PILOT STUDY: WEEKLY REPORTING OF INFLUENZA-LIKE ILLNESS AMONG STUDENTS IN A SAMPLE OF LOS ANGELES COUNTY SCHOOLS

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BACKGROUND

Influenza is a significant source of morbidity in healthy children, leading to excess hospitalizations and medical visits [1]. Epidemiological studies have shown that during an epidemic, influenza has the highest attack rate and occurs first in school-aged children, who subsequently spread the virus to their family members [2]. With the concern of pandemic influenza, there is an increased need to quickly identify influenza in the community and efforts have focused on creating syndromic surveillance systems to identify influenza-like illness (ILI) and other indicators of influenza in real-time. Several jurisdictions use or have attempted collecting student absenteeism as a proxy for influenza activity during the influenza season [2,3]. However, student absenteeism is non-specific as the reason for absence is not collected and there are certain times in the school year where a large percentage of students are absent, such as the week before and after holidays or during the first or last week of school [3]. To better assess influenza activity in school-aged children, the Los Angeles County Department of Public Health (LAC DPH) partnered with several schools to pilot a program where school nurses reported the weekly percentage of students in school presenting with ILI symptoms to the nurse's office.

METHODS

Participating schools were chosen based on geographic location, type of school (elementary, middle, or high school), and presence of a full-time nurse. Influenza-like illness (ILI) was defined as fever ≥100° F in addition to cough and/or sore throat. For this pilot program, the defined study period was from October 22, 2006 to March 24, 2007. During this time, the participating school nurses would report the weekly number of students with ILI and the total number of students who visited the nursing office during each school week (Monday through Friday). Data were extracted from an existing nurse data sheet used to categorize the primary reason for each student visit. Other categories listed on the form such as gastrointestinal illness or injury were not analyzed here.

ILI data were submitted to a nurse coordinator by Wednesday of the following week, who recorded and emailed the data in a Microsoft Excel spreadsheet to LAC DPH Acute Communicable Disease Control Program (ACDC). No information was collected during the four week winter break (12/10/06-1/6/07). Data were analyzed to determine completeness of reporting and ILI trends, both overall and by type of school. In addition, school based ILI was compared to other influenza surveillance systems in Los Angeles County, including sentinel and syndromic-surveillance systems.

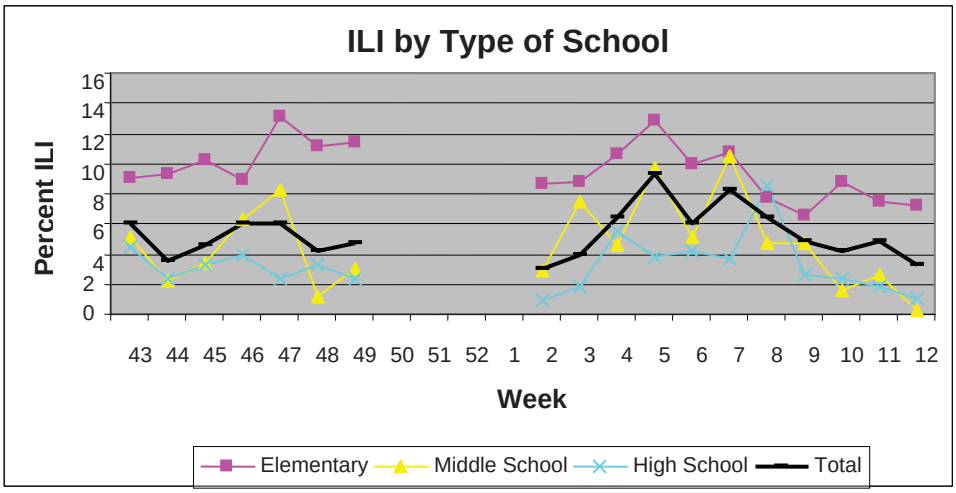
To thank the nurses for participating and to encourage further participation, each nurse was mailed a "Zebra Book" – Terrorism Agent Information and Treatment Guidelines for Clinicians and Hospitals, which is a comprehensive resource for clinicians on biological, chemical, and radiological agents. The books were mailed during the project in January, after the winter break period.

RESULTS

A non-random group of 24 schools were selected based on the location and type of school; one high school, middle school, and elementary school were chosen from eight local districts within the county. Twenty three nurses were assigned to these schools. Surveillance data was available for 18 weeks, excluding the weeks during winter break.

Influenza-like illness was highest among elementary school children (median= 9%) and decreased with increasing age (median = 5% and 3% for middle and high school students, Table 1). Two ILI peaks were observed during the study period (Figure 1)—a smaller peak during weeks 46 and 47 (11/12-11/25/06) followed by a larger peak in week 5 (1/28-2/3/07).

Figure 1. ILI by Type of School and Week, Excluding Winter Break (weeks 50-1)



During the peak in November (weeks 46 and 47), 6% of students presenting to the school nurse had ILI symptoms (Table 1). In week 46, ILI among high school students peaked at approximately 4%, followed by 8% in middle school students and 13% in elementary school students during week 47 (Table 1). The second, larger peak was observed during week five, where 9% of presenting students had ILI symptoms (Table 1). Interestingly, ILI among elementary school students who presented to the nursing office was highest during this peak (13%) while ILI among middle school students peaked during week 7 (11%) followed by high school students during week 8, where ILI peaked at 9% (Table 1).

Overall, reports were received from 92% of the schools (n=22). Nearly 40% of the school nurses reported data at least 75% of the time (n=9) and 50% reported data at least half of the time (n=12). Data was never received from two sites and nine school nurses stopped reporting after the winter break (Table 2).

Table 1. ILI by Type of School, by Week

WEEK	ES ILI	MS ILI	HS ILI	TOTAL
43	9.1	5.1	4.5	6.1
44	9.3	2.2	2.4	3.5
45	10.2	3.3	3.2	4.6
46	8.9	6.3	3.9	6.0
47	13.1	8.3	2.4	6.0
48	11.1	1.2	3.2	4.2
49	11.4	3.0	2.4	4.7
2	8.6	2.8	1.0	3.0
3	8.8	7.5	1.8	4.0
4	10.6	4.6	5.5	6.4
5	12.8	9.7	3.9	9.3
6	9.9	5.1	4.2	6.1
7	10.7	10.5	3.7	8.3
8	7.7	4.7	8.5	6.4
9	6.5	4.7	2.7	4.8
10	8.8	1.5	2.3	4.3
11	7.5	2.7	1.8	4.9
12	7.2	0.2	1.0	3.3

Notes: Winter break excluded (weeks 50-1)
Grey indicates <50% reporting

Table 2. Reporting Activity of Participating School Nurses		
Participation	**n**	**%**
>= 85%	4	17
>= 75%	9	38
>= 50%	12	50
>= 25%	22	92
Never	2	8
Quit After Break	9	38

DISCUSSION

Although the 2006-2007 influenza season was mild and a limited number of schools participated in the study, the second peak of ILI among school-aged children was consistent with other markers of influenza in LAC; including laboratory confirmed influenza in sentinel sites and reported cases of pediatric influenza (Figure 2). In particular, both ILI in school-aged children and cases of pediatric influenza peaked during week five. Laboratory confirmed influenza cases from sentinel sites (76% in children younger than 18 years) peaked during week four (Figure 2), somewhat unexpectedly, as other studies have shown that ILI in children precedes laboratory confirmed influenza [2,3]; however, compared to previous seasons, very few laboratory cases were reported and during the "peak" period, only six cases were reported. In a surrounding jurisdiction that utilizes more sentinel sites for influenza reporting, laboratory confirmed influenza peaked during week six [4]. Other markers of ILI activity in LAC, including persons with ILI presenting to emergency departments and total number of emergency department visits, peaked during week six; especially ILI in children aged five years and younger (Figure 3).

