A HOSPITAL-BASED AGGREGATE REPORTING SYSTEM FOR H1N1 PANDEMIC INFLUENZA SURVEILLANCE IN LOS ANGELES COUNTY, 2009

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BACKGROUND

The standard method of conducting disease surveillance involves collecting individual case information such as name, birth date, and address. When the H1N1 influenza pandemic emerged in April 2009, this method of individual case reporting and investigation was not feasible with such a highly infectious communicable disease. Theoretically, as the Centers for Diseases Control and Prevention (CDC) and other health agencies including the California Department Public Health (CDPH) and the Los Angeles County (LAC) Department of Public Health (DPH) agreed, aggregate reporting would allow efficient monitoring of influenza morbidity and mortality. Essentially unrealized in communicable disease surveillance before April 2009, the concept of aggregate reporting is to collect counts that represent a group of individuals. This report describes how the Acute Communicable Disease Control Program (ACDC) of LAC DPH established hospital-based aggregate reporting for influenza and the results of this surveillance system.

METHODS

In order to build a surveillance system that would feed into California and the national surveillance systems for H1N1 influenza, ACDC consulted with CDC, CDPH, Colorado Department of Public Health, and Iowa Department of Public Health. Although these agencies had limited experience with aggregate reporting, they shared ideas and recommendations. Data gathering methods were developed with an objective to obtain a high participation percentage from the 102 licensed hospitals in LAC. The professional account for SurveyMonkey™ was utilized to obtain weekly data on laboratory-confirmed influenza hospitalizations and deaths as entered by hospital infection preventionists (IPs). Collected data was analyzed by SAS®, summarized, and results were sent to CDPH on a weekly basis.

The initial implementation of the aggregate reporting system faced challenges from the hospital IPs. For the period from end of July to beginning of August 2009, ACDC followed CDC and CDPH specifications for survey design and asked IPs to begin submitting weekly data such as number of influenza patients with intensive care unit (ICU) admission, non-ICU hospital admission, and death. Only two hospitals complied. Many IPs expressed that the length was too long (31 fields and 9 pages) and that there was lack of clarity and reasoning in terms of what to report and when. The IPs also felt pressured that the reports could not be late per CDPH specification. Basing the IPs' feedback, the surveillance data collection methods were revised—simplified the language, shortened the survey (23 fields and 5 pages), and established a clearer methodology of when and what to report. The fields on ICU admission were omitted. Instructions explained to report hospital admissions and deaths of all types of laboratory-confirmed influenza occurring during the designated reporting week (Sunday to Saturday) by 5:00pm the following Tuesday. Specimen collection date of the first positive laboratory influenza result and date of death defined the occurrences of laboratory-confirmed influenza hospital admissions and deaths, respectively. Rather than having IPs enter a date, a drop down menu was made to allow IPs to select the reporting week. To alleviate the pressure of timely and accurate reporting, the revised protocol allowed the IPs to update reports from past weeks and enter reports even if they were late. Eight hospitals were excluded from reporting because they were under Pasadena, Long Beach, or federal jurisdictions. Weekly rates of total hospitalizations and total deaths accounted for the size (number of licensed beds) of hospitals that reported.

The surveillance protocol was as follows. From Sunday to Tuesday, hospital IPs would report on SurveyMonkey™ the numbers of laboratory-confirmed influenza hospitalizations and deaths by age group during the previous Sunday-Saturday week. On Monday, the ACDC Epidemiology and Data Support team would identify which hospitals had not yet reported so that the ACDC Hospital Outreach Unit (HOU) would send a reminder to report by 5pm Tuesday. On Wednesday, the Epidemiology and Data Support would review SurveyMonkey™ data, identify problems such as duplicates or missing data, report numbers of hospitalizations to CDPH, and report rates (per 1000 licensed hospital beds) of influenza hospitalizations and deaths to the ACDC Hepatitis, Antimicrobial Resistance, Invasive Bacteria (HARI) Unit which was responsible for reporting all influenza surveillance results to the Disaster Operations Center and for publishing the *Influenza Watch* weekly newsletter. From Wednesday to Friday, HOU nurses would investigate reporting problems and with HOU findings Epidemiology and Data Support would correct cumulative data to produce the weekly ACDC Report on Aggregate Reporting on Influenza. Summary reports for the IPs were sent in September 16 and November 2, 2009, and January 21 and April 22, 2010 to provide feedback and encourage continuous quality in reporting.

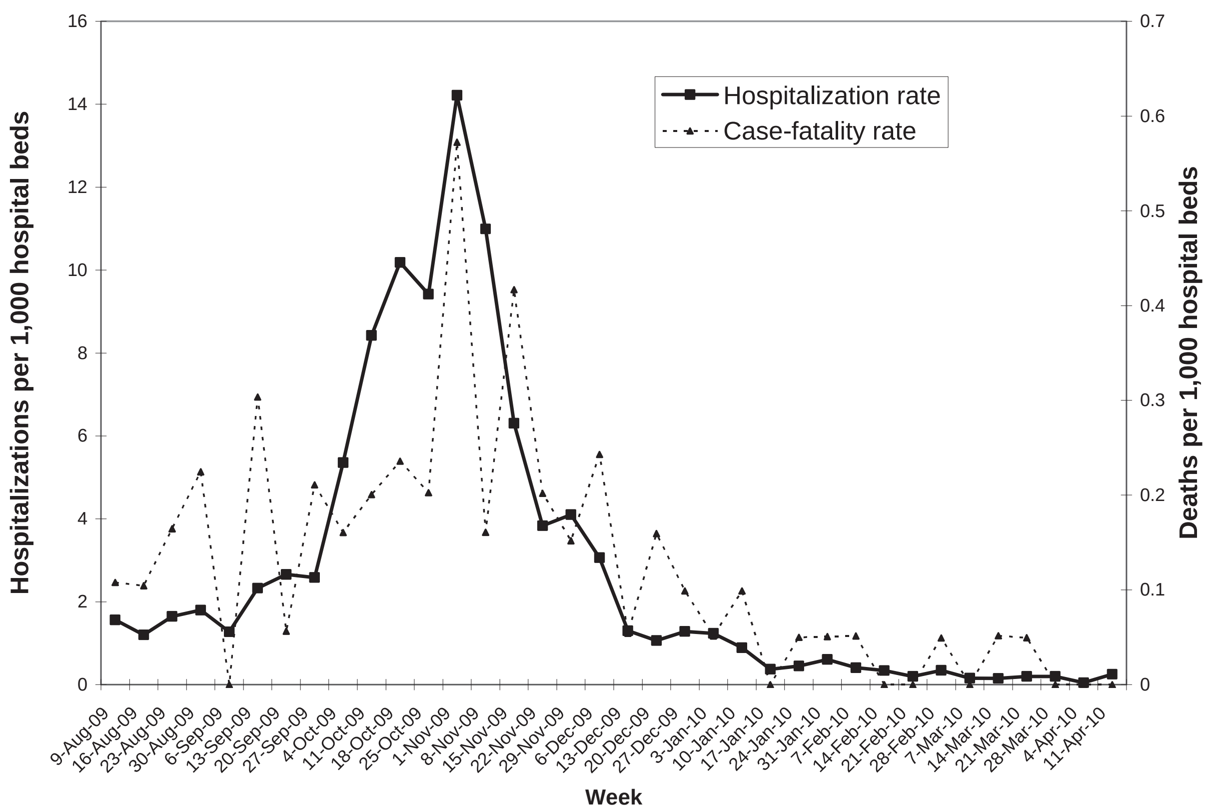
For this report, age-specific rates were calculated by using population estimates from LAC DPH. Some of the original eight age groups defined by CDC and CDPH were combined to fit denominator data for rates.

RESULTS

From August 9, 2009 to April 17, 2010, there were 1,979 hospitalizations and 88 deaths from laboratory-confirmed influenza identified by hospital-based aggregate reporting. Of the 94 acute care hospitals under LAC DPH jurisdiction, the percentage reporting averaged 71.7% per week. The number of hospitals reporting for a given week ranged from 61 to 72 (64.9%-76.6%).

Laboratory-confirmed influenza hospitalizations increased dramatically in October 2009, peaked during the week of November 1, 2009, and then drastically declined (Figure 1). The weekly number of laboratory-confirmed influenza hospitalizations ranged from one to 298. Laboratory-confirmed influenza deaths also peaked during the week of November 1, 2009 (n=12). The total number of laboratory-confirmed influenza deaths ranged from one to 12 per week.

Figure 1. Weekly number of laboratory-confirmed influenza hospitalizations (N=1,979) and deaths (n=88) per 1,000 licensed hospital beds from hospital-based aggregate reporting, Los Angeles County, CA, August 9, 2009 – April 17, 2010.



Analysis by age found that children <1 year-old had much higher hospitalization rates throughout the surveillance period (Figure 2) and the second highest case-fatality rate (Figure 3). Compared to older age groups, children aged 1-4 years had higher hospitalization rates but had the lowest case-fatality rate of all age groups (Figures 2 and 3). Despite hospitalization rates, number of hospitalizations was greatest among people aged 5-49 years-old (Figure 3).

Figure 2. Age-specific rates of laboratory-confirmed influenza hospitalizations from hospital-based aggregate reporting (N=1,979), August 9, 2009 – April 17, 2010, Los Angeles County, CA. Children less than five years old had the highest rates of hospitalization.

