Influenza and Other Respiratory Viruses Annual Report
2009-2010
Iowa Influenza Surveillance Network

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Influenza and Other Respiratory Viruses Annual Report, 2009-2010
Executive Summary

The 2009-2010 influenza season was the most active and challenging in the history of the Iowa Influenza Surveillance Network. The year brought the first pandemic in more than 30 years. The pandemic had a significant impact and two waves of illness occurred in 2009. The largest wave peaked in late October with very little seasonal influenza activity following.

IDPH added surveillance partners and the State Hygienic Laboratory (SHL) increased testing efforts while balancing the need for surveillance with capacity constraints. In 2009-2010, SHL tested more than 2,300 specimens for 2009 H1N1 by PCR and 2,800 by culture, detected a triple reassortant strain, and confirmed the presence of a handful of seasonal influenza B cases.

It is estimated that nearly 400,000 or >10% Iowans became ill with 2009 H1N1 from April 2009 through May 2010.

During the height of activity in October, an unprecedented 32% of Iowa schools reported absence due to illness that met or exceeded 10% of enrollment.

In September 2009, a temporary reporting order issued by the Iowa Department of Public Health mandated the reporting of 2009 H1N1 influenza-related hospitalizations and deaths. There were 659 hospitalizations reported from September 2009 to April 2010. The majority of hospitalizations occurred in two age groups- persons ages 5-18 and 25-49. However, the length of stay in the hospital was typically shorter for children at 2.9 days verses 3.6 days for adults.

There were 41 reported and confirmed deaths due to 2009 H1N1, though estimates project 107 actual deaths. The majority of deaths occurred in adults between the ages of 25-64 years.

IDPH participated in an influenza incidence pilot project in collaboration with the Centers for Disease Control and Prevention and seven other states. Six medical clinics throughout Iowa collected clinical information and laboratory specimens on patients with influenza-like illness. More than 500 patients were tested for influenza and other respiratory viruses, which was a little less than one quarter of all specimens tested from all eight states in the project.

SHL and Mercy Dunes Lab detected other non-influenza respiratory viruses including RSV, adenovirus, parainfluenza 1-3, rhinovirus, cytomegalovirus, and enteroviruses.

IDPH will continue enhanced surveillance activities in 2010-2011. A new temporary reporting order will go into effect September 1, 2010 requiring reporting of influenza-related hospitalizations and deaths. IDPH and SHL are again part of the incidence project and have greatly expanded testing for influenza and other viral pathogens. School-based surveillance will continue as well. The Iowa Influenza Surveillance Network weekly report will be published weekly with a summary of the activity for the previous week. The surveillance systems used in 2009 and 2010 provided high-quality, useful information throughout the pandemic and will continue to be used to characterize the impact of influenza on the population of Iowa.

Introduction

Influenza surveillance has been a joint effort of the Iowa Department of Public Health (IDPH) and State Hygienic Laboratory at the University of Iowa (SHL) for more than 10 years. Early surveillance was comprised of reports from outpatient health care providers, schools, and tests performed at SHL. In 2005, the Iowa Influenza Surveillance Network (IISN) was formally established with the expectation of tracking, detecting, and reporting influenza activity through interconnected programs. The network detects unusual or novel strains of influenza and has the ability to flex in an influenza pandemic to monitor crucial disease activity. The core programs of the IISN are outpatient health care (ILINet), hospital, school, laboratory, and mortality. Over the last six years the network has experienced exceptional growth.

Since 2001, IDPH has maintained at least 11 outpatient providers as part of ILINet; in accordance of the Centers for Disease Control and Prevention (CDC) recommendation for one site for every 200,000 state residents. Surveillance of student populations has occurred for about ten years and with an average of 35 schools reporting weekly throughout every flu season. By 2007, all programs reported data into real-time, web-based systems. In 2008, IDPH was also selected to participate in the Advancing Strategies for Influenza Surveillance in Hospitals project aimed at standardizing influenza monitoring and reporting in hospital settings. The following year, IDPH was selected to participate in the Influenza Incidence Pilot (IIP) project. This eight-state collaborative, assessed the incidence of influenza in outpatient settings.