Figure 2. School ILI Versus Reported Cases of Pediatric Influenza and Positive Tests for Influenza by Sentinel Sites, Los Angeles County

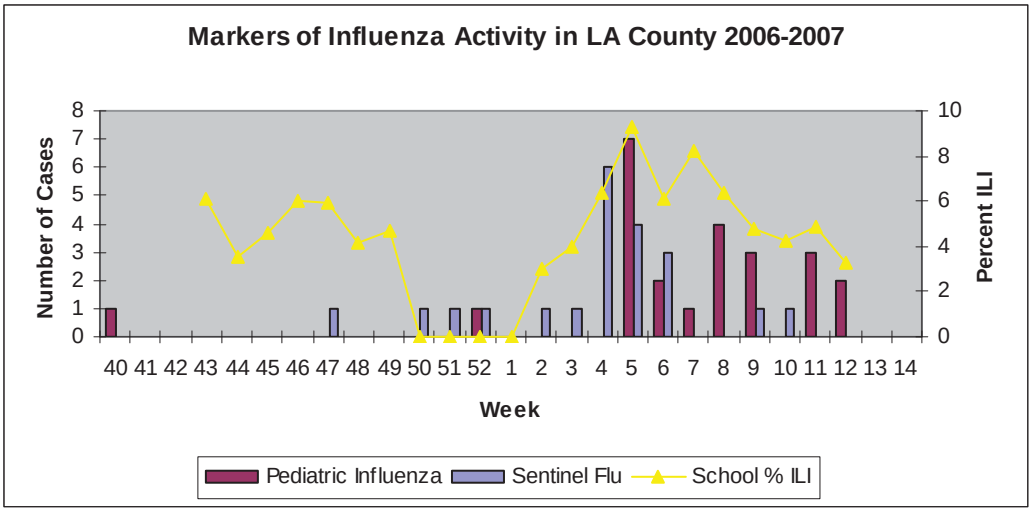
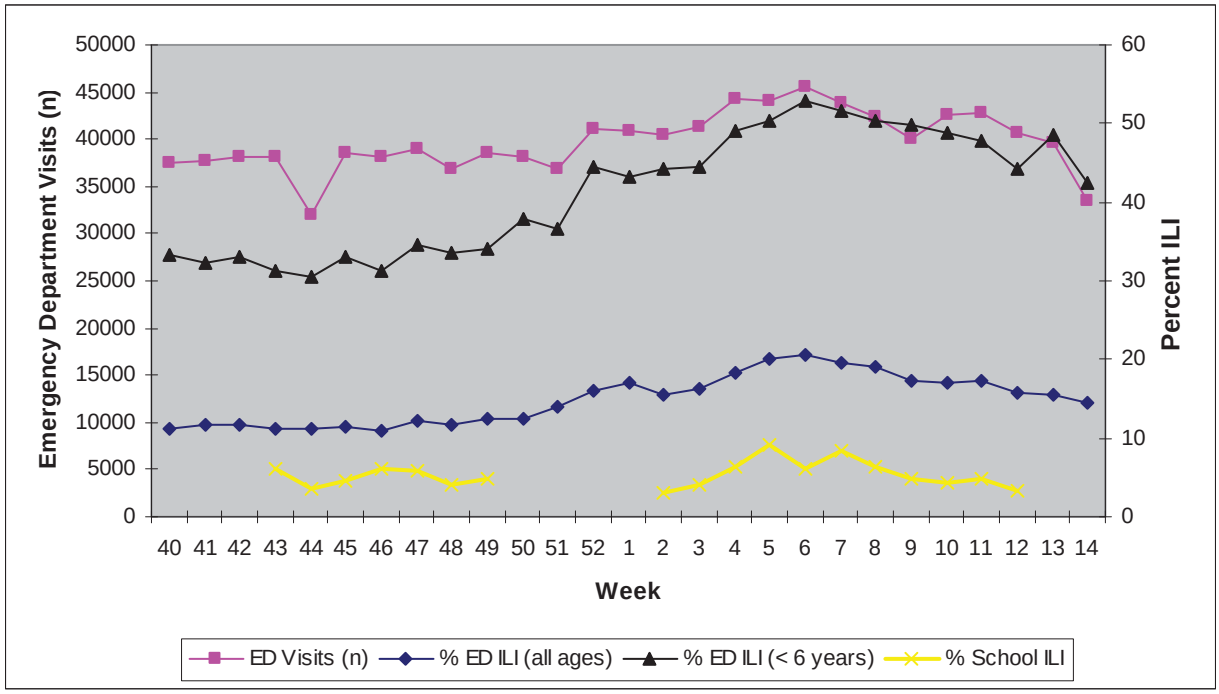


**Figure 3. School ILI Versus Markers of Syndromic Surveillance
Los Angeles County, 2006-2007**



Clinical information from student nurse visits provides a surveillance system for influenza detection that is more specific than absenteeism data alone. However, ILI may not indicate influenza as other viral or bacterial infections can cause similar symptoms. During the first observed peak of ILI activity in school-aged children, there were no other markers of influenza activity in LAC. The cause of this peak or the significance of the increase is unknown since there is no background rate for comparison. Another limitation is that no data is available during winter break, a period in which influenza activity is typically highest.

During this pilot study several challenges were identified, including issues of representativeness, timeliness, and acceptability. It is unlikely that 24 schools from one school district are an accurate representation of influenza activity in all LAC schools. Although data were reported on a weekly basis, ACDC did not receive the updated spreadsheet until the following week. In the future, the reporting system should be modified so that both the nurse coordinator and ACDC can access the data as it is being reported by the school nurses. In addition, participation in reporting was lacking, especially in middle and high schools after the winter break. Further investigation is needed to determine why this decrease occurred and feedback from the school nurses will be critical in understanding the lack of acceptability. Automated weekly reminders may be a useful tool to increase reporting.

Monitoring ILI in school-aged children provides a relatively simple and useful measure of influenza activity, especially when combined with other influenza surveillance systems. It may be particularly valuable in identifying influenza at the beginning, end, or outside the traditional season. In this study, ILI peaked first in elementary school children and reporting compliance was highest among elementary school nurses. Monitoring ILI in elementary schools alone may be a more effective and simpler alternative for conducting school-based ILI surveillance. In the future, a secure internet-based reporting system with automated reports can be designed to facilitate reporting and increase participation. This type of system would decrease the time for analysis and could be used to record ILI daily rather than on a weekly basis. Similar programs using electronic ILI reporting have been started elsewhere with success in predicting peaks of activity at least one week before they occur [5,6]. Further, an internet-based system could be applied in other settings such as laboratory or sentinel physician reporting.

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A PILOT STUDY ON THE FEASIBILITY OF MAKING HOSPITALIZED LABORATORY-CONFIRMED INFLUENZA A REPORTABLE DISEASE IN LOS ANGELES COUNTY

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ABSTRACT

To prepare for a pandemic or large epidemic of influenza, the Acute Communicable Disease Control Program (ACDC) of the Los Angeles County Department of Public Health (LAC DPH) recruited five hospitals in different geographic areas of the county for a pilot study on surveillance of hospitalized laboratory-confirmed influenza cases. From September 2006 to April 2007, infection control professionals (ICPs) of participating hospitals filed reports of hospitalized laboratory-confirmed influenza cases through Public Health's web-Visual Confidential Morbidity Reporting (VCMR) system and faxed medical records, laboratory results, and epidemiology case forms to ACDC for entry and analysis. Two of five hospitals reported a total of 11 cases, most of which were children <18 years old (64%). With no deaths and few study cases, LAC's influenza experience of low virulence and low infectivity was reflective of rest of the United States (US). Seven (64%) study cases had indications for influenza vaccination. Of these seven, three (43%) cases reported being vaccinated for the current season. Hospital laboratory data helped determine that this surveillance system had a 64.7% sensitivity (11 cases reported of 17 laboratory-confirmed) of detecting study cases with 50% of the sites with cases reporting information. Sensitivity decreased in March 2007. The median number of days between hospital admission date and report date was four (range 1-12 days). Among the five hospitals, 2197 influenza tests were performed with 106 (4.8%) positive results. This pilot study provided important information to consider in developing a functional surveillance system for influenza during a large epidemic or pandemic.

BACKGROUND

Influenza viruses are a major concern in the current era of emerging infectious diseases. Historically, influenza has made global impacts with the pandemics of 1918-19, 1957-58, and 1968-69. The Spanish flu pandemic of 1918-19 caused an estimated 20 million to 50 million deaths worldwide [1]. While pandemics rarely occur, annual or near-annual winter epidemics of influenza occur with an average health impact of >20,000 excess deaths and >110,000 excess hospitalizations per year in the United States [2].