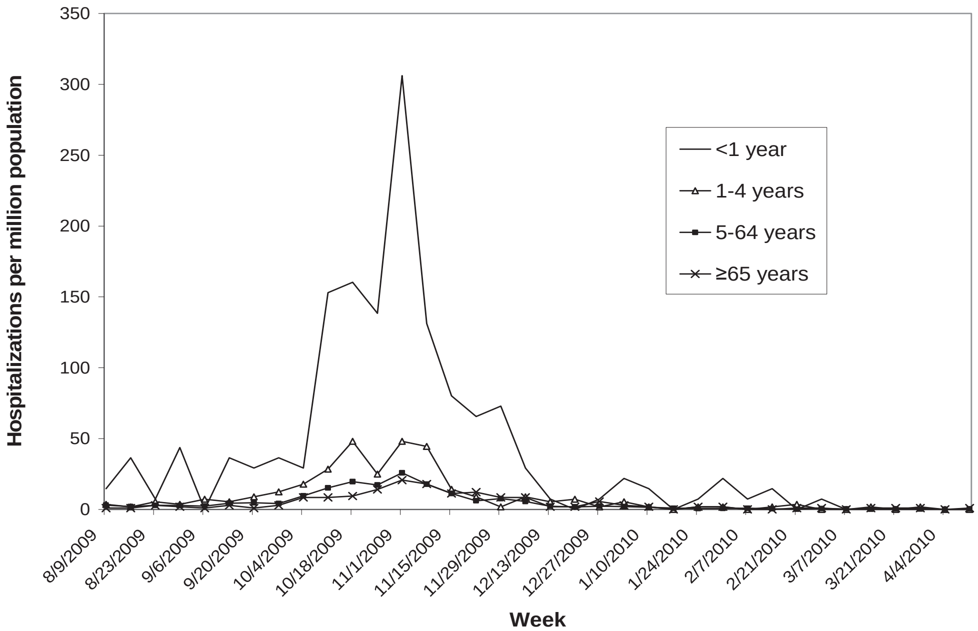
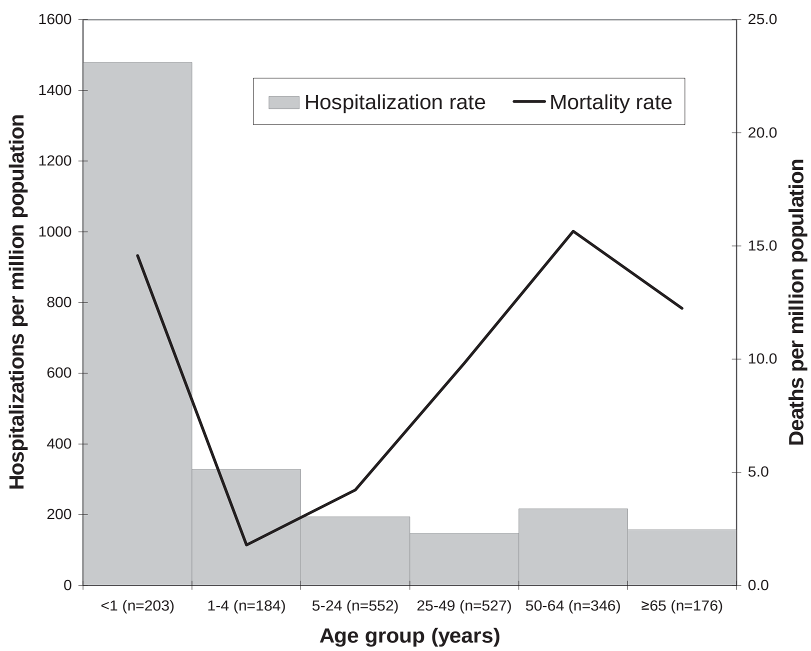


Figure 3. Age-specific rates of laboratory-confirmed influenza hospitalizations and deaths from hospital-based aggregate reporting (N=1,979), August 9, 2009 – April 17, 2010, Los Angeles County, CA. Age group 25-49 years had the lowest hospitalization rate (147.8 influenza hospitalizations per million population) and age groups 50-64 years and <1 year had the highest case-fatality rates (15.7 and 14.6 deaths per million population, respectively). Age group 5-24 years had the most influenza hospitalizations.



Differences between the data reported to CDPH, which represents the initial reports without de-duplication or correction of designated reporting week, and the data used by LAC, which represents updated data after HOU investigations, were greatest during the rise of influenza cases that started in September (the weeks of September 6 – October 11), the week after the peak occurred (November 8), and on the week of November 29, 2009 (Figure 4). The LA County method of allowing corrections and updating by reporting hospital IPs provided a more accurate measurement of the influenza outbreak. From September 6 to October 11, the LA County method showed consecutively greater numbers of 12, 13, 20, 20, 34, and 41 (32-100%) more hospitalizations than initially reported. For the week of November 8, following the influenza peak, the LA County method found 22 (12%) more hospitalized cases. For the week of November 29, the LA County method had 39 less cases than initially reported. A possible explanation for this is the rise in influenza cases presented in the November 2nd summary report to the IPs. After the summary report, previously non-reporting hospitals started reporting and some submitted data for multiple weeks. Providing greater flexibility for IPs, the LA County method found 99 (5.3%) more cases of laboratory-confirmed hospitalized influenza.

Figure 4. Numbers of laboratory-confirmed hospitalized influenza cases from hospital-based aggregate reporting by method of reporting: California State method which lacks de-duplication or corrections (N=1,880) versus Los Angeles County method which allows for updating and corrections (N=1,979), Los Angeles County, CA, August 9, 2009 – April 17, 2010.

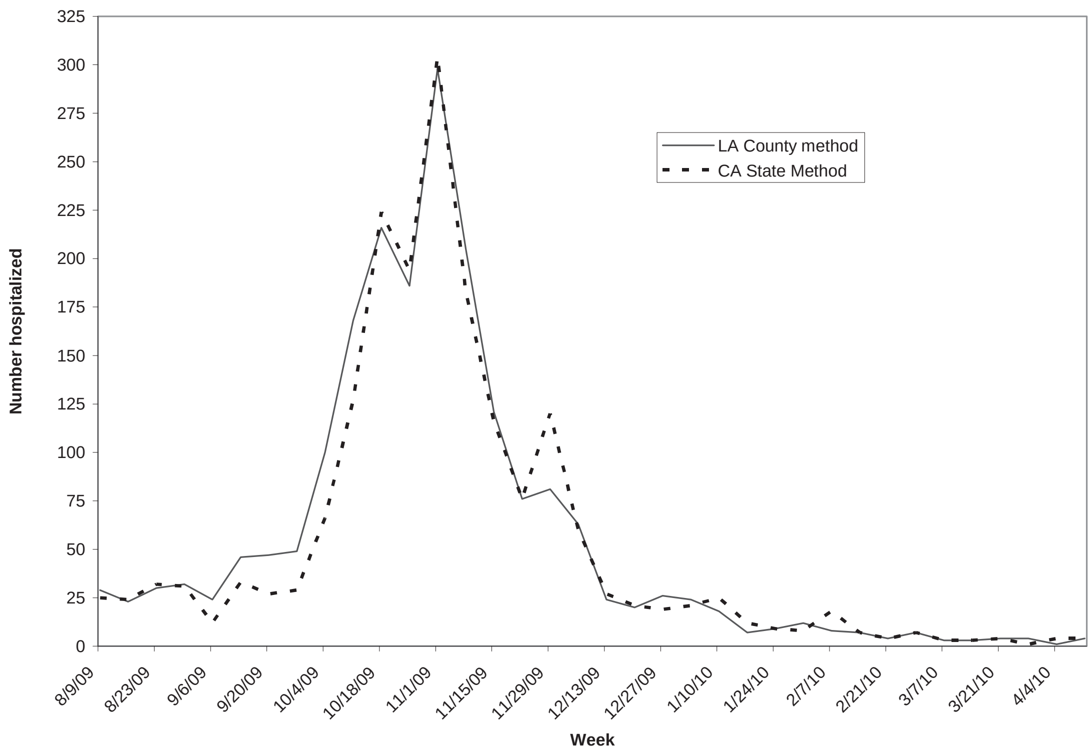
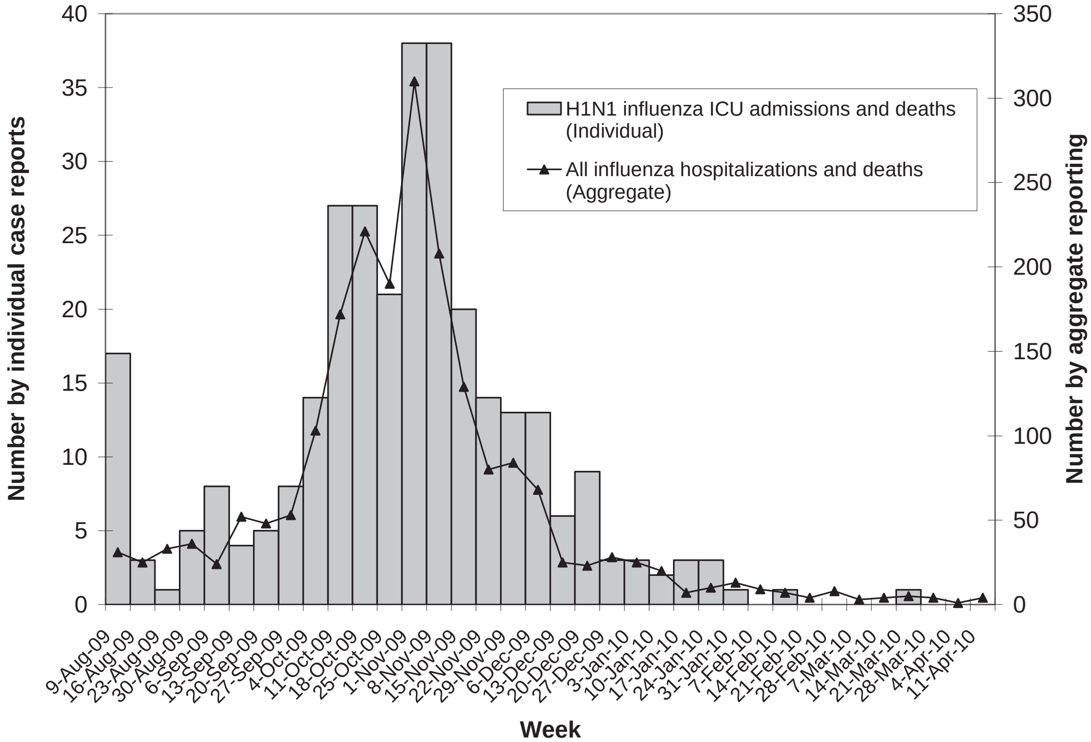