Another achievement was participation in the Emerging Infections Program (EIP). Prior to the formal start of the 2009-2010 influenza season on September 1, 2009, IDPH committed to joining the EIP network and to reporting patient-level data on all 2009 H1N1 hospitalizations. IDPH issued a mandatory reporting order for influenza-related hospitalizations and deaths on that date, and utilized the Iowa Disease Surveillance System to collect the information.

The State Hygienic Laboratory, is Iowa's public health laboratory, and is an essential partner in carrying out the goals of the IISN. SHL provides confirmatory testing, using real-time RT-PCR, for the more than 160 clinical and reference laboratories in the state. Since 2008, SHL has coordinated weekly, web-based reporting of rapid influenza test results that are performed in a variety of health care settings throughout Iowa. Results of these survey's are then sent back to the participants in order to assist them in determining the accuracy of their point of care tests. The combination of these two efforts has resulted in a highly sensitive detection system for influenza.

The SHL has a strong relationship with all hospital laboratories through years of site visits and annual meetings. SHL facilitates the Iowa Laboratory Response Network- a communication pathway routinely used by SHL and the state's clinical and reference laboratories.

The 2009-2010 influenza season was the most active and challenging in the history of influenza surveillance in Iowa. The year brought the first pandemic in more than 30 years. The pandemic had a significant impact and two waves of illness occurred in 2009. Seasonal strains of influenza

were reported in very low numbers and the typical late-winter or early spring peak was non-existent.

IDPH added surveillance partners and sites and SHL increased testing efforts while balancing the need for surveillance with capacity constraints. In 2009-2010, SHL tested more than 2,300 specimens for 2009 H1N1 by PCR and 2,800 by culture, detected a triple reassortant strain, and confirmed the presence of a handful of seasonal influenza B cases.

It is estimated that more than 330,000 or 10% of the population became ill with 2009 H1N1 from April 2009 through May 2010. There were 41 reported and confirmed deaths, though extrapolations project 87 deaths.

Table 1. Average number of surveillance sites reporting to IDPH during the first and second pandemic waves

Program	# of sites- 1st Wave	# of sites- 2nd Wave	Percent coverage in 2nd Wave
ILINet	16	20	Not available
Hospital	20	30	47% of all acute care inpatient beds
School	35	150	10% of all Iowa K-12 students
Laboratory	45	65	41% of all clinical and reference laboratories
Mortality	Polk County	Statewide reporting	100%

Methods

Outpatient health care provider program (ILINet, IIP project)

Twenty Iowa health care providers enrolled in ILINet for the 2009-2010 influenza season. Providers that may encounter patients with influenza infection were included in the program and were family practice, internal medicine, emergency medicine, pediatrics, and student health . Of the 20 enrolled sites, 16 reported routinely. Clinics tracked the total patients seen by age group and patients with ILI. The age groups were 0-4, 5-24, 25-49, 50-64, and >64. All reports were submitted on the ILINet website maintained by CDC[1]. The percentage of total patients with ILI was calculated each week.

IDPH also participated in the Influenza Incidence Pilot Project (IIPP). This project was supported by the Centers for Disease Control and Prevention and the Council of State and Territorial Epidemiologists. There were seven states that participated with the goal of determining the proportion of patients reporting influenza-like illness (ILI) that have laboratory-confirmed influenza. Six Iowa medical clinics participated and were located throughout the state. All age groups were represented and the clinics saw more than 150 patients per week on average. Of the 540 patients reported as having ILI by clinic sites, 519 were tested for influenza at the State Hygienic Laboratory.

IIPP participants collected more specific information including test results. Sites reported total patients, ILI patients, and rapid test results for ILI patients, weekly. Age groups used included <1, 1-4, 5-17, 18-24, 25-49, 50-64, and >64. Providers also submitted specimens on all patients with a rapid test to SHL for confirmatory testing. The results were released daily to IDPH and the provider. IDPH calculated positive predictive value of the rapid antigen test weekly using the rapid test data and case-matched results provided by SHL. Rapid test sensitivity and specificity were calculated twice during the season.

