Implementation of an Instantaneous Pathogen Specific Surveillance System

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Background

Real-time monitoring of infectious disease across the United States benefits public health. Tracking infectious disease requires 1) comprehensive, diagnostic testing and 2) rapid automated collection, analysis and distribution of this data. The first requirement has been met. Several diagnostic platforms are available for testing large groups of infectious agents causing similar syndromes. BioFire's FilmArray® System is one such device. The FilmArray Respiratory Panel (RP) detects 20 organisms. However, the second requirement for infectious disease tracking has not been fully addressed; there is no general mechanism for exporting test results and integrating the information across time and space. Existing infectious disease surveillance systems are limited to a small number of pathogens, labor intensive and slow, complex to implement, geographically localized or based only on symptoms.

Methods

We have implemented an instantaneous pathogen specific surveillance system: FilmArray Trend. It automates the flow of test results from FilmArray Instruments to a secure, HIPAA-compliant, database in real time. Specific views of this information can be presented to different audiences: source laboratories can track local trends and the public will have an up-to-date view of viruses and bacteria currently circulating. This approach does not require data extraction from hospital information systems that vary between hospitals, and does not need labor intensive manual data extraction.

Bottom-Out vs Top-Out Data Export
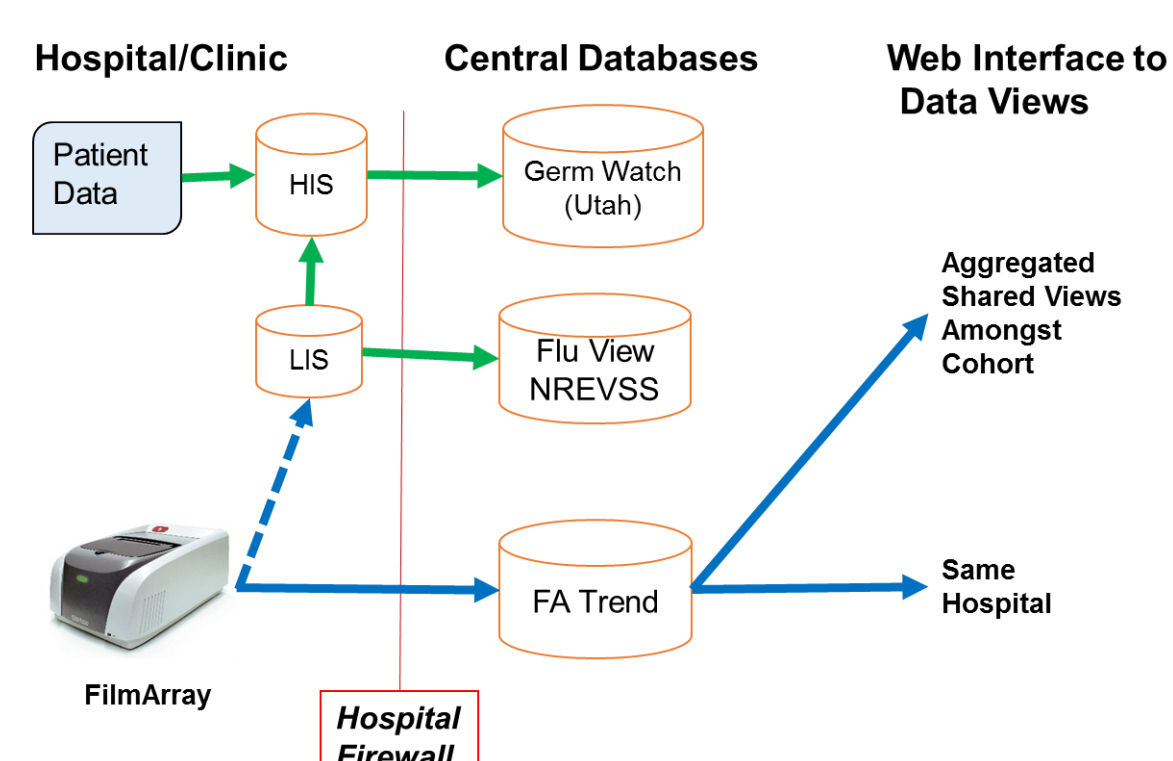
Lines: Green: existing data export pathways. **Blue dashed**: LIS connectivity of FilmArray systems. **Blue solid:** FilmArray export pathways developed through the FilmArray Trend project.