Figure 5. Similar epi-curves for number of pandemic H1N1 influenza Intensive Care Unit (ICU) admissions and deaths from individual case reporting (N=308) and for number of hospitalizations and deaths of all types of laboratory confirmed influenza cases from hospital-based aggregate reporting (N=2067), August 9, 2009 – April 17, 2010, Los Angeles County, CA.



DISCUSSION

ACDC successfully developed a hospital-based aggregate reporting system and conducted population-based active surveillance of influenza during the H1N1 influenza pandemic of 2009-2010. The most important key to the success of this surveillance was its acceptance by the IPs. Understanding their concerns from the first attempt in aggregate reporting and making a clear methodology for IPs and LAC DPH staff to follow helped establish a sustainable high participation percentage of 65%-77% of all 94 non-federal hospitals in LAC DPH jurisdiction on a weekly basis.

Other marks of success of the aggregate reporting system include specificity, sensitivity, accuracy, and adaptability of the surveillance system. In July 2009, CDC gave surveillance options of influenza-like illness or laboratory-confirmed influenza. Having chosen the latter, ACDC prevented the inclusion of other respiratory diseases in their surveillance and afforded greater specificity. While the epi-curves for influenza hospitalizations were similar between the CDPH method and the LAC method (Figure 4), the LAC method found 5.3% more hospitalizations and provided greater sensitivity, particularly during the increase of cases in September and October and during the week after the peak. There is no gold standard to measure the accuracy of the aggregate reporting surveillance system. However, based on data from the ACDC HARI Unit, the epi-curve for H1N1 influenza deaths and ICU admissions from individual case reporting is similar to that of all influenza hospitalizations and deaths from aggregate reporting (Figure 5). Finally, after the surveillance methodology was established, a weekly report for the Disaster Operations Center was imposed in the fall of 2009. Adaptations to meet this demand involved including more staff and minor changes to the protocol.

Aggregate reporting for communicable disease involving so many hospitals and such a large population of approximately 10 million was an unfamiliar and most likely untried idea before August 2009. Much of the concern for CDC and CDPH involved what data elements to obtain. In the second attempt to make the system work, ACDC actually dropped data elements requested by CDPH and CDC and focused on making an easy, streamlined process that would be minimally burdensome on IPs. In addition, ACDC put as much emphasis in analysis procedures so that updating, correcting initial reports, and quickly presenting weekly summaries would be possible and more accurate in measuring influenza morbidity and mortality. ACDC insisted on defining Sunday to Saturday reporting weeks as opposed to Tuesday to Tuesday weeks proposed by CDPH. As CDPH requested weekly counts of hospitalizations by noon on Wednesdays, the Sunday-to-Saturday week allowed some time to correct duplication and mistakes on reports submitted before Tuesday. After August 2009, ACDC was contacted by CDPH and individuals at different county health departments in California to describe and consult on influenza aggregate reporting.

The influenza aggregate reporting system stopped on April 17, 2010 as the number of hospitalizations and deaths had continually been low since last January 2010 and the H1N1 pandemic emerged in April 2009. To monitor for resurgence in 2010-2011, ACDC may implement a hospital-based aggregate reporting surveillance system using sentinel hospitals that consistently reported, had the highest numbers of hospitalizations and deaths of laboratory-confirmed influenza, and represent a relatively wider geographic area of LAC.

CHARACTERIZATION OF HOSPITALIZED PANDEMIC H1N1 2009 INFLUENZA CASES, LOS ANGELES COUNTY, APRIL 24, 2009 – AUGUST 3, 2009

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BACKGROUND

The influenza virus is an enveloped RNA virus that spreads easily from person to person via respiratory droplet secretions.[1] It causes an acute viral illness characterized by fever, muscle and joint pain, malaise, sore throat and runny nose.[2] Severe outcomes, including pneumonia, secondary bacterial infections and death, occur predominantly in children under age 2, adults over age 65, persons with chronic heart, lung, kidney, liver or metabolic disorders, or weakened immune systems.[2] The virus circulates throughout the world with seasonal increases during winter months; in Los Angeles County, flu season is typically between October and April with activity peaking around February.[3] Prior to April 2009, only severe pediatric cases of influenza were reportable to the local public health department.

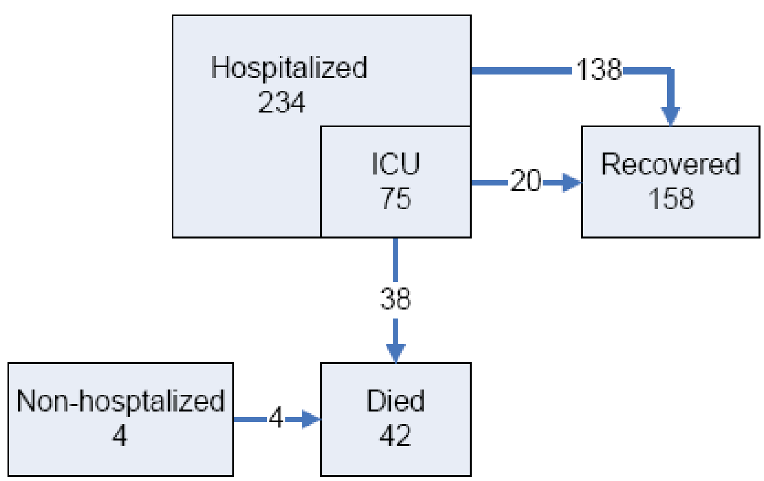
In April of 2009, reports from Mexico indicated the emergence of a novel influenza virus strain causing severe morbidity and mortality.[4] Two weeks later, the first two cases of pandemic influenza were identified in California[5] and, at the end of April, the US Secretary of the Department of Health and Human Services declared an emergency. At that time, the Los Angeles County (LAC) Department of Public Health (DPH) moved into Incident Command Structure to respond to the potential pandemic. Seasonal influenza surveillance systems were enhanced, new influenza case definitions were developed and influenza reporting requirements were amended to include reporting of all hospitalized patients with influenza or patients who died of influenza. This report summarizes hospitalized/deceased pandemic H1N1influenza (pH1N1) cases with symptom onset between April 24, 2009, when the reporting requirements went into effect, and August 3, 2009, after which time only ICU cases or deaths were individually reportable. These cases represent a novel cohort of patients seeking care for influenza far outside the regular influenza season and during the early stages of a pandemic; their disease severity and utilization of health care resources are instructive in assessing the response of the public health system with respect to case surveillance and detection and in planning for future pandemic events.

METHODS

A case was defined as any person who died or was hospitalized with influenza-like-illness who either had a positive influenza A test which was not subtypeable or who had a confirmed positive test for pH1N1 with onset between April 24, 2009 and August 3, 2009.

Cases were reported to LAC DPH Acute Communicable Disease Control Program by hospital infection preventionists, by the Public Health Laboratory, by the Office of the Coroner, and by other local health departments. Once reported, data were abstracted from case medical records using the LAC case report form.

Figure 1: Required Level of Care and Outcomes of All Reported Hospitalized Cases of Pandemic (H1N1) 2009 Influenza, April 24, 2009 - August 3, 2009, Los Angeles County.



Note: There are 38 cases with unknown outcomes

All case data were stored in a Microsoft® Office Access 2003 database and summarized and analyzed using SAS v9.2.

RESULTS

From detection of the first case of pH1N1 in LAC on April, 24, 2009 until August 3, 2009, 238 pH1N1 hospitalized/deceased cases were reported to LAC DPH (see Figure 1). Of the 234 hospitalized cases, 75 were hospitalized in the ICU. Outcomes were available for 200 (84%) of the reported cases. One hundred and fifty-eight of reported cases recovered while 42 died. Thirty-eight of the 42 deaths (90.5%) had been hospitalized in the ICU prior to death. Of cases hospitalized in the ICU with known outcomes, 38 (50.7%) died while 20 (26.7%) recovered. Four cases died without having been hospitalized prior to death (Figure 1). The overall rate of hospitalization due to pH1N1 during this time period was 2.44 per 100,000.