Hospital surveillance program

All hospitalizations attributed to 2009 H1N1 were made temporarily reportable as of September 1, 2009. The majority of cases were reported to IDPH electronically through the Iowa Disease Surveillance System. IDPH calculated the following from the hospital case reports:

- Age-specific rates of infection
- Percent characterization of demographics
- Percent characterization of clinical presentation
- Percent characterization of co-morbid conditions
- Regional, population-based rates of hospitalization

Specimens from hospitalized patients were collected and sent to UHL for testing.

School surveillance program

There were 58 schools enrolled in this program for 2009-2010. At various times throughout the season data from additional reporting systems in Linn and Polk Counties was obtained and

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[1] http://www2a.cdc.gov/ilinet/

included in the IDPH analysis. Schools reported the total students enrolled and total absent due to illness weekly. The sum percent absence was calculated weekly. Percent absence by region was also calculated. All reports were submitted through an IDPH-maintained web survey tool.

All Iowa schools are asked to report absence due to illness to IDPH when the percentage met or exceeded 10% throughout the school year. These reports were entered into the IISN access database and counted weekly.

Laboratory

The State Hygienic Laboratory at the University of Iowa (SHL) conducted testing for influenza using real-time RT-PCR on more than 2,800 specimens and culture for more than 2,300 specimens. SHL provides the H subtype for positive influenza strains and was approved by the CDC to provide confirmatory testing for the H1N1 pandemic strain within five days of receiving the reagents. This obviated the need to send these specimens to the CDC for confirmation and shortened the time interval of available results from days (or weeks) to hours. Specimens continued to be shipped to CDC for surveillance purposes according to their guidelines.

SHL also coordinates the surveillance of clinical and reference laboratories for rapid antigen testing for influenza and RSV. More than 160 laboratories participate in the Iowa Laboratory Response Network (ILRN). Of those, 65 report the number of tests performed, positive and negative through a web-based survey tool. Reporting is conducted throughout the usual influenza season. SHL also hosted a series of weekly, statewide teleconferences at the start of the pandemic to inform laboratorians of the latest diagnostic procedures and testing guidance.

IDPH had determined the minimum number of laboratories required to report rapid test results from each region to maintain reporting levels of one lab for every 50,000 people (Table 1). Additionally, the statewide percentage is calculated using a three-week moving average. Given the variability in the positive predictive value of the RSV rapid test at times of low prevalence, the use of an average helps eliminate non-significant fluctuations in results.

Table 2. Number of laboratory surveillance sites for every 50,000 residents by region

Region	Population of region	Pop. of region/50,000
1	806,425	16.1
2	289,212	5.8
3	326,562	6.5
4	283,189	5.7
5	347,572	7.0
6	886,537	17.7

Mortality

A temporary reporting order mandating the reporting of deaths due to 2009 H1N1 influenza was issued on September 1, 2009. Reports were submitted by fax, mail, and the Iowa Disease Surveillance System (IDSS). The majority of reports were submitted by hospitals.

Deaths classified as "confirmed" due to influenza infection must have laboratory confirmation of influenza infection within two weeks of death. Acceptable laboratory testing includes PCR, DFA, or culture. Testing may be performed up to two weeks prior to death or may be conducted with specimens taken post mortem. All cases must have had illness clinically compatible with influenza infection around the time of death.

Deaths classified as "probable" due to influenza infection must have laboratory confirmation of influenza infection by only rapid antigen testing. The patient must have also had illness clinically compatible with influenza infection around the time of death. All rapid influenza tests were encouraged to be confirmed by the State Hygienic Laboratory, but due to high patient census and specimen volume in hospital laboratories, confirmatory testing was not always feasible. In some cases, postmortem testing to confirm rapid antigen tests was encouraged but not accomplished.

Trends and Analysis

Trends in laboratory surveillance

The influenza season in 2008-2009 was mild and the dominant strain was the H1N1 seasonal virus. There were sporadic late-season influenza B cases confirmed in March and April. The first 2009 H1N1 pandemic cases were detected in early May. There were several small peaks of cases throughout the summer. In August and September activity starting picking up and peaked in mid-October. There were no cases of seasonal influenza detected until February 2010. At that time five cases of influenza B were reported out of Central Iowa. Seasonal influenza A strains were not identified in the seasonal time period of September, 2009 through April, 2010.