Results

FilmArray Trend software was installed on 71 FilmArray systems at 16 US sites. Nearly all IRBs ruled this study exempt. Greater than 145,000 tests were uploaded to the database. Data presented include plots of: 1) Pathogen percent detection by institution and in aggregate, displaying annual fluctuations of influenza and seasonality of organisms; 2) Polymicrobial detection to look for over- or under-represented co-detections; 3) FilmArray testing rate fluctuations, compared with the CDC Influenza-Like Illness (ILI) trends; 4) Comparison of the onset and duration of specific pathogens making up the respiratory season at different sites.

Pathogen Percent Detection

We display the overall pathogen percent detection per FilmArray test in aggregate for all 16 US pediatric and mixed population sites since 2013 with human rhinovirus being the most prominent.
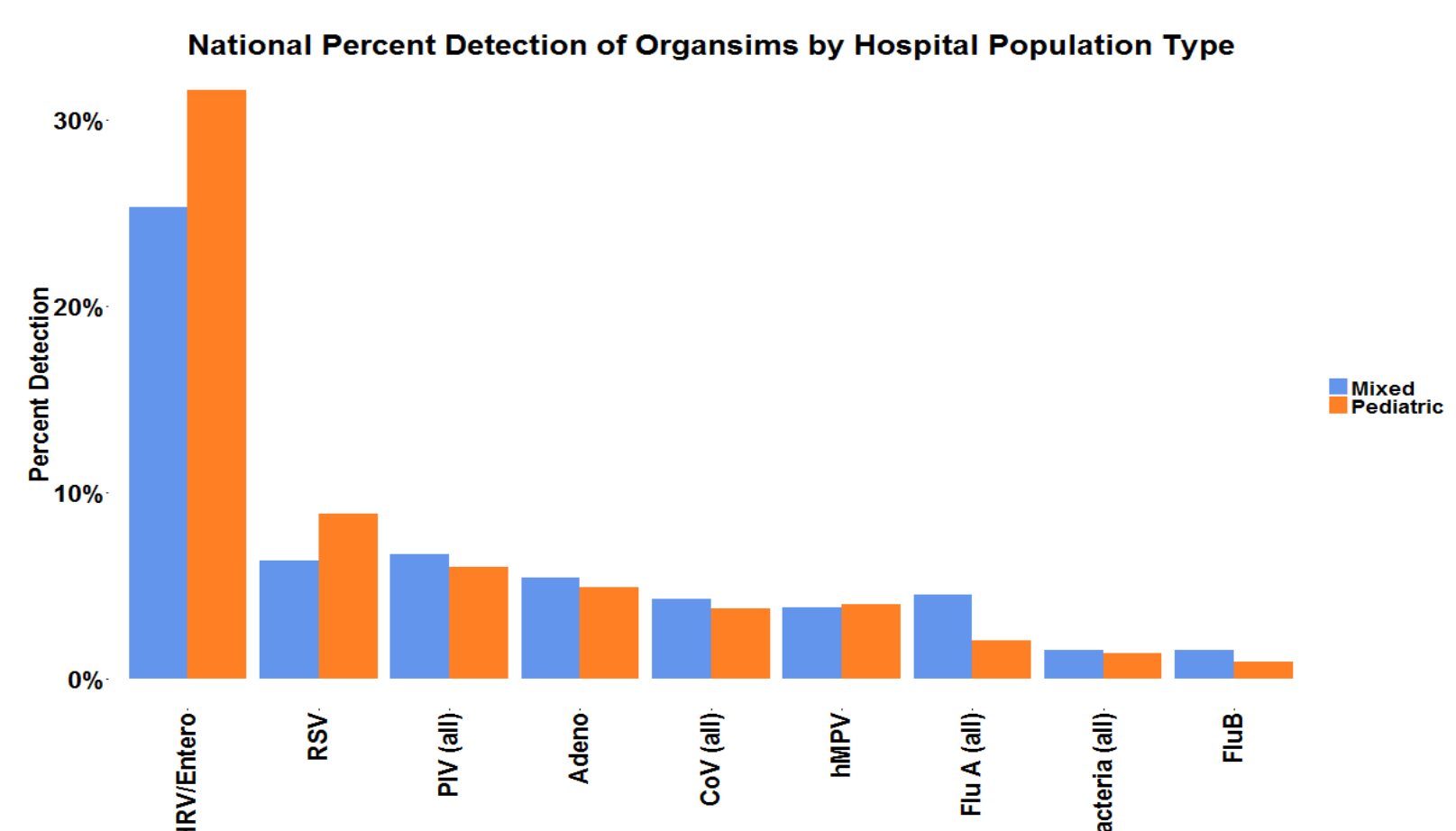
Pathogen Percent Detection Trending