Surveillance on influenza continues and develops today in hopes of identifying highly infectious strains and preparing for the next pandemic. Traditionally, methods of surveillance involved searching for pneumonia and influenza International Classification of Diseases, Ninth Revision (ICD-9) codes (codes 480-487) on death data as well as hospitalization data. More recently, with the U.S. government's focus on preparedness of bioterrorism, syndromic surveillance of emergency department and outpatient data has been used to gauge influenza activity [3]. However, with better rapid tests for influenza available today, studies on influenza surveillance are focusing on hospitalized laboratory-confirmed cases to get a more accurate picture of the disease [4,5].

In 1998, a joint study by the LAC Department of Health Services, the California Department of Health Services (CDHS), and the Centers for Disease Control and Prevention revealed that the medical capacity to handle influenza outbreaks in LAC was diminishing as the number of licensed hospital beds was decreasing with the growing population [6]. With 10 million people, LAC needs the ability to detect influenza quickly as the disease is highly infectious. Moreover, timely preparation efforts to prevent and handle the disease can alleviate the additional pressures on the medical and healthcare systems during influenza season.

The following one-year pilot study was performed by ACDC of LAC, DPH to determine the feasibility of conducting passive surveillance for hospitalized influenza, particularly whether hospital ICPs were willing to report hospitalized laboratory-confirmed influenza through VCMR. Currently, pediatric influenza cases

involving intensive care or death are reportable to the CDHS. This study expanded the influenza study population to all hospitalized laboratory-confirmed influenza cases in order to give health officials a better gauge of influenza activity in the entire LAC population. In addition, this study sought to determine if the surveillance and analysis of surveillance data can operate on a real-time basis and identify high-risk population groups to help direct influenza immunization campaigns.

METHODS

Selection factors for sentinel sites included location, high number of beds, being a general hospital, and strong rapport with the Hospital Outreach Unit (HOU) of ACDC. Hospital recruitment began informally in late August 2006. One hospital declined because being understaffed. Ultimately five hospitals (Hospitals A through E) participated and represented north, west, south, central, and east areas of LAC.

Surveillance began in September and October of 2006 and lasted until April 30, 2007. For each site, the study end date was defined to be the date after February 15 when six weeks passed without a laboratory-confirmed influenza admission or until June 30, 2007, whichever was sooner. ICPs of the five sentinel sites reported hospitalized influenza cases through the VCMR system of LAC DPH. Cases were defined as patients who were LAC residents (excluding Long Beach and Pasadena) admitted to the hospital with a positive result by any recognized laboratory test for influenza during the surveillance period. One hospital continued to report influenza cases without hospital admission, such as Emergency Room (ER) admission only cases, but indicated “ER only” in the notes section of the VCMR report. ICPs faxed history and presentation, laboratory results, and epidemiology case forms to HOU Liaison Public Health Nurses (LPHNs) who scanned these documents into VCMR. PHNs and the epidemiologist reviewed all documents from ICPs and made updates when necessary. The epidemiologist entered the epidemiology case form into the user-defined form (UDF) in VCMR which included patient demographics, type of laboratory test and specimen, date of culture, influenza type, onset date, admission date, admission with respiratory illness, admission from the ER, admission to the Intensive Care Unit (ICU), date of death, receipt of flu vaccine, history of chronic illnesses, co-infections, chest x-ray confirmed pneumonia, and pregnancy status.

The evaluation of the surveillance system focused on timeliness, sensitivity, predictive value positive, acceptability, and representativeness. While the system demonstrated stability, flexibility, and simplicity, only anecdotes can support this as no measures were performed to assess these aspects of surveillance. These anecdotes will not be described.

Sensitivity was defined as the number of hospitalized influenza cases reported divided by this same number plus the number of hospitalized influenza cases not reported during the surveillance period. To calculate sensitivity, when surveillance ended ACDC requested the number influenza tests performed, the number of positive results, and a list of names, medical record numbers, and specimen collection dates for patients with positive tests from the laboratories of each sentinel site. Having the ICP from each sentinel site review the laboratory list of patients with positive results and indicate which ones were admitted to the hospital defined the numerator for sensitivity calculations.

Predictive value positive was defined as the number of hospitalized influenza cases reported divided by this same number plus the number of reports of hospitalized influenza cases that actually were false because the cases were not hospitalized.

Representativeness was assessed by mapping the sentinel sites against the 2006 LAC population density estimates of the LAC Office of Vital Records and using hospital discharge data from CDHS to compare the numbers and medians of hospitalized influenza cases during 2001-2003 among the sentinel sites to those of other hospitals during the same time period. The percentage of hospital discharges with influenza coded of the sentinel sites was calculated for the 2001-2003 period to estimate the representation of the sentinel sites for the study.

RESULTS

Two of the five sentinel sites reported 77 influenza cases. Hospital B reported 13 influenza cases but only 10 were actually hospitalized. Hospital A reported 64 influenza cases but only one of these was hospitalized. In total, surveillance found 11 hospitalized influenza cases for the 2006-2007 season.

Most of the cases were children (n=7, 64%), with age ranging from 0 – 9 years, and median age at three years. Among the three cases with age of zero years, only one had influenza within a month of birth; the other two cases acquired influenza within two and five months of birth. Although race was almost evenly distributed among white, black, and Hispanic race-ethnicity categories, most of the child cases were male (n=5, 71.4%).

Among adult cases (n=4, 36%), median age was 49 years (range 21-89 years), race-ethnicity was white (100%), and gender was evenly distributed.

None of the eleven hospitalized influenza cases died. Ten cases (91%) were admitted from the ER. All were admitted with respiratory illness. Five cases (45%) had chest x-ray confirmed pneumonia (median age of seven years with a range of 0-89, versus median age of 6 years with a range of 0-24 for cases without chest x-ray confirmed pneumonia). Two cases, ages 89 and three years, were admitted to the ICU. Interestingly, the older of these two cases received the influenza vaccine earlier in the influenza season.

Although occupation in a health care setting was not asked, seven (64%) of the eleven cases had health indications for influenza vaccine. These indications included age less than six years (n=2, 18%), age greater than 65 years (n=2, 18%), chronic medical conditions (n=5, 45%), and pregnancy (n=1, 9%) in the second trimester. The chronic medical conditions included kidney disease (n=3), lung disease excluding asthma (n=2), heart disease (n=1), diabetes (n=1), and sickle cell disease (n=1). Three (43%) of the seven cases with health indications for vaccination reported receiving the influenza vaccine. The one case who knew his vaccination date had a disease onset 102 days later.

Four (36%) of 11 hospitalized influenza cases reported getting the influenza vaccine for the current influenza season. One of the four cases who received the vaccine did not have any recognized vaccine indications reported. In fact, this case was five months old and received the vaccine on the day of hospital admission. Therefore, three (27%) of the 11 hospitalized influenza cases that were reported to have received the influenza vaccine were not protected from disease. All three of these cases had influenza type A.

None of the eleven cases reported the risk factors of residence in a nursing home, current smoker, and chronic medical conditions of asthma, cancer, cystic fibrosis, anemia, and immunological disorders. In addition, none of the cases had respiratory co-infections reported.

Regarding timeliness of the surveillance system, the median number of days between hospital admission and report date was four (range 1-12 days), hospital admission and specimen collection for first positive influenza laboratory test result was one (0-1 day), disease onset and report date was eight (range 3-19 days), and disease onset and receipt of the epidemiology case form by ACDC was eight (range 3-26 days) (Table 1).