Table 1: Characteristics of Hospitalized pH1N1 Cases Los Angeles County, 04/23/2009 - 08/06/2009

		Number	% of Cases	% of LAC*
Age Group				
	0-4	60	25.2	7.2
	5-24	75	31.5	29.5
	25-49	68	28.6	37.1
	50-64	30	12.6	15.8
	65+	5	2.1	10.4
Race				
	Asian	10	4.9	13.3
	Black	18	8.7	8.8
	Latino	131	63.6	47.9
	White	40	19.4	29.8
	Other	7	3.4	0.3
Gender				
	Male	125	52.7	49.6
	Female	112	47.3	50.4

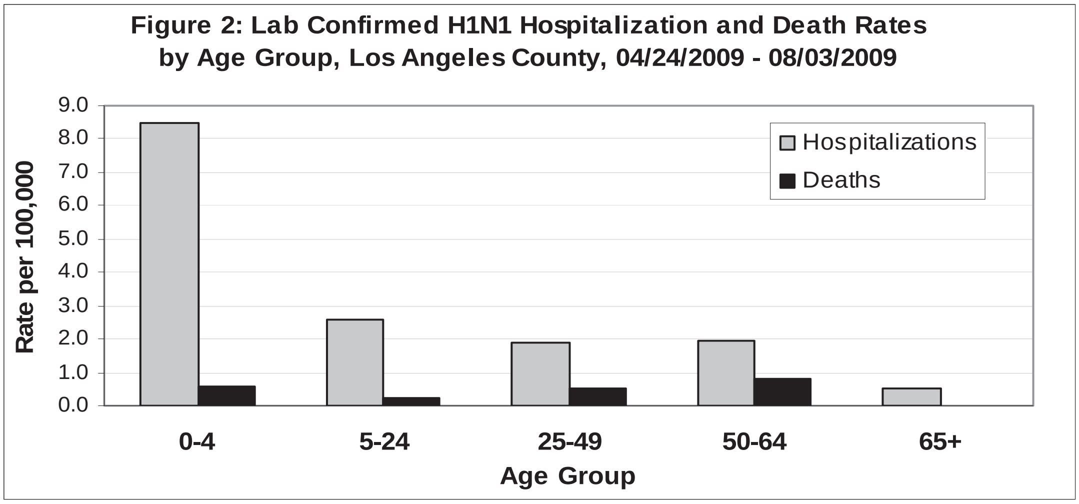
*The % of the population of LAC in specified demographic group

Age

The age of hospitalized cases ranged from 0-84 years with a median of 21.5 years. The age of fatal cases ranged from 0-62 with a median of 38.5 years. Persons aged less than 25 years (especially those aged 0-4 years) were overrepresented among cases when compared to the population distribution of LAC (Table 1). Persons aged 25 years and older (especially those aged 65 years and older) were underrepresented among cases (Table 1). The rate of hospitalization was highest in the 0-4 age group at 8.5 per 100,000 and lowest in persons aged 65 and older at 0.49 per 100,000 (Figure 2). The death rate due to H1N1 was highest among persons aged 50-64 years at 0.8 per 100,000 and lowest among persons aged 65 years and older in which group there were no deaths (Figure 2).

Race

Latinos constitute 47.9% of the population of LAC, however, they comprise 63.6% of cases. While Latinos were overrepresented among cases, Asians and whites were underrepresented (Table 1). The highest rate of hospitalization was seen among Latinos followed by blacks and then whites. Asians had the lowest rate of hospitalization (Figure 3).

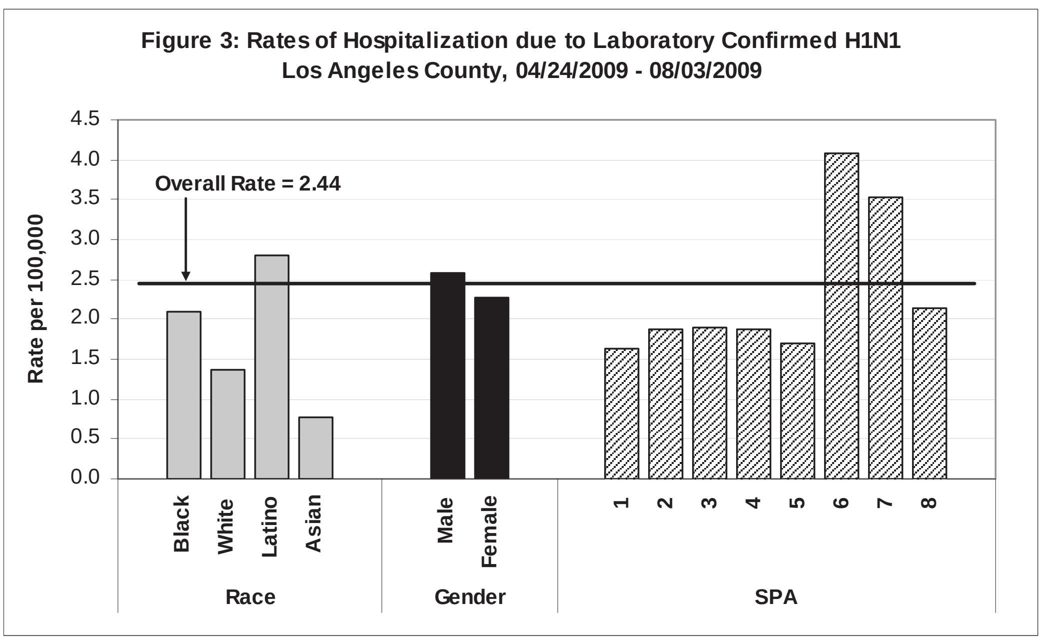


Gender

Approximately 53% of the cases were male while 47% were female (Table 1). The rate of hospitalization was 2.6 per 100,000 among men and 2.3 per 100,000 among women (Figure 3).

Location

The highest rate of hospitalization due to pH1N1 occurred in Service Planning Area (SPA) 6, followed by SPA 7 and SPA 8. The rates of hospitalization in SPAs 1-5 were well below the rate of hospitalization for all of Los Angeles County (Figure 3).



Underlying Medical Conditions

Among children less than 18 years old hospitalized with pH1N1, 60.2% (54) had at least one underlying medical condition, with chronic lung conditions being the most frequently cited conditions followed by developmental delay. Among adults 18 years of age or older hospitalized with pH1N1, 85.5% (118) had at least one underlying condition with obesity (body mass index ≥30) being the most frequently cited condition followed by metabolic disorders, pregnancy, and chronic lung and cardiac conditions (Table 2).

Table 2: Underlying Medical Conditions of Hospitalized pH1N1 Cases 04/24/2009 - 08/03/2009

	<18 years (n=93)			≥18 years (n=139)		
Underlying Condition	N*	#	%**	N*	#	%**
Cardiac condition	92	7	7.6	136	27	19.9
Chronic lung condition	92	33	35.9	137	31	22.6
Metabolic disorder	93	9	9.7	136	36	26.5
Developmental delay	93	22	23.7	136	8	5.9
Immunosuppression	93	6	6.7	135	15	11.1
Pregnancy†	5	1	20.0	88	23	26.1
Obesity	34‡	2	5.9	127	54	42.5

*Denominator includes those cases for which information on that underlying condition was available.
**As patients may have more than one medical condition, percentages may total over 100%.
†Denominator includes females of childbearing age only (15-44 years).
‡ Denominator includes only children aged 2-17 years.

DISCUSSION

Unlike seasonal influenza which disproportionately causes serious disease in the elderly and young children[3], pH1N1 influenza predominantly affected children of all ages and young adults. Approximately 57% of hospitalized pH1N1 cases were younger than 25 years. The hospitalization rate among children aged 0-4 years was 17.3 times higher than that among persons aged 65 years and older. However, the death rate in this age group was comparable to other age groups. While these differences could be due to true differences in susceptibility to pH1N1, it is likely that children under the age of 5 may have been admitted to the hospital more readily than older cases or that older cases may have delayed seeking care until illness was severe. These differences in treatment and care seeking behavior could have led to selection bias resulting in higher numbers of pediatric hospitalizations and adult deaths.

The pH1N1 hospitalization rate was highest for Latinos and lowest for Asians. While the rates in Figure 3 are not age-adjusted due to small numbers, analysis of more robust data on pH1N1 ICU admissions and deaths reveals little difference between un-age-adjusted and age-adjusted rates for all races. The differences in rates by race could be explained by several factors including differences in access to health care, treatment-seeking behavior, cultural and social behavior, knowledge of respiratory disease prevention, and prevalence of underlying medical conditions.

SPAs 6 and 7 had substantially higher rates of hospitalization due to pH1N1 compared to other SPAs. These two SPAs have the highest percentage of Latinos of all the SPAs in LAC. Latinos make up 63.7% of the population of SPA 6 and 70.5% of the population of SPA 7. SPAs 1 and 5 where pH1N1 hospitalization rates were lowest have the lowest percentage of Latinos of all SPAs (18.1% and 17.5% respectively). The high rates in SPAs 6 and 7 were most likely due to the high proportion of Latinos residing there. However differential testing or reporting practices by hospitals may have played a role if hospitals in certain SPAs were more or less likely to obtain specific influenza testing or to report cases.