Table 3. Lab results by influenza type reported by SHL, 2009-2010

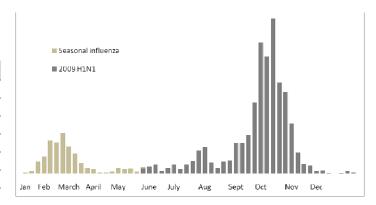|	Since 9/1/09
Negative for influenza	3,866 (65.1%)
Influenza A	1,957 (32.9%)
Influenza A H1N1	1,765 (29.7%)
Subtyping not reported	192 (3.2%)
Influenza B	5 (0.1%)
Indeterminate/Equivocal	112 (1.9%)
Total tested	5,940

Figure 1. Number of laboratory-confirmed cases, seasonal and pandemic, 2009

The following is a graph of influenza rapid antigen results reported to SHL over the past two years. The positive predictive value of rapid antigen tests is low and variable when prevalence is low. This is supported by the fluctuations in the percent positive when less than 500 tests per week are performed.
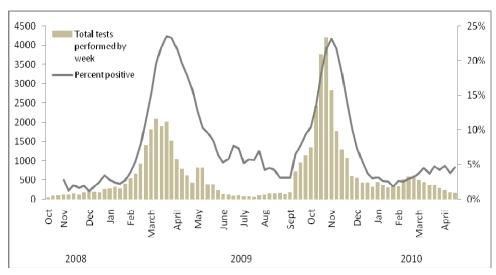

Figure 2. Influenza rapid antigen laboratory results, percent positive and total tests performed, 2009-2010

Trends in outpatient surveillance

Influenza-like illness (ILI) reported by outpatient health care providers reached the highest percentage of all patient visits ever reported compared to historical data dating back to 2001. In mid-October, more than 10% of all patient visits were attributed to ILI. The percentage of ILI reported in 2009 was higher than any other previously reported year, but comparatively it was only 1.5% higher than two H3N2-dominant seasons, 2004-2005 and 2007-2008. Activity in the 2009 H1N1 pandemic was similar to years when H3N2 seasonal influenza strains were dominant.
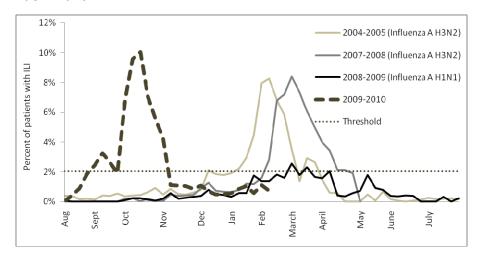

Figure 3. Percent of patient visits for influenza-like illness, 2004-2009

Modeling and extrapolation

When the second pandemic wave began in August, 2009, the flu team attempted to model how the pandemic might progress. It was not possible to determine when each wave would start, but it was quickly apparent in the fall that the second wave would be significant. The models were used to determine what actions schools might need to prepare for high rates of absence and for approximately how long. The models were used to assess possible surge impacts on hospitals. And they were also used to plan for support the state health department might provide to medical clinics.
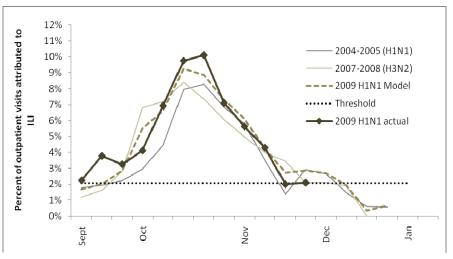

Figure 4. Outpatient visits for influenza model, actual percent of visits for influenza and modeled visits for 2009