Table 1. Days Between Clinical Events During Pilot Surveillance of Hospitalized Influenza Cases (N=11), Los Angeles County, 2006-2007

	Days between clinical events						
Case	Disease onset to admission	Hospital admission to laboratory test	Laboratory test to report of case to health department	Report of influenza case to report of epidemiology case form	Disease onset to report of case to health department	Disease onset to report of epidemiology case form	Hospital admission to discharge
1	7	0	3	16	10	26	1
2	6	1	3	4	10	14	6
3	2	1	2	1	5	6	3
4	2	1	2	0	5	5	10
5	2	1	1	0	4	4	7
6	*	1	6	0	*	*	1
7	10	0	9	0	19	19	3
8	1	1	4	0	6	6	1
9	2	0	1	0	3	3	3
10	9	0	11	0	20	20	1
11	0	0	12	-2	12	10	2
Median difference (days)	2	1	3	0	8	8	3
Range (days)	0-10	0-1	1-12	-2-16	3-19	3-26	1-10

*Unknown disease onset date.

Among the sentinel sites, 2197 influenza tests were performed with 106 (4.8%) positive results (Table 2). Among those testing positive for influenza, 17 (16.0%) were hospitalized. Testing for influenza was varied as Hospital B performed 1612 tests while Hospital C and Hospital D performed 38 and 22 tests, respectively.

Regarding sensitivity of the surveillance system, laboratory data and review by ICPs found six additional hospitalized influenza cases (Table 2). With six hospitalized influenza cases not reported, the overall sensitivity of the surveillance system was 64.7%. Sensitivity for individual sentinel sites was either 0% or 100%.

Table 2. Evaluation Measures of Pilot Surveillance System for Hospitalized Influenza Los Angeles County, 2006-2007.

Testing and hospitalization

Hospital	Influenza tests performed	Positive tests	% tests positive	Positives hospitalized	% of positives hospitalized
Hospital A	348	65	18.7%	1	1.5%
Hospital B	1612	29	1.8%	10	34.5%
Hospital C	38	3	7.9%	3	100.0%
Hospital; D	22	0	0.0%	0	Not applicable
Hospital E	177	9	5.1%	3	33.3%
OVERALL	2197	106	4.8%	17	16.0%

Sensitivity

	Hospitalized influenza cases			
Hospital	Reported	Not reported	Total	Sensitivity
Hospital A	1	0	1	100.0%
Hospital B	10	0	10	100.0%
Hospital C	0	3	3	0.0%
Hospital; D	0	0	0	Not applicable
Hospital E	0	3	3	0.0%
OVERALL	11	6	17	64.7%

Predictive Value Positive

	Reported cases			
Hospital	Hospitalized	Not hospitalized	Total	Predictive Value Positive
Hospital A	1	63	64	1.6%
Hospital B	10	3	13	76.9%
OVERALL	11	66	77	14.3%

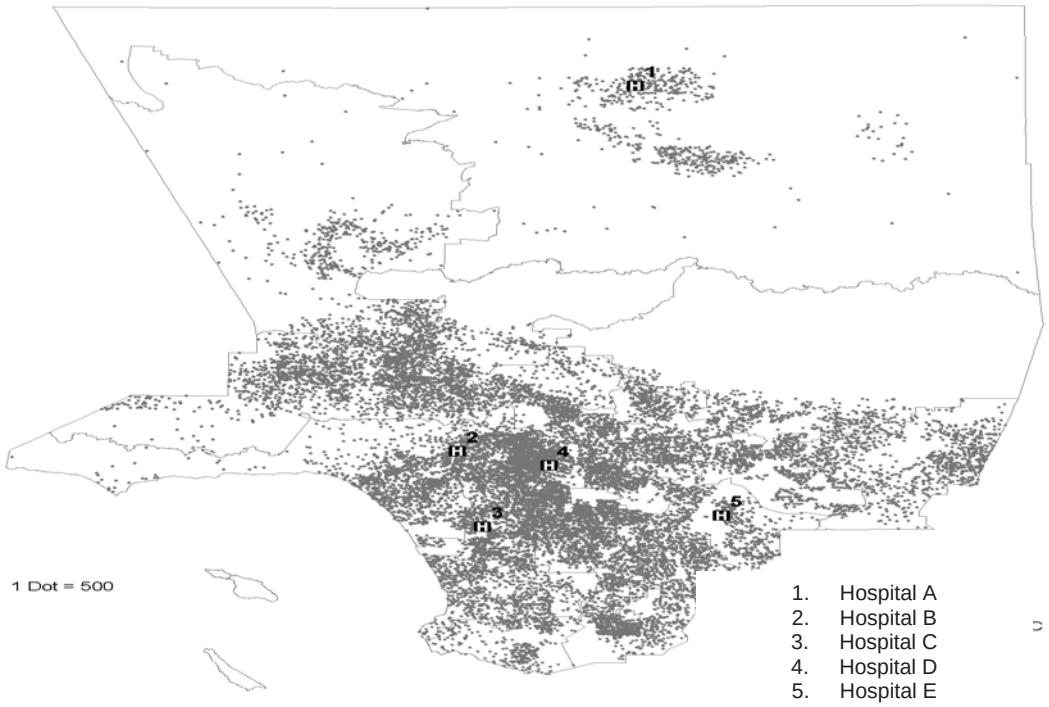
The predictive value positive of the surveillance system was low as only two sentinel sites reported cases that were not hospitalized. (Table 2). With 11 hospitalized influenza cases reported and 66 influenza cases reported but not hospitalized, the overall predictive value positive for the surveillance system was 14.3%. The predictive value positive for Hospital A was 1.6% but for Hospital B was 76.9%.

Acceptability was assessed for each sentinel site. The first consideration was sensitivity, which was 100% for Hospital A and Hospital B, but 0% for Hospital C and Hospital E. Hospital C had only 38 influenza tests performed but Hospital E had 177 influenza test performed. For either sentinel site, the low sensitivity suggests lower acceptability of ICPs to report hospitalized influenza cases. The second consideration was predictive value positive, which only Hospital A and Hospital B had because they reported cases. The low predictive value positive of Hospital A suggests a high willingness to report as the ICP reported 64 of 65 cases of laboratory-confirmed influenza. The predictive value positive of Cedars Sinai was 76.9% and in the beginning of the surveillance study the median number of days between hospital admission date and report date was three (range 2-4). After January 2007, the median number of days between hospital admission date and report date for Hospital B was eight (range 1-12). The decrease in timely reporting suggested a diminishing willingness to report, which might be due various reasons such as other hospital priorities and passing of the traditional peak of influenza season.

In terms of representativeness of the surveillance system, Figure 1 shows that the sentinel sites are located in various densely populated parts of LAC. In addition, during 2001-2003, the sentinel sites had a

median number of 17 (range 8-79) hospitalized influenza cases while other hospitals reporting discharges with influenza had a median number of 11 (range 1-323) hospitalized influenza cases. The study sites represented 145 (7.3%) of 1982 hospital discharges coded with influenza during 2001-2003 among 95 hospitals in LAC.

Figure 1. Hospitalized influenza sentinel sites by population density*
Los Angeles County, 2006 - 2007

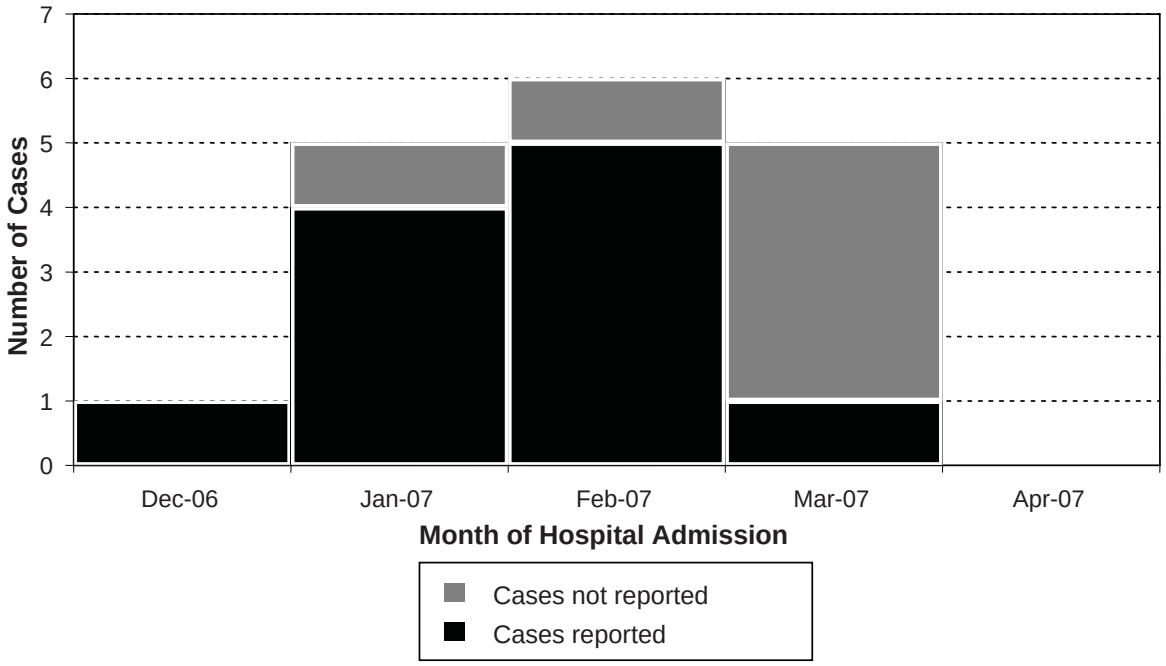


*Population estimates for 2006 as provided by the Los Angeles County Office of Urban Research.