Underlying medical conditions were a significant factor in both child and adult hospitalized cases of pH1N1. Of all children under 18 years old for which past medical history was known, 54 (60.2%) had a past medical history. The most frequently cited risk factors for hospitalization among patients under the age of 18 years were chronic lung conditions (including asthma, chronic lung disease, and cystic fibrosis) and developmental disability (including neuromuscular disorders, mental retardation, and seizure disorders). Of 138 patients aged 18 years and older for which past medical history was known, 118 (85.5%) had some kind of underlying condition. The most frequently cited underlying condition for adults was obesity. While 22.2% of LAC adults are obese, 42.5% of hospitalized pH1N1 cases with height and weight information were obese. Seventeen (31.5%) of the 54 obese adult patients had obesity as the only underlying medical condition while thirty-six (67%) had at least one additional concurrent medical condition. (Information on additional underlying conditions was not available for one obese case). This raises the question whether obesity in and of itself is a significant risk factor for complications from pH1N1 infection.Metabolic disorders, pregnancy, chronic lung conditions, and cardiac conditions were also prominent risk factors for adults. Chronic lung conditions were present in both children and adults suggesting compromised lungs are a risk factor for more severe infection with pH1N1 at any age. Obesity was the most common underlying condition present in adults but the least common in children suggesting that adult obesity may indicate greater risk for more severe infection with pH1N1. However, obesity data were missing from a large proportion of child cases. Obesity data may be reported less frequently for children indicating a gap in knowledge for this potential risk group. Among women of child bearing age (15-44 years), pregnancy was a frequent underlying condition for both children (15-17 years) and adults (18 years and older) in hospitalized cases. Others have reported on a high morbidity of pH1N1 in pregnancy[6] and this is consistent with published literature which indicates pregnant women experience significant morbidity from influenza and so should be an important target group for prevention and vaccination.[7]

CONCLUSION

We present 238 hospitalized cases of pandemic H1N1 2009 influenza reported between symptom onset of the first case detected in Los Angeles County on April 24, 2009 and when hospitalized cases were no longer reportable on August 3, 2009. Hospitalized cases appeared to be younger than cases of seasonal influenza while death rates across all age groups were comparable. Latinos were disproportionately affected with the largest proportion of cases and highest rates with blacks having the second highest rates. The geographic distribution of cases appeared to follow racial distributions within LAC which has implications for resource distribution and health care utilization patterns, however, differences in reporting of cases between areas of LAC may have affected this observation. Presence of an underlying health condition was an important factor in disease severity in both child and adult hospitalized cases. Presence of obesity, various chronic lung conditions, metabolic disorders and cardiac conditions in adults, presence of chronic lung conditions and developmental delay in children, and pregnancy in women of childbearing age should all be considered when evaluating a case of pH1N1 as they are predictors of a more severe outcome.

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Los Angeles County Acute Communicable Disease Control Influenza Watch Publications
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PRE-SYMPTOMATIC HEALTHCARE WORKER TRANSMISSION OF PANDEMIC (H1N1) 2009 INFLUENZA IN ACUTE CARE SETTINGS LOS ANGELES, CALIFORNIA, 2009

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BACKGROUND

Nosocomial transmission of seasonal influenza resulting in outbreaks in healthcare settings has been previously documented in the literature [1]. Asymptomatic or pre-symptomatic transmission of influenza is not well understood [2]; however, it is believed to be possible and thus a concern in healthcare settings. Pandemic H1N1 influenza (pH1N1) was first seen in Los Angeles County in April of 2009. Los Angeles County (LAC) Department of Public Health (DPH) investigated outbreaks in two acute care facilities where it was hypothesized that influenza transmission occurred during the pre-symptomatic infectious period from a healthcare worker (HCW) to patients. Both outbreaks occurred in units with immunocompromised patients where HCWs are required to have higher skill competencies. In each situation, contact between a HCW and the index patient took place before the HCW's symptom onset. According to the investigations, ill HCWs were not at their workplace while symptomatic. This report describes these two outbreaks, which occurred during a pandemic prior to vaccine availability.

METHODS AND RESULTS

Outbreak A

The first influenza outbreak occurred in July 2009 on the hematology-oncology unit of facility A. The infection preventionist (IP) at the facility notified DPH of two cases of pH1N1 influenza on the same unit within five days of each other. A case was defined as a patient residing in the hematology-oncology unit who was positive for pH1N1 influenza via real-time reverse transcriptase polymerase chain reaction (rRT-PCR). Both cases were recently diagnosed leukemia patients who resided in adjacent rooms on the same unit and were admitted for chemotherapy treatment. Case 1 was admitted to the facility 27 days prior to symptom onset, and Case 2 was admitted seven days prior to symptom onset (Table 1). Interviews with facility staff revealed one symptomatic HCW (HCW 1) who had onset of influenza-like illness (ILI) the same day as Case 1. HCW 1 provided direct care to Case 1 for three days prior to Case 1 onset. Indirect contact occurred between both cases through the mother of Case 2, who had contact with the mother of Case 1 and would visit with Case 1 in their room while Case 1 was in isolation. Nursing staff believed the mother of Case 2 could be the source of transmission between Cases 1 and 2. No clinical information was available on the mother. Case 2 developed ILI five days after Case 1; HCW 1 did not have direct contact with Case 2. Neither case was exposed to any other known symptomatic or pre-symptomatic visitors or staff.

Late in the investigation another case was identified, Case 0, who had been admitted to the facility with ILI seven days prior to the onset of illness in HCW 1. HCW 1 provided primary care to Case 0 for several days prior to HCW 1 symptom onset; HCW 1 could have contracted influenza from Case 0. HCW 1 was clinically diagnosed with influenza by an outside provider; no specimen was obtained for testing. No contact between HCW 1 and any patients occurred while HCW 1 was symptomatic. HCW 1 did not return to the workplace until symptoms resolved and completely treated with oseltamivir. Respiratory distress required all three case patients be transferred to the pediatric intensive care unit (PICU) for further care, where all were treated with oseltamivir. All cases subsequently expired in the PICU from complications of influenza.

Table 1. Case Characteristics for Facility A Outbreak.			
	Case 0	**Case 1**	**Case 2**
Age	8 years	15 months	3 years
Underlying chronic condition	Chronic Langerhans histiocytosis	Down syndrome/ Acute myelogenous leukemia	Down syndrome/ Acute myelogenous leukemia
Admission diagnosis	Fever/neutropenia	Chemotherapy treatment	Chemotherapy treatment
Days in facility prior to onset	0	27	7
Symptoms:			
Cough	Yes	Yes	Yes
Fever	Yes	Yes	Yes
Respiratory distress	Yes	Yes	Yes
Diarrhea	Yes	Yes	Yes
Vomiting	No	Yes	No

Outbreak B

A second H1N1 influenza outbreak was investigated in October 2009 in the neonatal intensive care unit (NICU) of facility B. The IP notified DPH of one infant symptomatic with ILI and two infants with non-specific symptoms, all in the NICU within a 24 hour period (Table 2). Two infants were rRT-PCR positive for pH1N1, the third was antigen positive for influenza A. A case was defined as a patient residing in the NICU who was positive for pH1N1 via rRT-PCR. Facility B has a strictly enforced visitor policy excluding sick visitors from the NICU; there were no known ill visitors. Prior to the outbreak, roll calls to assess HCWs for ILI were implemented in the NICU and maternity unit. Interviews with NICU staff revealed four HCWs who cared for the three cases who subsequently became ill. The index HCW (HCW 1) cared for index Case 1 and Case 2 during the two days prior to onset of ILI. This HCW experienced a mildly achy prodrome at the end of the shift on the second day and did not return to work the next day. She reported having fever during the course of illness.

Table 2. Case Characteristics for Facility B Outbreak.			
	Case 1	**Case 2**	**Case 3**
Gestational age (weeks)*	37	27	32
APGAR scoreº	7, 8, N/A	5, 6, 9	8, 9, N/A
Underlying medical condition	Gastroschisis	Respiratory distress	Respiratory distress
Ventilator dependent	Yes	Yes	Yes
Days in NICU prior to onset	148	125	44
Symptoms:			
Cough	No	Yes	No
Fever	Yes	No	No
Increased secretions	No	Yes	Yes
Vomiting	Yes	No	Yes
Poor feeding	Yes	Yes	Yes

ºAt one, five and ten minutes

HCWs 2, 3, and 4, became symptomatic with ILI within 1-2 days after HCW 1. HCW 2 provided care to Case 1 and 2 while pre-symptomatic; HCWs 3 and 4 provided care to Case 3 while pre-symptomatic. No HCWs cared for patients while symptomatic. None of the ill HCWs was tested for influenza by facility B or their primary medical doctors. All infants and healthcare workers recovered from their illness.

DISCUSSION

Vaccination continues to be the primary method to prevent influenza infection and transmission each season [3]. Exposure of HCWs to ill patients, as well as the exposure of vulnerable patients to ill HCWs, is an occupational hazard that can be greatly reduced via influenza vaccination each season [4]. Despite this, seasonal influenza vaccination rates among HCWs remain below 40% worldwide [4]. The ability to transmit influenza to others while pre-symptomatic or asymptomatic may contribute to viral transmission in healthcare settings. As many as 50% of individuals have asymptomatic influenza infection or have mild symptoms; studies have shown approximately 20% of unvaccinated adults have serological evidence of infection each winter [5]. In addition, HCWs are apt to work while symptomatic, becoming a potential source of infection for patients and coworkers [3]. Influenza vaccination also prevents workplace disruption and staffing issues by limiting the number of HCWs out of work due to illness [6]. The beneficial effects of HCW vaccination on patient morbidity and mortality have a larger effect when the employee vaccination rate in facilities exceeds 50% [5]. The Centers for Disease Control and Prevention recommends a target rate for HCW compliance with vaccination of 80% [7]. Increased numbers of vaccinated HCWs contribute to herd immunity that protects unvaccinated HCWs and vulnerable high risk individuals treated in healthcare settings.

California enacted legislation in 2007 that requires all general acute care hospitals to provide on-site influenza vaccination to employees at no cost to the employees. It also requires reporting of the numbers employees vaccinated as well as the number of documented vaccination declinations. During the pandemic this regulation was interpreted to cover the new H1N1 vaccine.