When creating the outpatient health care provider models, we reviewed data from seasonal years when an H3N2 virus was dominant. During those years morbidity and mortality were usually greater. These data were expected to provide comparable data for modeling. The model created in Figure 4 was very accurate in predicting both the peak and duration of pandemic activity in outpatient health care clinics.
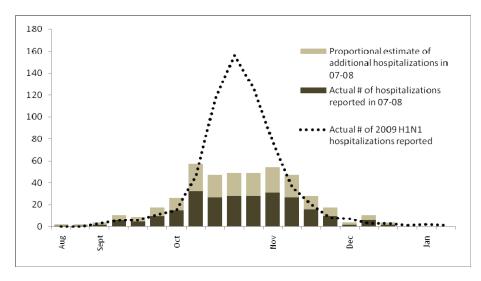

Figure 5. Estimated and actual hospitalizations due to 2009 H1N1

Anticipating hospitalizations in Figure 5 was more challenging than developing the outpatient model. Hosptializations due to influenza are not required to be reported in Iowa, therefore data from previous years only represents a portion of actual hospitalizations. The model predicted that there would be no more than 60 hospitalizations per week during peak weeks, but that a high level of hospitalizations would be maintained for at least six weeks. During the fall wave of the pandemic in 2009, the number of hospitalizations exceeding what was expected lasted six weeks. However, the peak of hospitalizations was very sharp and nearly three times what the model indicated.

In early 2010, CDC developed state-level exptrapolation guidance to assist states in estimating the impact of the pandemic. IDPH confirmed 659 hospitalizations in 2009-2010 and from that number were able to calculate the extrapolated number of hospitalizations, deaths, and symptomatic cases. At the end of the second pandemic wave, it was estimated that more than 10% of Iowans had symptomatic influenza illness.

Table 4. 2009 H1N1 extrapolations using confirmed and probable hospitalizations reported September 1, 2009-April 30, 2010

Confirmed hospitalizations since 9/1/09	659
Hospitalization multiplier	2.7 (range 1.9-4.3)
Extrapolated hospitalizations	1779 (range 1252-2834)
Extrapolated deaths	107 (range 75-170)
Prevalence multiplier	0.45% of symptomatic cases are hospitalized
Extrapolated number of symptomatic cases	395,333 (>10% of all Iowans)
Fatality multiplier	6%

Age group characterization

The 2009 H1N1 pandemic was different from typical, seasonal influenza trends in that patients from all age groups were hospitalized for influenza and influenza-related conditions. Age specific rates reveal the highest proportion of hospitalized patients occurred in persons 50-64 years old. In a typical influenza season, persons aged 0-4 and those over 64 years of age are more likely to be hospitalized than any other age group.

Rate	0 to 4 years	5 to 17 years	18 to 24 years	25 to 49 years	50 to 64 years	>64 years
	76.96	15.01	16.20	9.33	24.86	11.46

Table 5. Rates of hospitalization for influenza by age group, 2009

There were a total of 659 confirmed and probable hospitalizations reported to IDPH between September 1, 2009 and April 30, 2010.

Age appears to have an impact on not only whether a person is hospitalized for influenza, but also how long the patient was hospitalized. Persons 19 years and older were hospitalized an average of 3.6 days (median 2.0, +/- 5.7 days) compared to patients 18 years and younger that averaged 2.9 days (median 2.0, +/- 4.9 days) in the hospital.
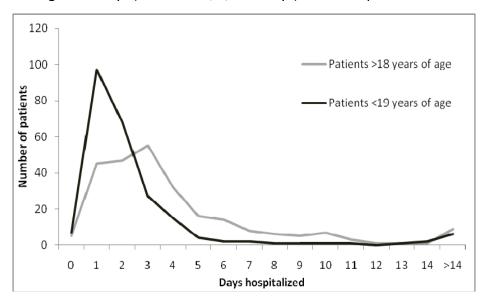

Figure 6. Influenza-associated hospitalizations-days hospitalized by age cohort

Trends in school populations

Another interesting characteristic of this pandemic was the number of children and adolescents affected. IDPH tracked extremely high percentages of absence due to illness in peak weeks of activity, including significant outbreaks of flu-like illness in 32% of Iowa schools in one week alone. Despite the fact that this young age group experienced widespread illness, severe illness as evidenced by hospitalized rates was not as common as in other age groups.
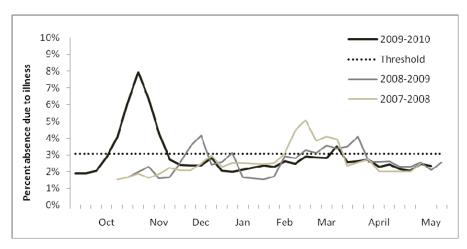