Regarding accuracy of the surveillance system, three duplicates reports were submitted during the study. These were removed from the analysis but reflected the low incidence of influenza this season as well as the possibility of ICPs reporting old cases as new ones perhaps because of delayed reporting.

Figure 2 presents reported and non-reported hospitalized influenza cases during the surveillance study by month of admission. Hospitalization would have seemed to decrease dramatically in March if only reported cases were considered. However, March had as many hospitalized influenza cases as January.

Figure 2. Reported and Non-Reported Hospitalized, Laboratory-Confirmed Influenza (N=17) by Month of Admission, Los Angeles County, Influenza Pilot Study Sept. 2006 - April 2007.



DISCUSSION

This pilot study on making hospitalized laboratory-confirmed influenza a reportable condition in LAC showed that ICPs are willing to report these cases. While only two of five sentinel sites reported true cases, one site did not have any true cases, and two sites did not report any cases despite having a few. Of these two sites, Hospital C did not have an ICP during the time the cases were admitted so an assessment of willingness to report cannot be made with this site. However, this study may be biased in choosing sentinel sites with the best working relationships between the hospital ICPs and the HOU LPHNs. Therefore, when including all hospitals in LAC, the acceptability and sensitivity of the surveillance system might diminish.

Staffing issues as indicated by Hospital C and the hospital that had to be replaced during the recruitment phase of this study seem to be important in the sensitivity of detecting hospitalized laboratory-confirmed influenza cases through this surveillance system. With laboratory reporting developing with VCMR, another surveillance design might be more effective in detecting hospitalized laboratory-confirmed influenza cases.

The value of this surveillance system in detecting hospitalized laboratory-confirmed influenza in real-time can be seen from at least two perspectives. First, from hospital admission to first report of a hospitalized laboratory-confirmed influenza case usually took four days (range 1-12). Health officials need to decide if that's fast enough, particularly during an epidemic or pandemic. Second, determination of risk groups to target for vaccination from the information on the epidemiology case form will take longer than four days. Because the measure to calculate the time it took to investigate and complete the case epidemiology form was inaccurate or missing, only personal experience can attest that it usually took at least a week to get all the information for the epidemiology case form. Health officials need to decide if they will use the information from the epidemiology case form to formulate preventive efforts during a high-incidence influenza season. While the case epidemiology form might be omitted as part of a real-time surveillance

system, outcome of death, status and date of discharge, and vaccine status would not have been known if no case epidemiology form and follow-up were performed.

This pilot appears to have shown a fairly accurate picture of hospitalized laboratory-confirmed influenza in LAC, particularly because the incidence was low all around the United States this year. Unfortunately, the higher numbers of cases during a high-incidence year would have provided better estimations in evaluating making hospitalized laboratory-confirmed influenza a reportable condition.

Hospitalized laboratory-confirmed influenza is a specific condition and surveillance focused on this captures only the most serious cases to gauge how virulent the strain of influenza is for the current season. Health officials should recognize that this might not be the best way to assess the effect of influenza on the population, especially during a very high-incidence year as hospitals might reach bed-capacity or during a year of a highly infectious strain with low virulence. Alternatives to the surveillance system of this pilot study should be developed and explored. For example, one alternative is to make influenza laboratory reportable with demographic and residential address information and no follow-up. This is a very simple surveillance system with probably high acceptability if electronic laboratory reporting functions well in regards to timeliness and completeness and accuracy of data. While hospitalization admission would be unknown, the demographics of the population testing positive for influenza would be available to determine a strategy for prevention education and vaccination. While the surveillance system of this pilot study operated well during this season, it would be very resource intensive during a high-incidence season, mainly because of the work required to confirm hospital admission and complete the epidemiology case form.

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UNIVERSITY INFLUENZA SURVEILLANCE PROJECT SUMMARY 2003-2007

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BACKGROUND

The Los Angeles County Department of Public Health Acute Communicable Disease Control Program (ACDC) implemented the University Influenza Surveillance Project since 2003 until 2007. The project background and methods have been previously described in the 2003 ACDC Special Studies Report [1]. This report will summarize the project and present the final data. The objectives of the project were to: 1) describe the characteristics of respiratory illness in university students, 2) evaluate the feasibility of university student health centers as sentinel sites for influenza surveillance, 3) facilitate the identification of common and novel respiratory viruses in circulation, and 4) compare student viral surveillance with other respiratory illness surveillance systems.

RESULTS

A total of seven universities in Los Angeles County (LAC) participated in the project from 2003 to 2007. Participating universities varied by geographic location, student body size, and student characteristics (Table 1).

Table 1. University Demographics*

	University A	University B	University C	University D	University E	University F	University G
Student Body	> 30,000	5,000 – 10,000	> 30,000	< 5,000	> 30,000	5,000 – 10,000	10,000 – 15,000
Undergraduate	77%	71%	5O%	44%	70%	39%	71%
International Students	6%	8%	21%	26%	6%	5%	1%
Flu vaccination	Nominal Fee	Nominal Fee	Nominal Fee	Free	Free	Nominal Fee	Free
Type of School	Private	Private	State	State	Private	State	Private

* Data collected from university registrars/websites and student health center self-reports

Table 2 shows the types of residence of participants by year. A majority of students lived in either a dormitory or apartment. Dormitory residence had the largest percentages for three of the four flu seasons except for 2003-2004 (42%). The 2005-2006 season had the highest percentage of dormitory residence (63%).

Table 2. Participants' Residence by Year

	2003-04	2004-05	2005-06*	2006-07
Dormitory	5 (42%)	7 (58%)	10 (63%)	5 (38.5%)
Apartment	6 (50%)	4 (33%)	2 (13%)	5 (38.5%)
Fraternity/Sorority	0 (0%)	0 (0%)	1 (6%)	1 (8%)
Home	1 (8%)	1 (8%)	2 (13%)	2 (15%)

* 1 unknown

A total of 120 specimens were submitted by seven sites from 2003 to 2007. Of these, 53 (44%) were positive for influenza, 61 (51%) specimens tested negative, and 6 (5%) specimens were unknown for those respiratory viruses identifiable via complete viral culture test. Table 3 shows the breakdown of specimen results by university. Overall, 44% of the submitted specimens were positive for a respiratory virus. The universities had a range of 13% to 88% of submitted specimens testing positive for a respiratory virus.