The reports of organism percent detection per RP test shown here date back to 2014. Three week moving averages of pathogen positivity rates are shown in stacked area graphs. Detection rates are overlaid with CDC ILI rates, displaying respiratory season fluctuations of common viral and bacterial pathogens.
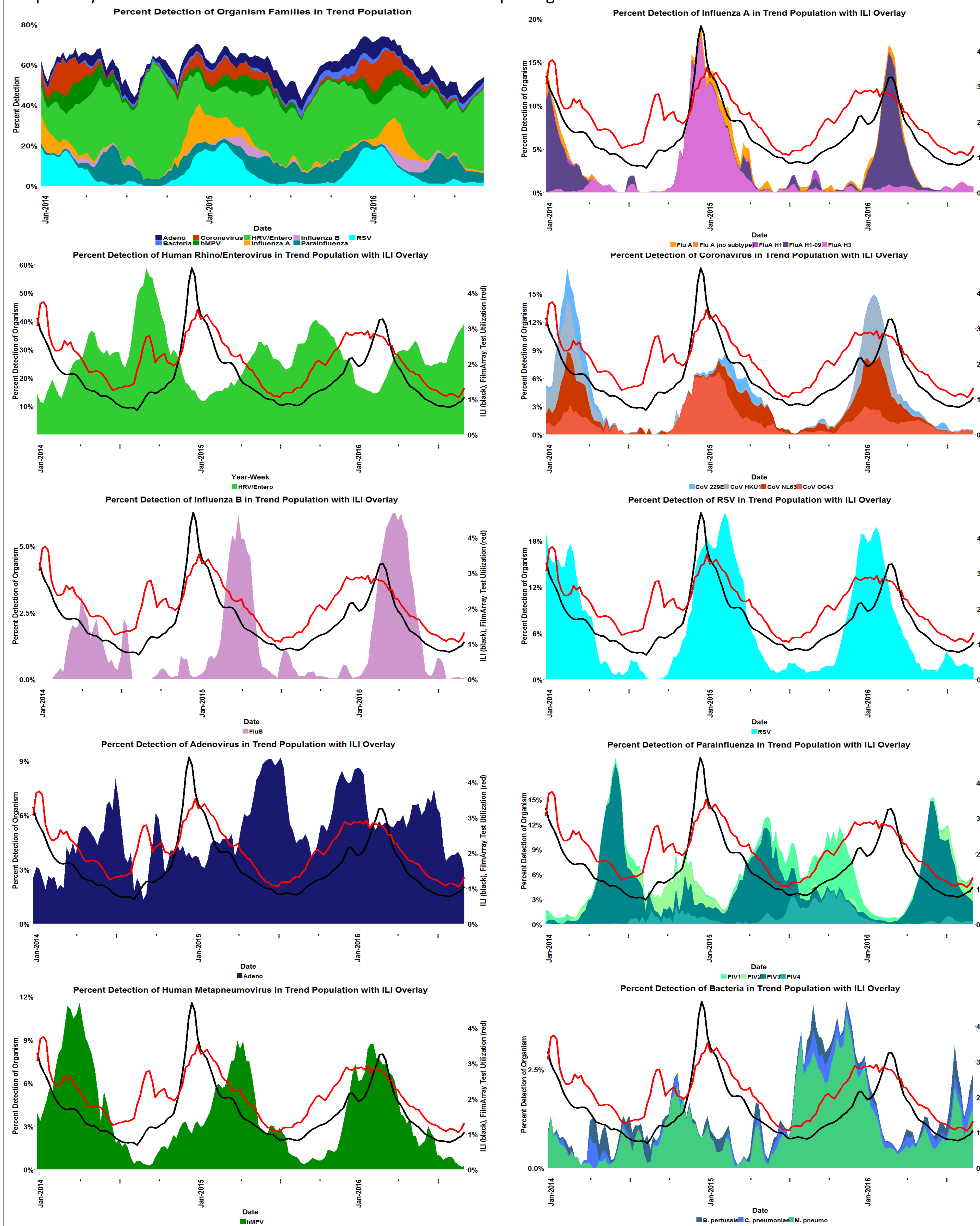
Normalized FilmArray Test Utilization Rate