Figure 7. Percent of students absent due to illness among surveillance school sites, 2007-2010

Influenza predicability and weather patterns

Typically, seasonal influenza viruses are susceptible to heat and humidity. The peaks of the past six influenza seasons have been closely related to the state's average temperature. The following figure displays the statewide average weekly temperature and the weekly percentage of patient visits reported for influenza-like illness (ILI). For almost all years, the highest percentages of patients with ILI were reported within 1-2 weeks of the week with the lowest average temperature. In most years, the week with the lowest recorded temperature occurred between January and March. One notable exception was 2004-2005, an especially severe influenza season. That year the coldest winter weather was recorded in early January and the peak of the influenza season followed immediately after.

Also in figure 8, there are two peaks where ILI peaked at 8%. The dominant influenza virus in those seasons was an H3N2 strain. The impact of the 2009 H1N1 pandemic strain has been compared to severe H3N2 years. The percent ILI is close to those seen in 2005 and 2008, but still exceeded those percentages by two. The pandemic virus did not display the same susceptibility to heat and humidity seen in typical seasonal flu viruses. Two 2009 H1N1 peaks were recorded in 2009; one in May and the second in October. Activity after the second peak declined quickly. A third peak in 2010 was not detected. Temperature data for 2010 is not yet available.
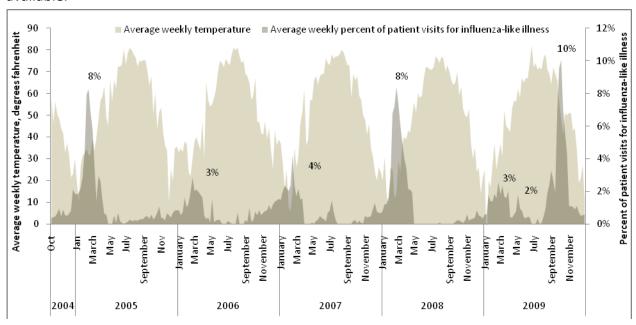

Figure 8. Iowa average weekly temperature and percent influenza-like illness reported by ILINet sites, 2004-2009

Mortality surveillance

Between September 1, 2009 and April 30, 2010 there were 40 deaths reported to the Iowa Department of Public Health. All cases were confirmed by PCR, culture, or DFA except for three. The majority of deaths occurred in persons ages 25-49 years. This is an unusual pattern for influenza, as most deaths from seasonal influenza occur in persons less than age 4 or older than 65; most have underlying medical conditions. Obesity was noted for 35% of cases, but data required to calculate BMI and determine obesity status was not available on all cases. Most cases were hospitalized for pneumonia or respiratory distress.

IDPH, SHL, and the Office of the State Medical Examiner worked to emphasize the importance of testing patients postmortem when influenza infection was suspected but not confirmed by a laboratory test. Postmortem testing was successful in identifying 11 of 40 cases where antemortem testing for influenza was not done or was negative.

Table 6. Summary of demographics, co-morbidities, and reason for hospitalization among patients with fatal 2009 H1N1 infections

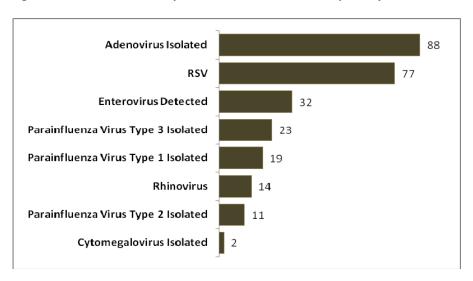| Cases	N	Percentage
Confirmed	37	92.5%
Probable	3	7.5%
Age group		
0-17	3	7.5%
18-24	4	10.0%
25-49	16	40.0%
50-64	11	27.5%
>64	6	15.0%
Total	40	
Underlying medical conditions		
Obesity	14	35.0%
Chronic lung disease	8	20.0%
Diabetes	8	20.0%
Hypertension and/or CVD	8	20.0%
Mental impairment	7	17.5%
Renal disease	5	12.5%
Immunosupressive condition	6	15.0%
Neuromuscular condition	3	7.5%
Primary reason for hospitalization		
Pneumonia	22	55.0%
Respiratory distress	14	35.0%
Other	5	12.5%