Unfortunately, the H1N1 vaccine was not available at the time of these outbreaks. Neither investigation showed any significant lapses in infection control. Both outbreaks demonstrate the possible transmission of influenza from pre-symptomatic HCWs and highlight that enhanced respiratory and hand hygiene is critical for HCWs in high-risk patient settings, especially during a pandemic in the absence of an effective vaccine.

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RAPID ASSESSMENT OF PUBLIC KNOWLEDGE AND ATTITUDES ABOUT LIVE ATTENUATED INFLUENZA VACCINE (LAIV) AT MASS H1N1 INFLUENZA VACCINATION CLINICS

Caitlin Reed, MD, MPH; Amy Lightstone, MPH; Susie Baldwin, MD, MPH; David Dassey, MD, MPH; Laurene Mascola, MD, MPH

BACKGROUND

At Los Angeles County (LAC) Department of Public Health (DPH) pandemic H1N1 vaccination clinics in 2009, uptake of nasally-administered live attenuated influenza vaccine (LAIV) was lower than expected. At the first mass H1N1 vaccination clinics (aka Point of Dispensing clinics, PODs) 77% of the available injected monovalent vaccine (IMV) doses were used, in comparison of only 31% of LAIV. LAIV production may be more rapid and may produced higher yields compared with IMV, resulting in greater LAIV availability early in pandemics. A rapid assessment was performed to determine why LAIV uptake was low in the setting of an overall H1N1 vaccine shortage, and what interventions might improve LAIV uptake.

Initially, LACDPH H1N1 vaccination clinics were targeted at persons in the following five priority groups:

1. children and young adults aged 6 months to 24 years
2. pregnant women
3. caregivers of infants aged <6 months
4. persons aged 25-64 years with chronic medical conditions
5. health care workers.

Certain of these groups have contraindications to receiving LAIV, including persons aged <2 years and >49 years, pregnant women, and persons with chronic medical conditions such as asthma, diabetes, and HIV. For this reason, children ages < 2 years in group 1 and all persons in groups 2 and 4 were offered only injected vaccine. However, persons in LAC DPH vaccine clinic priority groups 1 (except for children aged <2 years), 3, and 5 were eligible to be vaccinated with LAIV. Although these persons were eligible, poor uptake of LAIV was noted. The anecdotal impression of clinic staff was that parents and persons seeking to be vaccinated preferred IMV, even when eligible for LAIV.

METHODS

Formative Research

LAC DPH Acute Communicable Disease Control Program (ACDC) conducted formative research by briefly interviewing persons standing in line at two mass H1N1 vaccination clinics regarding LAIV and IMV and observing the flow of patients through the vaccine clinic.

1) Several themes emerged from these interviews:

- some people had never heard of the nasal spray live attenuated influenza vaccine (LAIV),
- many people had heard of LAIV, but most did not know much about it,
- some knew that the nasal spray was a live virus and the injection (flu shot) was inactivated virus, but did not know what the significance of live versus dead virus was,
- common misperceptions among those who knew about LAIV were that 1) it doesn't work as well as the flu shot 2) it is only for children and 3) that because it is a live virus it could possibly make you sick,
- another common concern was that live virus shedding from LAIV could make others sick
- people felt more comfortable with the familiar injectable flu shot
- some people preferred LAIV if they had the choice because they are afraid of needles
- other people preferred a flu shot because they don't like having things sprayed in their nose

2) Observations of patient flow through H1N1 clinics

Observations noted busy clerical staff at the outdoor check-in tables with multiple demands on their attention. In this setting, there were some errors made in determining which persons should be offered LAIV. For example, a registration worker thought that children > 2 years old who are in childcare should not receive LAIV because of a possible risk of transmission of vaccine virus to other children at the childcare center. Clinical personnel were stationed inside the hall and were unable to observe these types of screening decisions occurring at the outdoor registration area. Both clinical and clerical personnel stated that although they had completed training modules, the guidelines for LAIV eligibility were confusing, particularly since persons eligible for LAIV were only a subset of the priority groups for influenza vaccination.

Survey

A survey was designed to assess public knowledge and attitudes toward LAIV, in collaboration with colleagues at the LAC DPH Health Assessment Unit. The following data were collected: basic demographic information, including age, sex, race/ethnicity, educational level, language group, household size and income, usual source of H1N1 vaccine information, most trusted source of vaccine information, and a series of true/false and yes/no knowledge and attitude questions about LAIV and IM vaccine (see Figure 1).

Figure 1. Knowledge and Attitude Questions from Survey

True-False Questions

The H1N1 vaccine is available in a nasal spray **(True/False/Don't Know)**

The H1N1 nasal spray vaccine: **(True/False/Don't Know for each prompt)**

- contains live weakened virus
- is OK for everyone to get
- is as good as the shot in preventing flu
- could give me the flu
- could make my friends or family get the flu

Yes or No Questions

I am more comfortable getting vaccines in the form a shot than a nasal spray
I am afraid of live vaccines
I am afraid of shots
I do not like having something sprayed in my nose

Vaccine Preference Question

If I could choose which type of H1N1 vaccine to get, I would choose the (choose one):
Nasal spray/Shot/Whatever the doctor recommends/Don't know

The survey was conducted as a convenience sample (N=326) in English and Spanish of persons aged ≥18 years at four mass H1N1 vaccination clinics from November 11-14, 2009. People waiting in line to be vaccinated were given a paper-and-pencil survey prior to reaching the registration tables at the front of the line, where surveys were collected. Low LAIV knowledge scores was defined as two or fewer correct answers to four true/false questions (mean correct: 2.3 ± 1.4; median: 2). Chi-square was used to compare knowledge by age, sex, race, and education.

RESULTS

Demographics

A slight majority of respondents (54%) were female. Age distribution was fairly even (see Table 1) among persons aged <65 years. Educational levels in the surveyed group included elementary school only (6%), some high school (9%), high school graduate (18%), some college (24%), college graduate (28%), and advanced degrees (15%). A wide range of income levels were also represented, with 33% reporting < $25,000 in total household income, while 25% reported > $100,000. Fifty-eight percent of respondents were born in the United States. English was the primary home language in 66% of households, Spanish in 24%, and other languages 6%.

Table 1. Demographics of survey respondents (N=326)

	No. respondents	%
Sex	318	
Male	147	46
Female	171	**54**
Age (years)	326	
18–29	51	16
30–39	87	**27**
40–49	87	**27**
50–65	82	25
> 65	19	6
Education	323	
Elementary school	18	6
Some high school	30	9
High school graduate	59	18
Some college	77	24
College graduate	90	**28**
Advanced degree	49	15
Total Household income	297	
< $25,000	100	**34**
$25,000-$50,000	61	21
$50,000-$100,000	61	21
> $100,000	75	25
US born		
Yes	185	**57**
No	138	43
Primary language at home	313	
English	206	**66**
Spanish	75	24
Other	30	10

The racial/ethnic distribution of respondents is shown in Table 2. There were more Asians represented in this survey and among POD attendees, and fewer Hispanic survey respondents and POD attendees, than in LAC as a whole. Blacks were better represented in the survey (11%) than their overall attendance at the PODs (3%). Whites were overrepresented in the survey (34%) compared with their POD attendance (19%) or proportion of the LAC population.

Table 2. Distribution of race/ethnicity in survey respondents compared with overall POD attendees and LAC population overall

	Survey (%)	POD attendees† (%)	2009 LAC population estimate (%)
Asian/Pacific Islander	23	30	10
Black	11	3	11
Hispanic	32	44	54
White	34	19	26
Other	1	2	<1

† as of 11/24/09, N=133,202

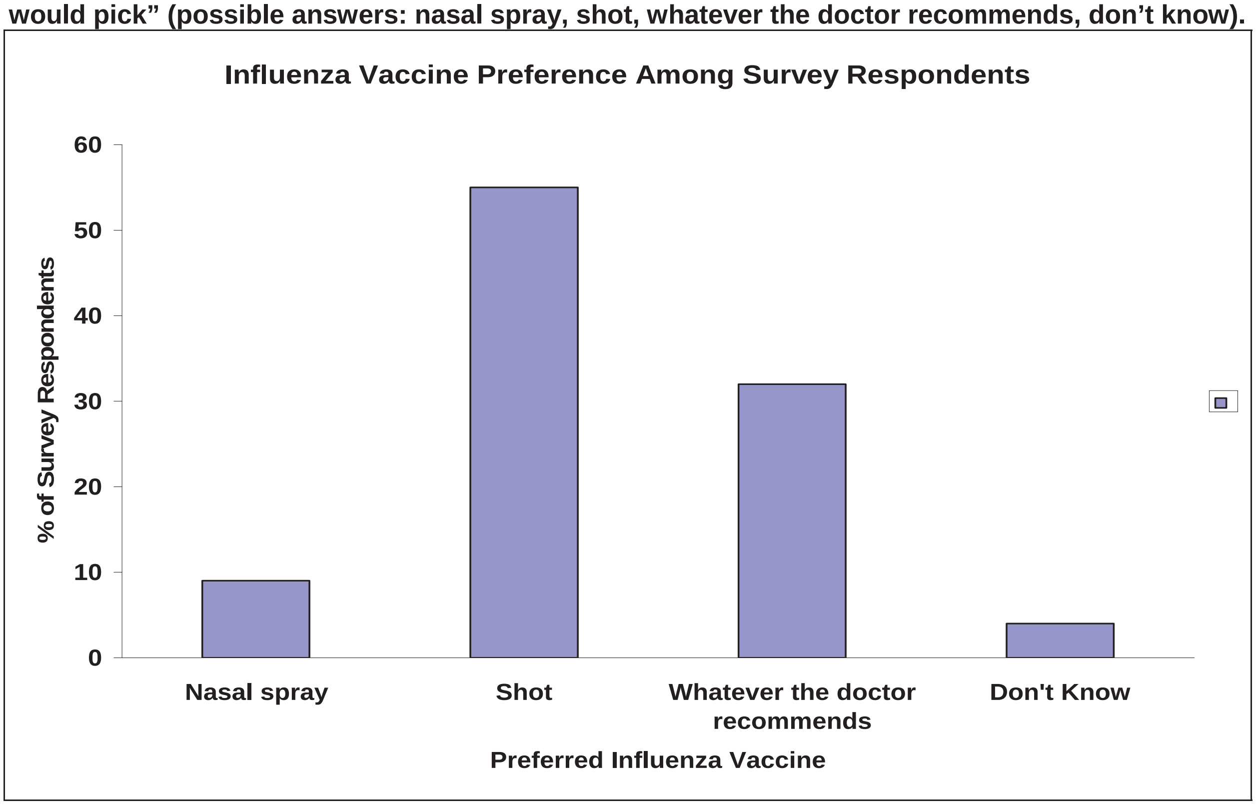
Knowledge and Vaccine Information Sources