The normalized FilmArray test utilization rate per week is shown here. This metric may be used as an indicator of generalized respiratory disease fluctuations. The FilmArray test rate is shown along with the ILI rate reported by the CDC. Fluctuations in the test rate are similar to ILI trends, and may identify general respiratory disease not detected by ILI as seen in the increased test rate associated with human rhinovirus/enterovirus, Fall 2014.
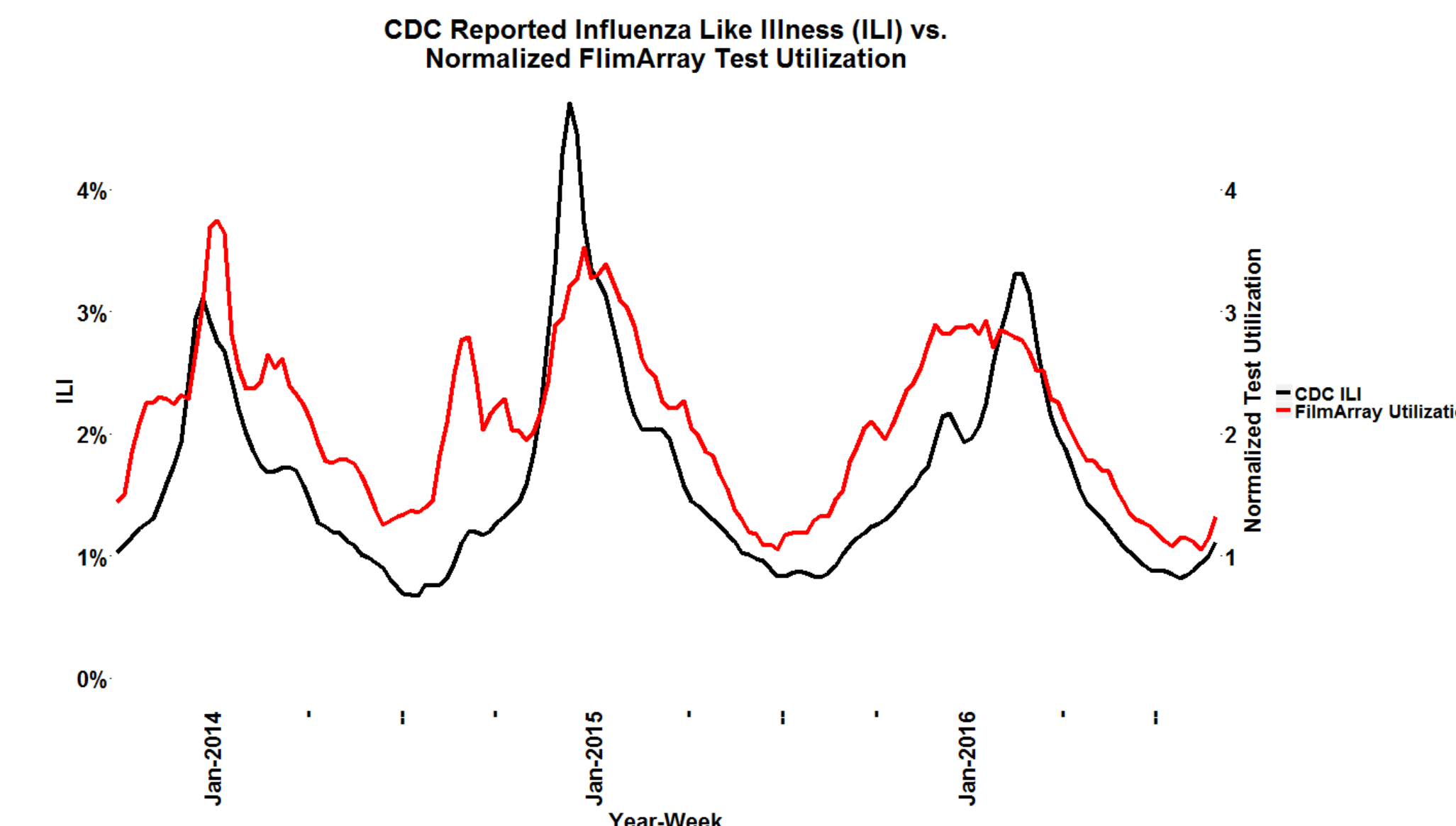
Polymicrobial Detections

