	<b>-0.65897</b>	<b>0.14115</b>	<b>-4.67</b>	<b>&lt;.0001</b>
Pneum_Adeno_480_0	Pneum_Adeno_480_0	1	-1.46835	0.78788	-1.86	0.0666
Pneum_parainf_480_2	Pneum_parainf_480_2	1	-0.02585	0.78993	-0.03	0.9740
UnspChlamInf_079_98	UnspChlamInf_079_98	1	-0.13875	0.07851	-1.77	0.0816



# Regression

Dependent Variable: Positive\_Specimens

## Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	39695	5670.76032	41.41	<.0001
Error	69	9448.75566	136.93849		
Corrected Total	76	49144			

Root MSE	11.70207	R-Square	0.8077
Dependent Mean	17.80519	Adj R-Sq	0.7882
Coeff Var	65.72280		

## Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr >  t
Intercept	Intercept	1	3.99873	7.83780	0.51	0.6116
<b>Flu_wOthManif_487_8</b>	<b>Flu_wOthManif_487_8</b>	<b>1</b>	<b>0.36628</b>	<b>0.02681</b>	<b>13.66</b>	<b>&lt;.0001</b>
<b>AcTracheitis_464_10</b>	<b>AcTracheitis_464_10</b>	<b>1</b>	<b>0.94347</b>	<b>0.37177</b>	<b>2.54</b>	<b>0.0134</b>
<b>AcLaryngotrac_464_20</b>	<b>AcLaryngotrac_464_20</b>	<b>1</b>	<b>0.34665</b>	<b>0.13879</b>	<b>2.50</b>	<b>0.0149</b>
Pneum_inOthID_484_8	Pneum_inOthID_484_8	1	-0.24720	0.13653	-1.81	0.0746
Pneum_Adeno_480_0	Pneum_Adeno_480_0	1	-0.16768	0.79601	-0.21	0.8338
Pneum_parainf_480_2	Pneum_parainf_480_2	1	0.59383	0.78253	0.76	0.4505
UnspChlamInf_079_98	UnspChlamInf_079_98	1	-0.14368	0.07852	-1.83	0.0716