Table 3. Summary of Specimens Results by University, 2003-2007

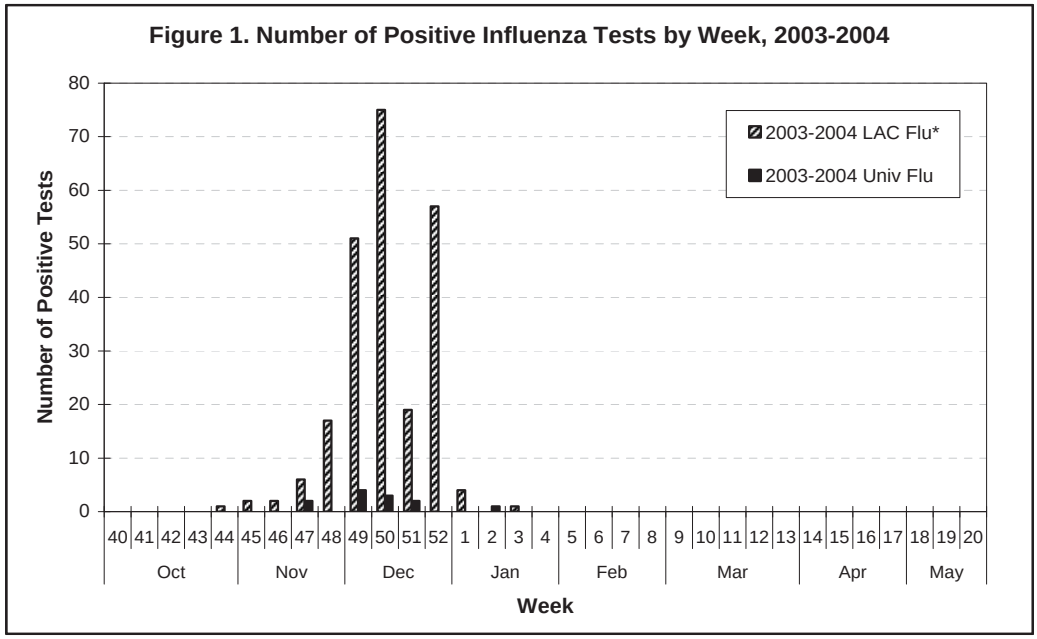
	No. Specimens Submitted	Positive	Negative	Unknown	Percent Positive
University A	5	2	3	0	40%
University B	38	12	24	3	32%
University C	15	2	13	0	13%
University D	8	7	1	0	88%
University E	16	9	6	1	56%
University F	23	14	8	1	61%
University G	15	8	6	1	53%
Total	**120**	**53**	**61**	**6**	**44%**

Table 4 below shows three major strains of influenza identified in this study including influenza A (H1N1 and H1N2), influenza A (H3N2) and influenza B. In both the universities and the U.S. specimens, influenza A (H3N2) had the largest percentage 70.6% and 44.8% respectively. No novel influenza strains were identified during the four seasons.

Table 4. Positive Specimens by Influenza Strain 2003-2007

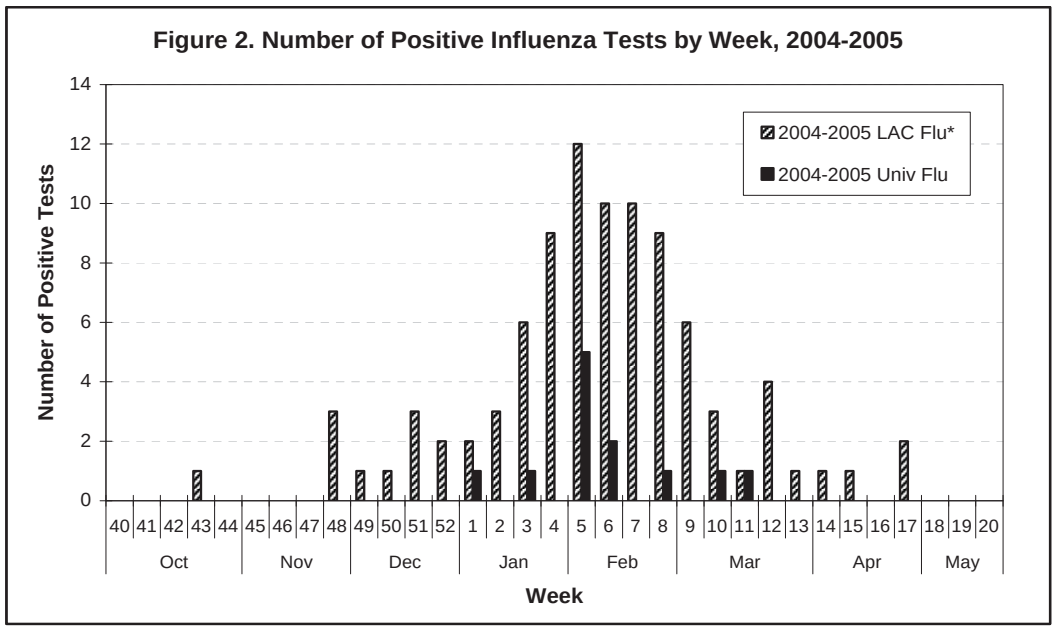
	Universities	United States
Influenza A (H1N1 & H1N2)	6 (11.7%)	14379 (16%)
Influenza A (H3N2)	36 (70.6%)	40252 (44.8%)
Influenza B	9 (17.6%)	13695 (15.2%)
Total	**51**[a]	**89928**[b]

[a] 1 positive case of parainfluenza and rhinovirus not included in universities' total.
[b] 21602 positive cases of Influenza A of unknown strain not shown above are included in U.S. total.



*Does not include university influenza positive tests; data obtained from 5-7 surveillance hospitals including outpatient clinics and ERs.

Figure 1 shows the number of positive influenza tests by week for all participating universities (n=12) and LAC (n=235) in 2003-2004. All participating universities had a peak number of positive tests in week 49. The university tests data was consistent with the peak number of positive tests occurring in week 50 reported by LAC. Among the universities the first positive case was detected in week 47 compared to week 44 in LAC.

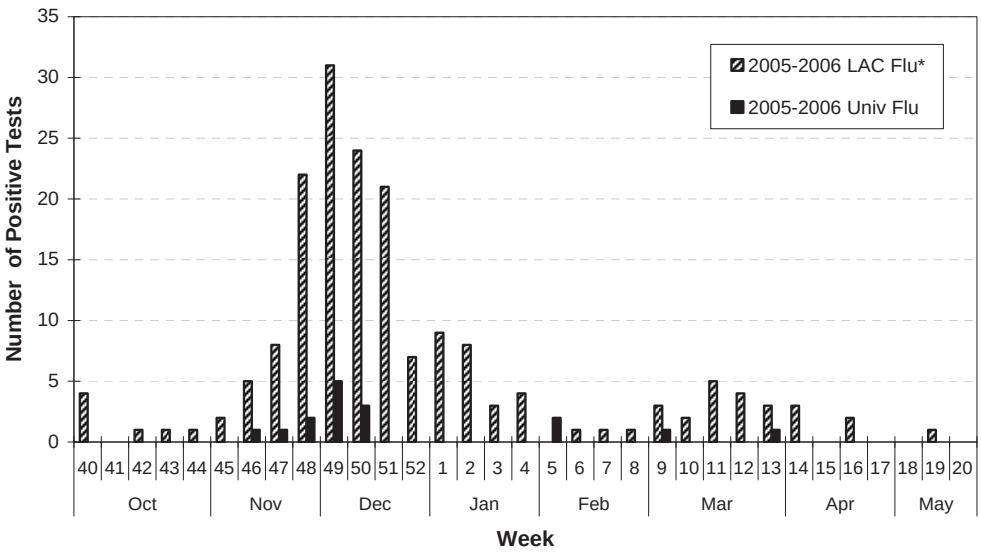


*Does not include university influenza positive tests; data obtained from 5-7 surveillance hospitals including outpatient clinics and ERs.

The above graph shows the number of positive influenza tests by week for all participating universities (n=12) and LAC (n=91) in 2004-2005. All participating universities had a peak number of positive tests in week 5. The university tests data was consistent with the peak number of positive tests occurring also in

week 5 reported by LAC. Among the universities the first positive case was detected in week 1 compared to week 43 in LAC.