Of 326 respondents, 81% knew that H1N1 vaccine was available in a nasal spray, 50% that it contained live weakened virus, 49% that it was not indicated for everyone, and 54% that it was as effective in preventing influenza as injected vaccine. Persons with high school education or less were 3.1 (95% confidence interval [CI], 1.9–5.1) times more likely to have a low score than those with more education. Compared with whites, blacks were 6.2 (CI, 2.6–15.2) times and Hispanics 3.3 (CI, 1.9–5.8) times more likely to have a low score. Most blacks and Hispanics reported their primary vaccine information source was television (59% and 53%, respectively); whites reported relying more on the Internet (42%; *P*<.0001). Compared with whites, blacks were 9.5 (CI, 3.2–28.0) and Hispanics were 6.7 (CI, 2.8–15.5) times more likely to report television as their most trusted information source.

Vaccine preferences

The initial anecdotal reports of patient preference for IMV over LAIV were borne out by the survey responses.

Figure 2. Response to the survey question "If I could choose which type of H1N1 vaccine to get, I would pick" (possible answers: nasal spray, shot, whatever the doctor recommends, don't know).



The majority of respondents preferred IMV (see Figure 2). More persons endorsed fear of live nasal spray vaccines (25%) than fear of injections (shots) (13%). Forty-one percent were unsure if LAIV “could give me the flu” and 63% reported “I am more comfortable with vaccines in the form of a shot than a nasal spray.” Persons who believed that LAIV could make them ill and those who reported feeling more comfortable with injected vaccines were more likely to prefer IMV (AOR=3.3, 95% CI=1.3–8.4 and AOR 15.1, 95% CI=6.5-35.5, respectively). After adjustment, age, sex, race, and education were not associated with preference for IMV.

LIMITATIONS

This survey was a convenience sample, not a demographically representative sample of all persons being served by LAC DPH mass H1N1 vaccination clinics. For practical reasons, the survey result could not link to individual information on whether the respondent was eligible to receive LAIV, or to which vaccine they ultimately received. However, the vaccine preference question was framed as “If I could choose”, to indicate a hypothetical choice.

DISCUSSION

Education level and racial/ethnic differences in knowledge about LAIV exist, although these did not emerge as the primary reasons driving the observed preference for IMV. The majority of patients attending a mass vaccination clinic preferred IMV to LAIV because of their comfort with injectable vaccines and uncertainty about whether LAIV could cause them to become ill with influenza. This suggests that an educational campaign aimed at the myth of LAIV reversion to virulence could be helpful in increasing uptake. Television was the most popular overall media information source, and physicians were the most trusted information source. This finding suggests that television coverage, particularly earned ‘free media’, could be of particular utility in communicating vaccine safety messages. Finally, shifting clinicians to the registration area to help with vaccine exclusion decisions, having LAIV inclusion and exclusion criteria printed on reference cards at the registration tables, and a switch to an ‘opt-out’ strategy to funnel medically eligible persons to LAIV could help to increase LAIV uptake. These findings might be applicable to future influenza vaccination campaigns.

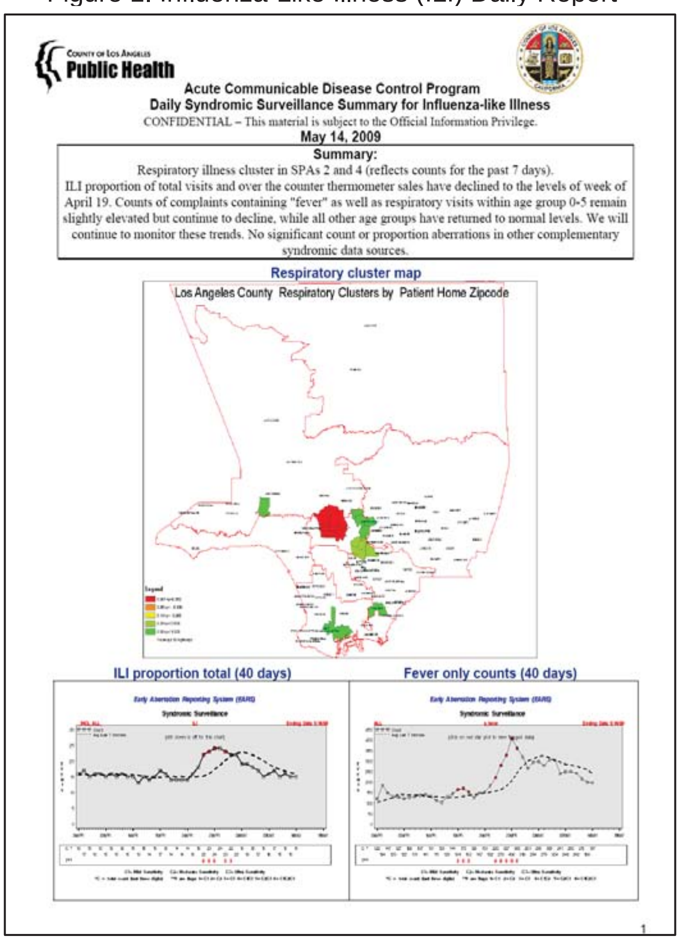
USE OF SYNDROMIC SURVEILLANCE DURING THE 2009-2010 INFLUENZA SEASON IN LOS ANGELES COUNTY

Patricia Araki, MPH; Bessie Hwang, MD, MPH

In April of 2009, several media reports and notifications from neighboring health jurisdictions warned of the possible circulation of a novel strain of influenza near central Mexico and the Mexico/US border. Later that month, these suspicions were confirmed by the World Health Organization (WHO) as the first confirmed cases of Pandemic Influenza (H1N1). As a large metropolitan region in close proximity to the potential outbreak, the Los Angeles County (LAC) Department of Public Health (DPH) Automated Disease Surveillance Section (ADSS) of Acute Communicable Disease Control Program (ACDC) began conducting enhanced surveillance for Influenza-like illness (ILI) activity in LAC through its pre-existing syndromic surveillance and complementary systems. In addition to this, a daily ILI report was created to provide key public health stakeholders and Departmental Operations Center (DOC) staff with near real-time ILI-related analysis results, trend graphs and temporal-spatial statistics and maps.

The LAC emergency department syndromic surveillance (EDSS) system analyzes data from approximately 60% of all emergency department (ED) visits throughout LAC. For every participating hospital, each ED visit is systematically classified into one of several syndrome categories based upon patient chief complaint. These include: rash, respiratory, gastrointestinal, neurological, and ILI. Each syndrome category is then tallied and compared to a threshold generated by the Centers for Disease Control and Prevention (CDC)-Early Aberration Reporting System (EARS) algorithm based upon the individual hospital's previous data. During the period from April to May 2009, ILI- and fever- classified counts obtained from the syndromic surveillance system were utilized to produce overall and age-group stratified trend graphs for a daily ILI report which summarized and displayed analysis results from several surveillance systems (Figure 1).

Figure 1. Influenza-Like Illness (ILI) Daily Report



Other data source results selected for the ILI report included information from SaTScan™, respiratory-classified nurse calls, respiratory-classified coroner's deaths, respiratory-related 911-calls, and emergency department volume biosurveillance (total ED visits and total ICU admissions from the ED). Most results were generated by SAS® in Cary, North Carolina and presented in trend graph format, with the exception of the respiratory SaTScan™ cluster map. Data sources were selected based upon prior knowledge about the quality of information, timeliness and consistency of reporting, relevancy with respect to ILI early-event detection surveillance, and additional value gained by inclusion in the report. Since the pandemic was the first observed since the foundation of early-event detection surveillance in LAC, the circumstances served as an opportunity to assess the utility of each of the data sources utilized and presented in the report for inclusion in any future report related to ILI. For this assessment, retrospective evaluation of daily ILI reports from mid April through May 2009 was conducted.

