Impact of laboratory-reporting on influenza surveillance, Arizona, 2004-2010

(Poster is shared here as an 8.5”x11” document for easier viewing. All content is identical.)

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Background:

Influenza surveillance is an important way for public health authorities to assess the severity of an influenza season and make local policy recommendations. The challenge is determining the most useful and feasible methods for tracking activity.

In 2004, Arizona implemented a rule that made positive influenza tests reportable to the Arizona Department of Health Services (ADHS) by laboratories performing the tests, effective October 2004 (Arizona Administrative Code R9-6-204). Since then, ADHS has used three consistent, statewide sources of influenza surveillance data:

- **ILI activity at sentinel outpatient providers**: Sentinel outpatient providers participating in CDC’s ILINet surveillance system report weekly on the number of patients with ILI and the total number of patient visits that week, from which the proportion of ILI visits is calculated.
- **Arizona State Public Health Laboratory (ASPHL) influenza testing**: ASPHL conducts viral isolation and, in recent years, real-time polymerase chain reaction (RT-PCR) on respiratory specimens from clinical or hospital laboratories, and, to a limited extent, from sentinel providers. This testing confirms the presence of influenza in the community and identifies the circulating types and subtypes.
- **Laboratory-reported cases**: Laboratories performing influenza tests should submit reports of positive results within five days, including personal identifiers, birth date or age, submitter, date of report, type of testing (e.g., culture, molecular testing, rapid diagnostic test), and results. The first case of each season must be confirmed at ASPHL before rapid diagnostic tests are accepted as confirmed cases.

The objectives of this poster are to:

- Compare the data collected from Arizona surveillance sources after six seasons of laboratory reporting;
- Assess how laboratory reporting can affect interpretation of surveillance data; and
- Describe the value and limitations of influenza laboratory reporting.
**Methods:**

**Data Sources:**

Data from three surveillance sources from six seasons (2004-2010) were compiled:

- **ILINet:** Data were extracted from the CDC website for state influenza coordinators. The baseline percentage of ILI for the state and each region was calculated as the mean of the state ILI percentage in weeks in the 2007-2010 seasons when <10% of specimens were positive at ASPHL.

- **ASPHL influenza testing:** Data were extracted from the ASPHL information management system. Specimens that had multiple tests performed (e.g., influenza culture and PCR) were merged so that only one test result was used per specimen, and considered positive if either result was positive. Reports were analyzed by earliest test completion date.

- **Laboratory-reported cases:** Reported cases are entered into a database and cleaned for classification status and duplicates throughout the season and at the end of the year. Reports were analyzed by the week first reported to public health.

**Data Analysis:**

- Data from all systems were assigned to an influenza season (MMWR week 40 through week 39), to the MMWR week of report, and to one of four regions, based on the county of residence (lab reporting), county of specimen submitter (ASPHL), or county of sentinel provider. The dates used are intended to reflect the time when public health officials would receive the data.

- All three data sources were plotted together to examine differences in the timing of changing trends, statewide and by region, and the numbers of weeks with non-zero data were compared between sources.

- The geographical distributions of each source were compared.

- Change-point analysis (1,2) was applied to all three sources to detect significant changes in the number of reports over time, using SAS code developed by Soyoun Park (CDC) and colleagues (3). Parameters used were: confidence level=95%, bootstraps = 1000, sampling without replacement.
Results:

The number of records included from each of the three data sources is shown in Table 1.

Table 1. Number of records, by data source and influenza season

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Lab Reporting: Number of confirmed cases</td>
<td>1,662</td>
<td>5,289</td>
<td>1,745</td>
<td>5,175</td>
<td>9,159</td>
<td>13,030</td>
</tr>
<tr>
<td>ASPHL: Number of positive flu results</td>
<td>364</td>
<td>493</td>
<td>390</td>
<td>794</td>
<td>3,333</td>
<td>2,610</td>
</tr>
<tr>
<td>ILINet: Number of regular reporters* (number of enrolled reporters)</td>
<td>41 (54)</td>
<td>41 (63)</td>
<td>36 (66)</td>
<td>35 (66)</td>
<td>43 (59)</td>
<td>42 (65)</td>
</tr>
</tbody>
</table>

*Regular reporters are enrolled sites that reported at least 65% of the weeks from weeks 40-20.

Data concordance:

The trends during each season are roughly concordant for all three data sources (Chart 1).

Rapid diagnostic tests were received in a total of 22 weeks before the official start of each Arizona season was declared based on confirmation at ASPHL. The lab-reporting data for these weeks are not included in Chart 1.

Lab reports were received in 206 weeks statewide after the ASPHL-confirmed start of each season. In 27 (13%) of these weeks, no ASPHL results were received; in 76 (37%) the statewide ILI percentage was not elevated above baseline (Table 2). These proportions varied between regions. The statewide results were more extreme when using higher thresholds for each value (epidemic threshold instead of baseline for ILI, and for each season using the number of lab reports and ASPHL results recorded for the first week of local activity for each season, rather than one): of 132 weeks above this lab-reporting threshold, 32 (24%) and 80 (61%) did not meet the ASPHL and ILI thresholds, respectively.