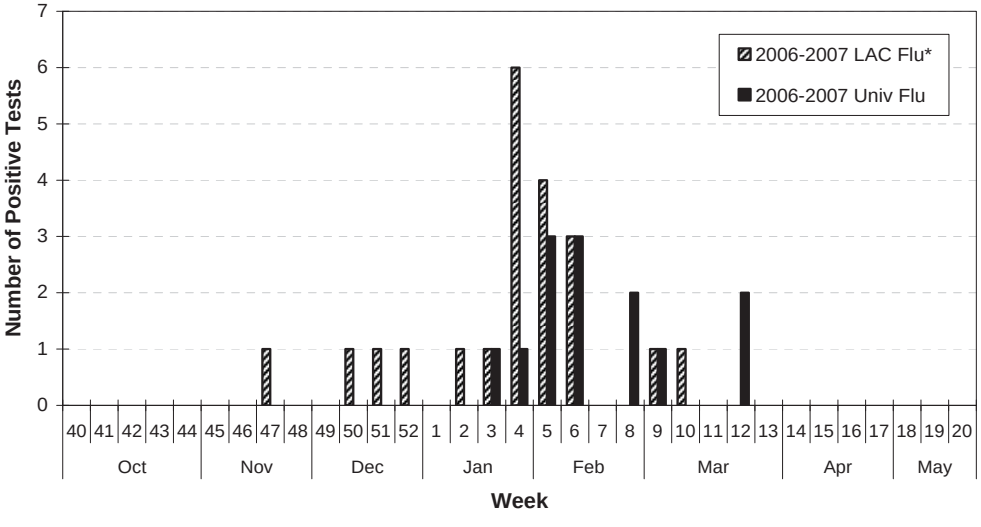
Figure 3. Number of Positive Influenza Tests by Week, 2005-2006



*Does not include university influenza positive tests; data obtained from 5-7 surveillance hospitals including outpatient clinics and ERs.

The above graph shows the number of positive influenza tests by week for all participating universities (n=16) and LAC (n=177) in 2005-2006. All participating universities had a peak number of positive tests in week 49. The university tests data was consistent with the peak number of positive tests occurring also in week 49 reported by LAC. Among the universities the first positive case was detected in week 46 in the universities compared to week 40 in LAC.

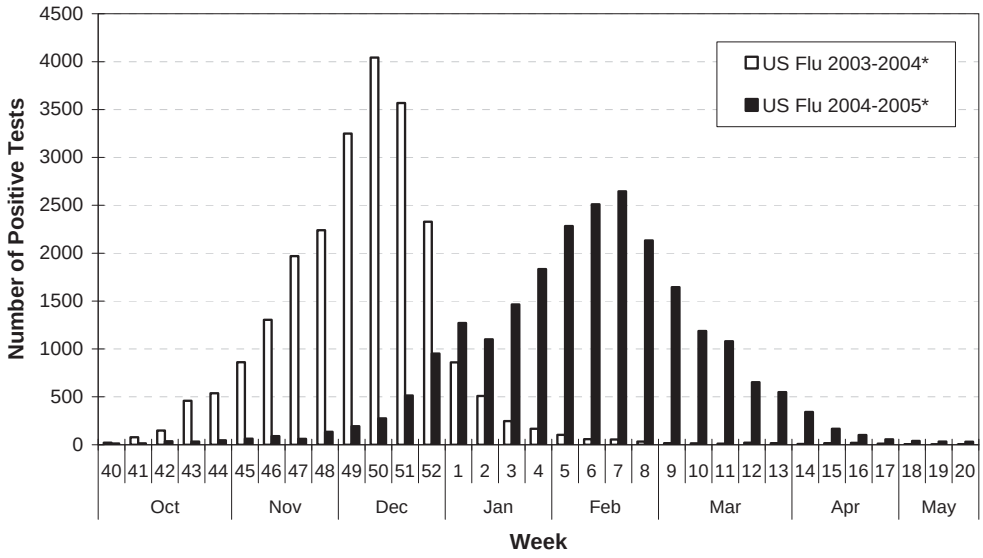
Figure 4. Number of Positive Influenza Tests by Week, 2006-2007



*Does not include university influenza positive tests; data obtained from 5-7 surveillance hospitals including outpatient clinics and ERs.

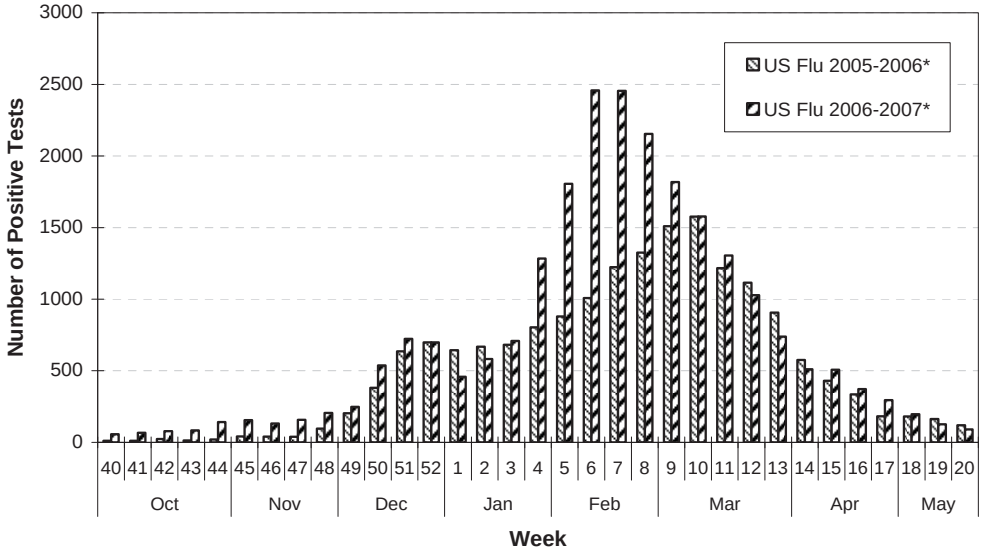
Figure 4 shows the number of positive influenza tests by week for all participating universities (n=13) and LAC (n=21) in 2006-2007. All participating universities had a peak number of positive tests in weeks 5 and 6. The university tests data was consistent with the peak number of positive tests occurring in week 4 reported by LAC. Among the universities the first positive case was detected in week 3 in the universities compared to week 47 in LAC.

Figure 5. Number of Positive Influenza Tests by Week, 2003-2005



*Does not include university influenza positive tests; data obtained from 5-7 surveillance hospitals including outpatient clinics and ERs.

Figure 6. Number of Positive Influenza Tests by Week, 2005-2007



*Does not include university influenza positive tests; data obtained from 5-7 surveillance hospitals including outpatient clinics and ERs.

The above two graphs (Figures 5 and 6) show the number of positive influenza tests by week for the U.S. from 2003 to 2007. The occurrence of peak number of positive tests at the universities is consistent with both the LAC and U.S. tests data (Table 5). However, in almost all cases positive influenza cases were detected earlier in the U.S. influenza tests compared to the universities and LAC. For all four influenza seasons, positive cases were detected first in week 40 in the U.S. tests (Table 6).

Table 5. Peak Number of Positive Tests by Week

	2003-2004	2004-2005	2005-2006	2006-2007
Universities	Week 49	Week 5	Week 49	Week 5 & 6
Los Angeles County	Week 50	Week 5	Week 49	Week 4
United States	Week 50	Week 7	Week 10	Week 6

Table 6. First Positive Tests by Week

	2003-2004	2004-2005	2005-2006	2006-2007
Universities	Week 47	Week 1	Week 46	Week 3
Los Angeles County	Week 44	Week 43	Week 40	Week 47
United States	Week 40	Week 40	Week 40	Week 40

DISCUSSION

In all four influenza seasons there was a delay in the detection of the first positive influenza case in the participating universities compared to the earlier detection in LAC and U.S. This can be attributed to two factors. First the total number of submitted specimens per year among the universities is much smaller, ranging from 19 to 46. A major limitation of this university study is the small sample size reflected in the low number of specimens submitted each year. Secondly, the positive university cases are a selective and unique population composed mainly of young healthy individuals ages 18 to 21 years. Due to the unique characteristics of the university population it is not a representative sample and was skewed toward a primarily young healthy population. In the LAC, positive cases are composed of individuals of all ages but a vast majority (90%) is young children under age 15 years.

Another weakness of the surveillance project is that students are not randomly selected to participate in the study. Increase in enrollment may occur or students may be selected in response to public fear and increased media attention and reports on influenza trends. Due to these limitations conclusions cannot be drawn from the data and greatly limit the type of statistical analyses that can be done.