Non-influenza viral respiratory pathogens

The State Hygienic Laboratory and the Mercy Dunes Medical Laboratory submit non-influenza virus results to IDPH on at least a weekly basis. The labs screen for the following:

- Adenovirus
- Cytomegalovirus
- Enterovirus
- Parainfluenza 1-3
- Respiratory syncytial virus
- Rhinovirus

Parainfluenza 2 and 3 viruses were detected primarily in January-May. Parainfluenza 1 was detected September through December. Adenovirus was identified in winter months similar to the timing of seasonal influenza.

Figure 9. Number of cultures positive for non-influenza, respiratory viruses, 2009

Respiratory syncitial virus

Surveillance for RSV began in late November. The CDC considers RSV widespread in a population when the percent of rapid antigen tests that are positive exceeds 10%. This occurred in Iowa in December. The 2009 season began about two weeks earlier than in 2008 and ended about one week later. The longer season may be attributed to better reporting from laboratory surveillance sites.
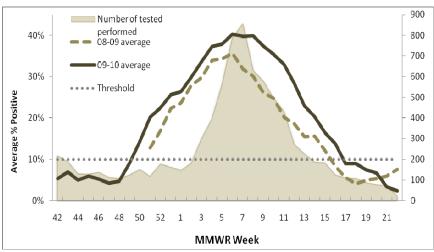

Figure 10. RSV laboratory summary, 2008-2010

Surveillance in 2010-2011

The Iowa Influenza Surveillance Network will retain the five core program areas of surveillance for the 2010-2011 season including outpatient, hospital, school, laboratory, and mortality surveillance.

The outpatient provider program will consist of six clinics dually enrolled in the Influenza Incidence Surveillance Project (IISP) and ILINet- both projects coordinated by IDPH and CDC. These six clinics will collect detailed clinical information on a set number of patients with acute respiratory infections or influenza-like illness (ILI) each week. Specimens will also be collected on these patients for testing for influenza and non-influenza respiratory pathogens using both molecular methods and culture. Pathogens included for testing in this project include:

- Influenza A, B
- Human Metapneumovirus
- Adenovirus
- Parainfluenza 1-3
- RSV
- Rhinovirus

The State Hygienic Laboratory will perform all testing for this project. Additional clinic sites will be enrolled in ILINet and will track and report ILI and total number of patients each week.

The Iowa Department of Public Health (IDPH) plans to release a new reporting order mandating reporting of influenza-associated hospitalizations and deaths starting September 1, 2010. This order will replace the previous order issued on the same date in 2009. Infection prevention staff at hospitals will be asked to complete a simple case investigation form for each patient. Hospital-based surveillance has historically been a source of valuable information. The patient reports allow IDPH to determine age-specific rates of hospitalization, proportion of patients with a history of vaccination, which co-morbidities are significant among inpatients, and what clinic syndromes most likely lead to hospitalizations.

School-based surveillance will remain the same as it has in past years. Participating schools will report total students enrolled, total students absent due to illness, and days school was in session, weekly.

The State Hygienic Laboratory (SHL) will continue confirmation of influenza rapid antigen tests, and specimens submitted on hospitalized patients and deceased patients with a suspected cause of death due to influenza. SHL will report all results through HL7 messaging directly to the IDPH electronic disease reporting system, the Iowa Disease Surveillance System. SHL will also coordinate a weekly query of influenza and RSV rapid test results supplied to a web-based survey tool.

With a new reporting order, IDPH will require the reporting of influenza-associated deaths. Patients with a cause of death due to influenza must have laboratory confirmation of influenza infection. Postmortem and ante mortem test results will be considered.