Table 2. Variation in reports received each week from different sources, by region

<table>
<thead>
<tr>
<th>Region</th>
<th>Number of weeks with lab reports received (after statewide season start)</th>
<th>Number (%) of weeks with lab reports but no ASPHL positives</th>
<th>Number (%) of weeks with lab reports but ILI not elevated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona</td>
<td>206</td>
<td>27 (13%)</td>
<td>76 (37%)</td>
</tr>
<tr>
<td>Central</td>
<td>206</td>
<td>34 (17%)</td>
<td>22 (11%)</td>
</tr>
<tr>
<td>Northern</td>
<td>151</td>
<td>81 (54%)</td>
<td>15 (10%)</td>
</tr>
<tr>
<td>Southern</td>
<td>166</td>
<td>72 (43%)</td>
<td>83 (50%)</td>
</tr>
<tr>
<td>Western</td>
<td>120</td>
<td>46 (38%)</td>
<td>39 (33%)</td>
</tr>
<tr>
<td>Arizona (with high thresholds – see text)</td>
<td>132</td>
<td>32 (24%)</td>
<td>80 (61%)</td>
</tr>
</tbody>
</table>
**Geographic differences in coverage:**

The proportion of test results received from the four regions differs significantly between lab reporting and ASPHL testing (p-value for chi-square <0.0001), for all years combined (Table 3) and for each year alone.

**Table 3. Proportion of reports received from laboratory reporting and state public health laboratory testing**

<table>
<thead>
<tr>
<th>Region</th>
<th>Lab Reporting N (%)</th>
<th>ASPHL Positive Tests N (%)</th>
<th>Percentage of the Arizona Population (2007)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central</td>
<td>22,665 (63%)</td>
<td>6,281 (79%)</td>
<td>66%</td>
</tr>
<tr>
<td>Northern</td>
<td>3,619 (10%)</td>
<td>443 (6%)</td>
<td>8%</td>
</tr>
<tr>
<td>Southern</td>
<td>8,307 (23%)</td>
<td>679 (9%)</td>
<td>19%</td>
</tr>
<tr>
<td>Western</td>
<td>1,469 (4%)</td>
<td>575 (7%)</td>
<td>7%</td>
</tr>
</tbody>
</table>

From ILINet, at least 10 of 15 counties had at least one regular reporter for each season; during two seasons 11 counties had a regular reporter. All regions had regular reporters in each season.

**Change point analysis:**

The results of the change point analysis are shown in Chart 2. The dots at the top of the graph represent the change points identified for each of the three sources, though the magnitude or length of the changes cannot be interpreted from this graph.
Discussion:

- Laboratory reporting data show strong concordance with other data sources in season initiation and trends.
- Laboratory reports during the summer months and at the beginning and end of each season likely include some false-positive rapid diagnostic test results. However, these reports help identify early cases for which specimens can be sent to ASPHL for confirmation. During the pandemic, influenza laboratory reporting also helped with detection and reporting of 2009 H1N1 cases.
- During many weeks in which lab reports were received, there were no ASPHL results and ILI was within baseline. This was exacerbated when using a higher threshold for each measure. While this could indicate lack of specificity of lab reporting for identifying key indicators, we believe it instead reflects greater sensitivity of this indicator and provides a continued source of situational awareness throughout the season.
- The geographical coverage of lab reporting seems to better approximate the statewide population distribution than the ASPHL testing, which was focused more on the Central region. This may in part reflect the location of large submitting laboratories in the Central region, but is a true limitation of data from ASPHL testing.
- As both charts indicate, ILI seems to be an earlier indicator in this retrospective analysis, but during the season the increases are often subtle and heavily affected by late reporting from many providers.

Limitations:

- Low numbers of laboratory-reported cases may not be meaningful, especially given the possibility of false-positive rapid tests.
- True ILI baselines likely varied between seasons, but the same baselines were applied to all seasons.
- The dates used for laboratory reporting (date reported) and ASPHL data (date completed) may not best represent the disease trends, but reflect when information was available for decision-making.
- Further study is needed on regional variations, identifying useful thresholds, and applying change point analysis to key events such as season start and activity level changes.
Conclusions:

Laboratory reporting has greatly influenced Arizona’s influenza surveillance activities, assisting with earlier detection of suspect cases, continued situational awareness throughout the season, and wider geographic coverage than from state laboratory and ILI activities alone. Lab reporting has complemented our other surveillance indicators well, giving us greater confidence in interpreting flu data for public health purposes. Limitations to laboratory reporting include not knowing the completeness or consistency of these reports, and the intensive data entry resources required until electronic laboratory reporting is implemented for all major labs. However, lab reporting of influenza has been an important component of Arizona’s influenza surveillance and will continue to be used in this state.

References:

Chart 1. Epidemiologic curve, by week, for each of the three surveillance methods, 2004-2010
Chart 2. Change point analysis: Lab reporting, ASPHL testing, and ILINet

Confidence Level=95%, Bootstraps = 1000, Sampling Without Replacement