In this project the first and fourth objectives to describe the characteristics of respiratory illness in university students and compare student viral surveillance with other respiratory illness surveillance systems were met. The third objective was also met by identifying common respiratory viruses in circulation and existence of no novel strains. The evaluation of the feasibility of university student health centers as sentinel sites for influenza surveillance were not formally done. However, the university participation was overall positive and good. Most universities utilized registered nurses, laboratory and/or administrative support personnel to participate in the project. Communication and understanding of the protocol were an important component of the project as there was some turnover in staff at the universities as well as at ACDC.

Although there were not many students who traveled to other countries during this project, monitoring students may be of significance in detecting novel strain for surveillance and response purposes. Given that the university population frequently travels to and from countries that may expose them to novel viral strains and often lives in close quarters in dormitories, conditions that can facilitate the spread of

respiratory illness, future surveillance efforts can focus specifically on detection of new and emerging strains in this population. Instead of testing throughout the influenza season, increased and active testing can occur following university holidays (spring, summer, and winter breaks) when students have often traveled. Existing resources can be redirected to active and increased testing during these time periods.

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SURVEILLANCE SYSTEMS USED TO MONITOR INFLUENZA ACTIVITY IN LOS ANGELES COUNTY DURING THE 2006-2007 INFLUENZA SEASON

Lindsey Hageman, MPH

BACKGROUND

Influenza is a vaccine-preventable disease, yet it is associated with approximately 36,000 deaths and 200,000 hospitalizations in the United States each year [1]. Since most influenza cases are not reportable in Los Angeles County (LAC) except for severe pediatric influenza and suspect avian influenza, influenza activity is monitored by the Los Angeles County Department of Public Health (LAC DPH) Acute Communicable Disease Control Program (ACDC) using a variety of surveillance methods (Table 1). Healthcare providers, hospitals, and laboratories play an integral role in providing influenza data, including reporting laboratory tests, participating in syndromic surveillance at hospitals, and reporting outbreaks. During the 2006-2007 influenza season, the LAC DPH ACDC used this information to publish a weekly electronic newsletter, *Influenza Watch*, created to inform health professionals of influenza activity in LAC. This report provides a brief summary of how several surveillance systems were used to characterize the 2006-2007 influenza season in LAC.

Table 1. Selected Surveillance Systems Used to Monitor Seasonal Influenza in Los Angeles County

SURVEILLANCE SYSTEM	DESCRIPTION
Positive Influenza Tests*	Seven sentinel laboratories serving L AC healthcare providers and institutions report the number of positive tests indicating influenza or respiratory syncytial virus in a weekly basis.
Severe Pediatric Influenza†	Children <18 years who are hospitalized in the Pediatric Intensive Care Unit (PICU) or die from laboratory confirmed influenza are reportable in LAC.
Emergency Department Visits**	Participating emergency departments (ED) (n=36) throughout LAC provide initial self-reported symptoms of patients presenting to the ED. Influenza-like illness (ILI) is categorized by symptoms such as: fever, congestion, sneezing, sore throat, runny nose, and cough. The proportion of ILI ED visits for all ages and for children < 6 years of age is analyzed weekly.

*** Sentinel Surveillance** – surveillance network where a sample of selected Los Angeles County hospitals and laboratories report cases

† **Population Based Surveillance (passive)**–all LAC hospitals and laboratories are required to report cases

**** Syndromic Surveillance** –surveillance using health-related data (e.g. ILI data) that precede diagnosis and signal a sufficient probability of a case or an outbreak to warrant further public health response

METHODS

A variety of surveillance systems were used to evaluate influenza activity in LAC during the 2006-2007 season, including the number of laboratory confirmed influenza tests, the number of severe pediatric influenza cases, and the percentage of patients presenting to the emergency department (ED) with symptoms of influenza-like illness (ILI) for all ages and for children five years and younger. Data from each surveillance system was analyzed by week, looking for peak activity and correlation with other systems. The influenza surveillance season begins during week 40 (usually October) of the calendar

year, continues through the end of the year (week 52), and ends during week 20 (May) of the following year. See Table 1 for a description of each surveillance system.

RESULTS

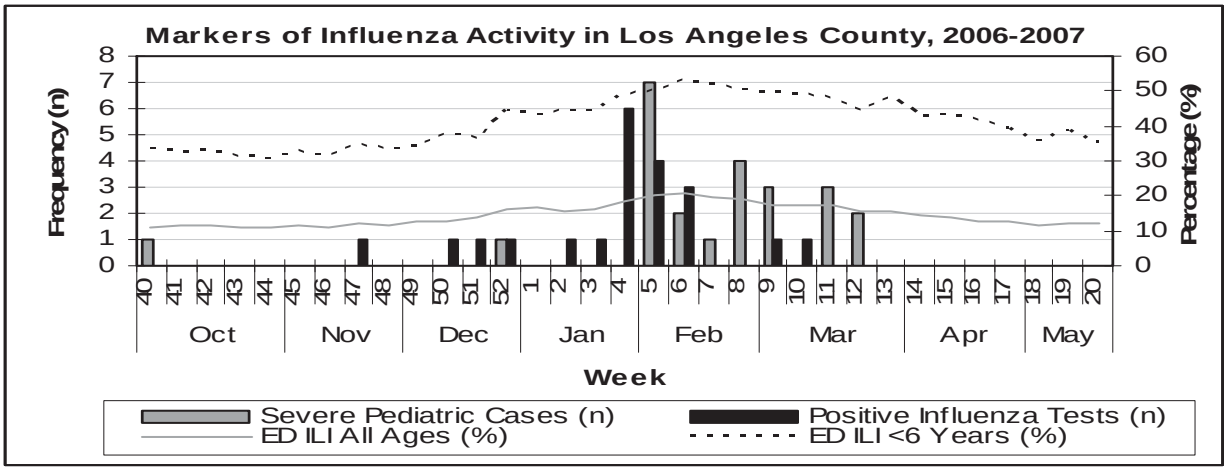
In total, sentinel sites reported 21 cases of laboratory confirmed influenza. The majority of these cases were influenza type A (91%). LAC DPH also received 24 cases of severe pediatric influenza, including one death. Laboratory-confirmed influenza cases (n=6) peaked during week four (Figure), from January 21-27, 2007. In the following week, a peak was observed in the number of severe pediatric influenza cases (n=7).

Syndromic data indicated that ILI in LAC was highest during week six (February) and remained above baseline for several weeks; especially in children aged five years and younger (Figure). ILI ranged from 11% to 21% in all ages and from 31% to 53% in children aged five years and younger.

DISCUSSION

Overall, LAC experienced a mild influenza season, consistent with state and national reports [2,3]. Each surveillance system peaked during a three-week period, from January 21 to February 10, 2007. Interestingly, laboratory-confirmed influenza from sentinel sites and severe pediatric influenza peaked before ED ILI. This was unexpected as other studies have shown that ILI in children precedes laboratory-confirmed influenza [4,5]. However, during weeks four and five, ILI was increasing in LAC (Figure).

Influenza surveillance is challenging, as individual cases are not reportable and the diagnosis is usually determined based on clinical symptoms rather than laboratory diagnosis. In addition, the severity and timing of the influenza season changes with each year. As a result, there is no “gold-standard” method of influenza surveillance and a combination of data sources are used to track influenza in LAC. Although the 2006-2007 influenza season was mild compared to previous years, all surveillance systems detected an increase in activity at approximately the same time. However, each surveillance system has distinct advantages. Laboratory-confirmed influenza verifies the clinical diagnosis and can also provide the type of influenza in circulation. Severe pediatric influenza is useful to monitor the severity of influenza each season and provides information about influenza-associated morbidity and mortality in children. Though less specific, syndromic data offers near real-time data and is useful in identifying trends from year to year. Taken as a whole, each surveillance system provides a picture of influenza activity in LAC.



To learn more about influenza in Los Angeles County, visit our dedicated website: http://lapublichealth.org/acd/Flu_Seasonal.htm. To sign up for *Influenza Watch* send an email to ListServ@ListServ.ladhs.org with SUBSCRIBE FLUWATCH in the **body** of the email, or visit http://lapublichealth.org/acd/Flu_Sea_Surveillance.htm

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