We display dual-positive detection rates, where two targets are detected within a single RP test for polymicrobial reports. Dual detections occurred in approximately 9% of all RP tests within this population. The report below displays the organism percent positivity along with the percent dual positivity. These rates of dual positivity show some correlation with the overall rates of detection.
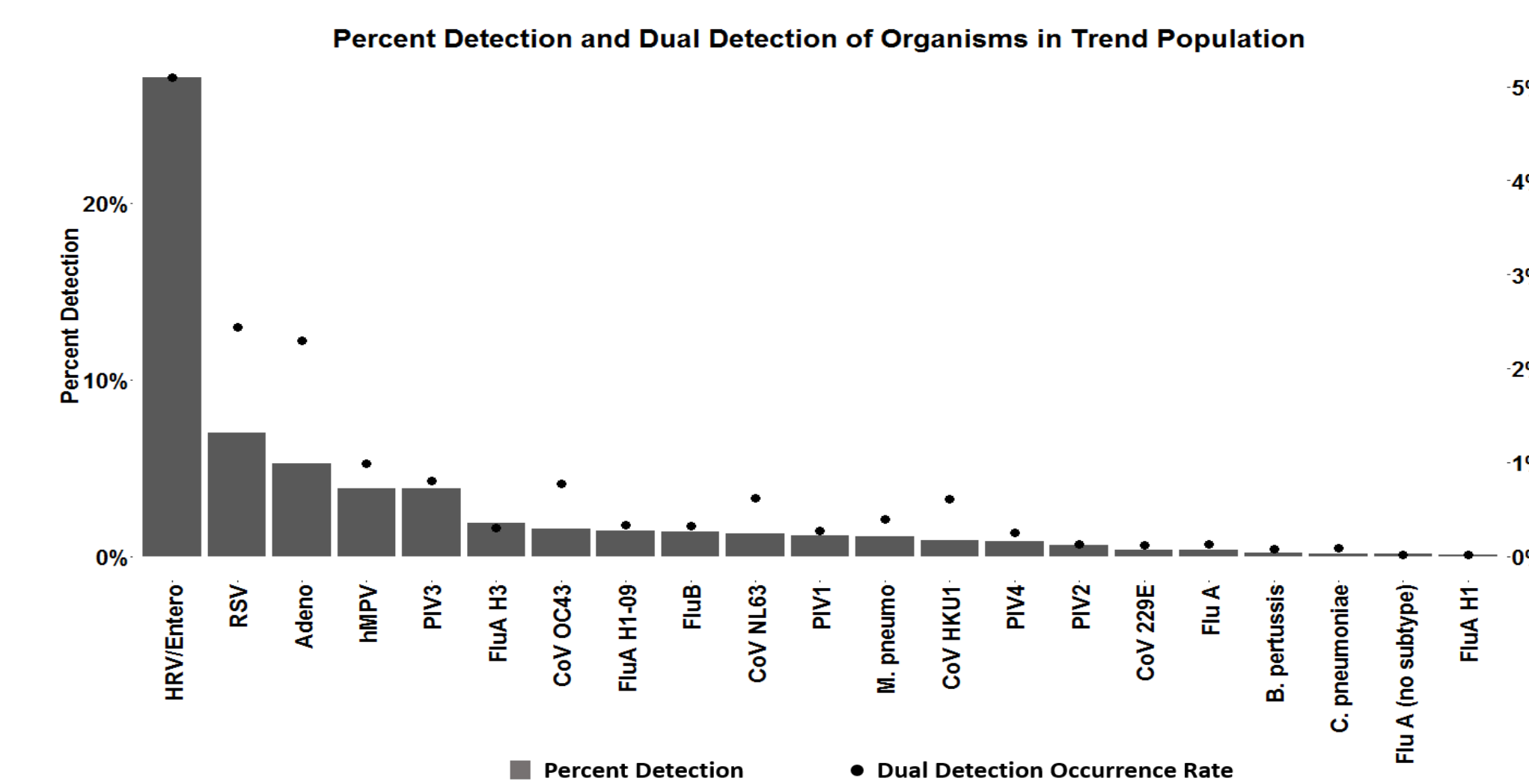
Regional Differences

Regional time series charts display differences in geographic seasonality of percent organism detection per FilmArray test. Here we show influenza A three week moving average percent detection trends for the Midwest and Northeast regions differing in 2015 and converging in 2016.
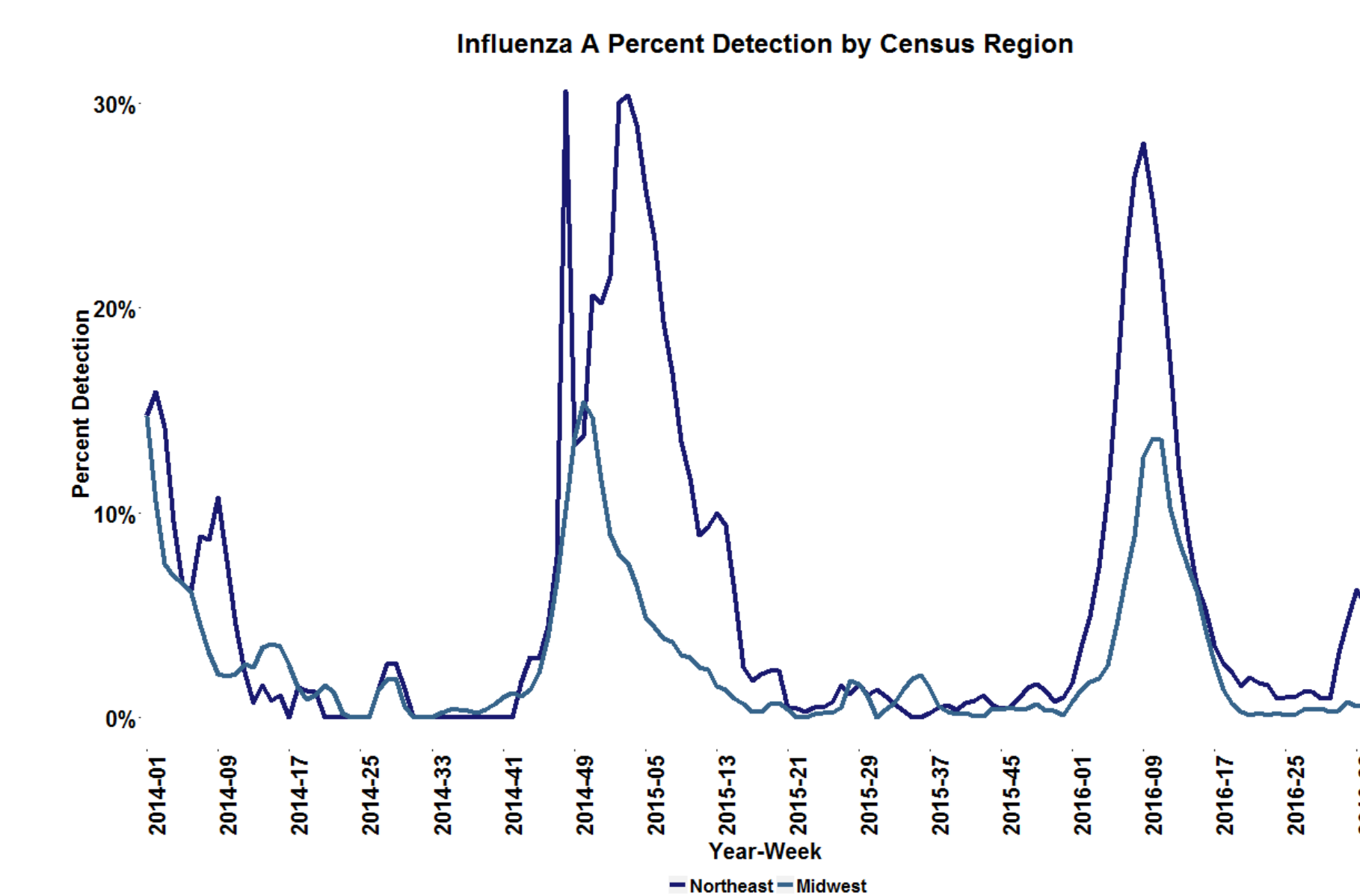
Conclusions

FilmArray Trend is easily scalable (number of sites and different panels) and the lessons learned will make it easier to bring the next 100 to 500 laboratories on board. As the participants and scope of FilmArray Trend expands it will be possible to demonstrate, in real time and in high resolution, the spread of various infectious diseases across the US.

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