Each data source in the ILI report was retrospectively assessed for increasing trend from April through May, 2009, due to a known increase in confirmed cases of novel H1N1 influenza (H1N1) reported during this time period. From reviewing the reports, a sudden and significant increase in the proportion of total ED ILI visits (~8-10%) within the timeframe of a few days (Figure 2) is observed in combination with early signaling among EDSS fever-categorized visits during the same period (Figure 3), to suggest the possibility of an ILI outbreak in the community. Respiratory SaTScan™ cluster maps confirmed several clusters of local communities with significant respiratory activity during the analysis period (Figure 1). Age-stratified EDSS ILI data identified age categories in which the burden of illness was greatest (Figure 4), observing an increase in ILI ED visits among younger persons (<45 years old) and more specifically, those between the ages of 14-44 years old, with little to no difference in trend detected among those over 45 year old. Respiratory-classified nurse calls and total volume of ED visits biosurveillance data also confirmed increases in ILI-related encounters during the assessment period. In contrast, 911-calls and total ED-to-ICU transfers volume trend data remained static throughout the observation period and Coroner's results were unreliable due to delayed data receipt. For future reports, these data sources may not be as useful an indicator for detecting ILI activity.

Figure 2. Total EDSS ILI-classified visits per day

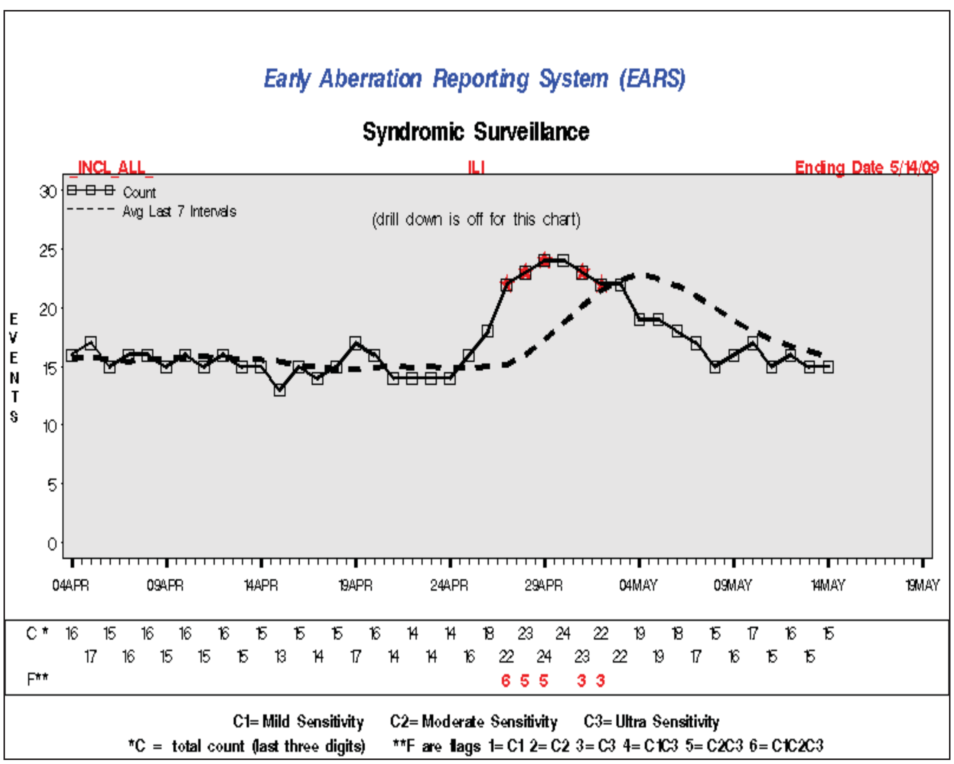


Figure 3. Total EDSS fever-classified visits per day

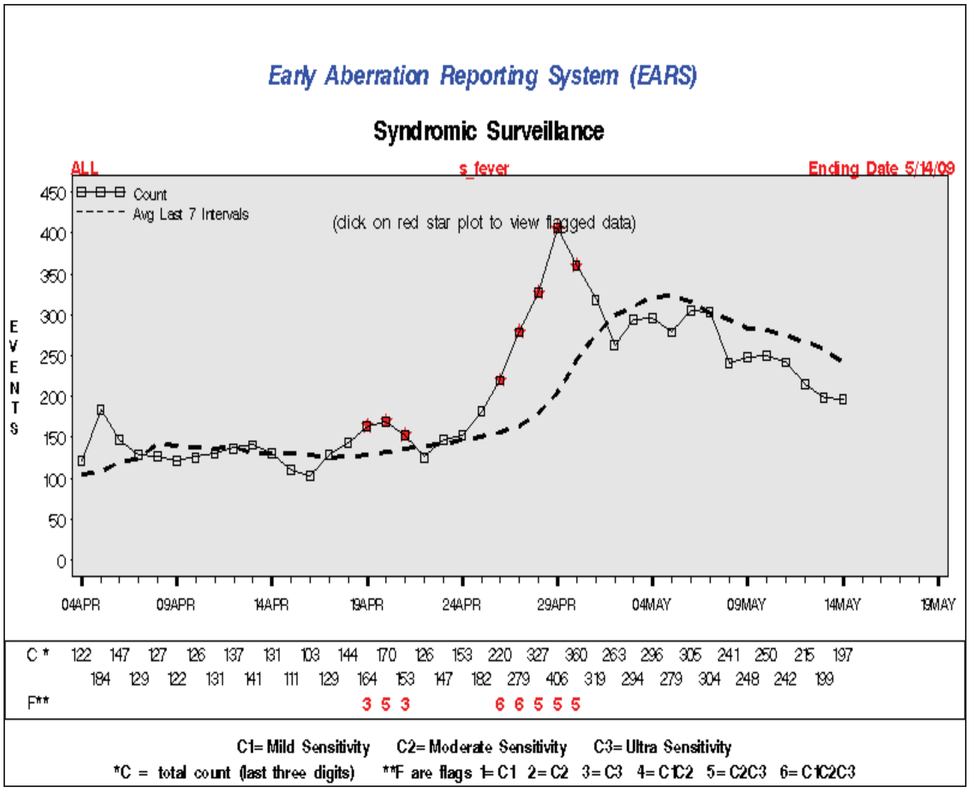
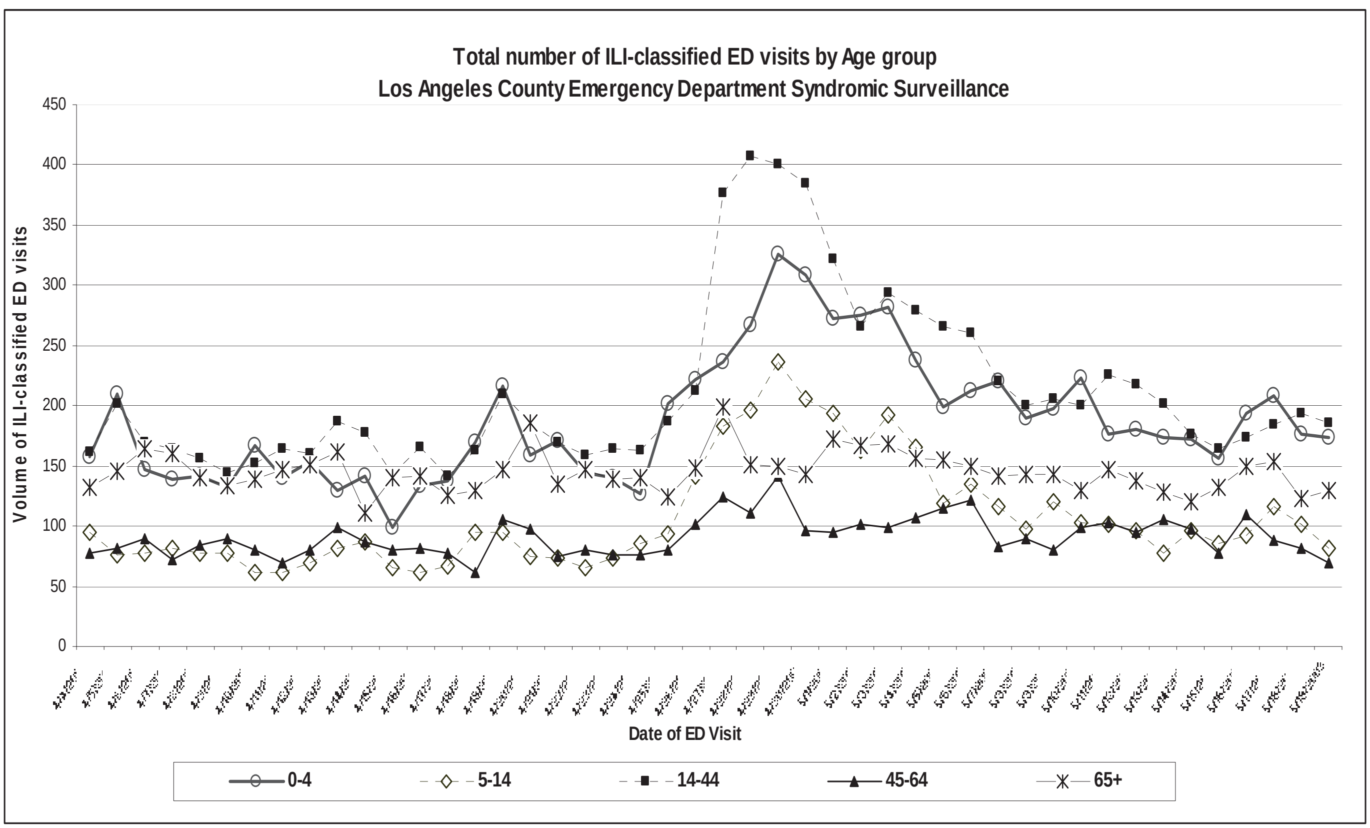
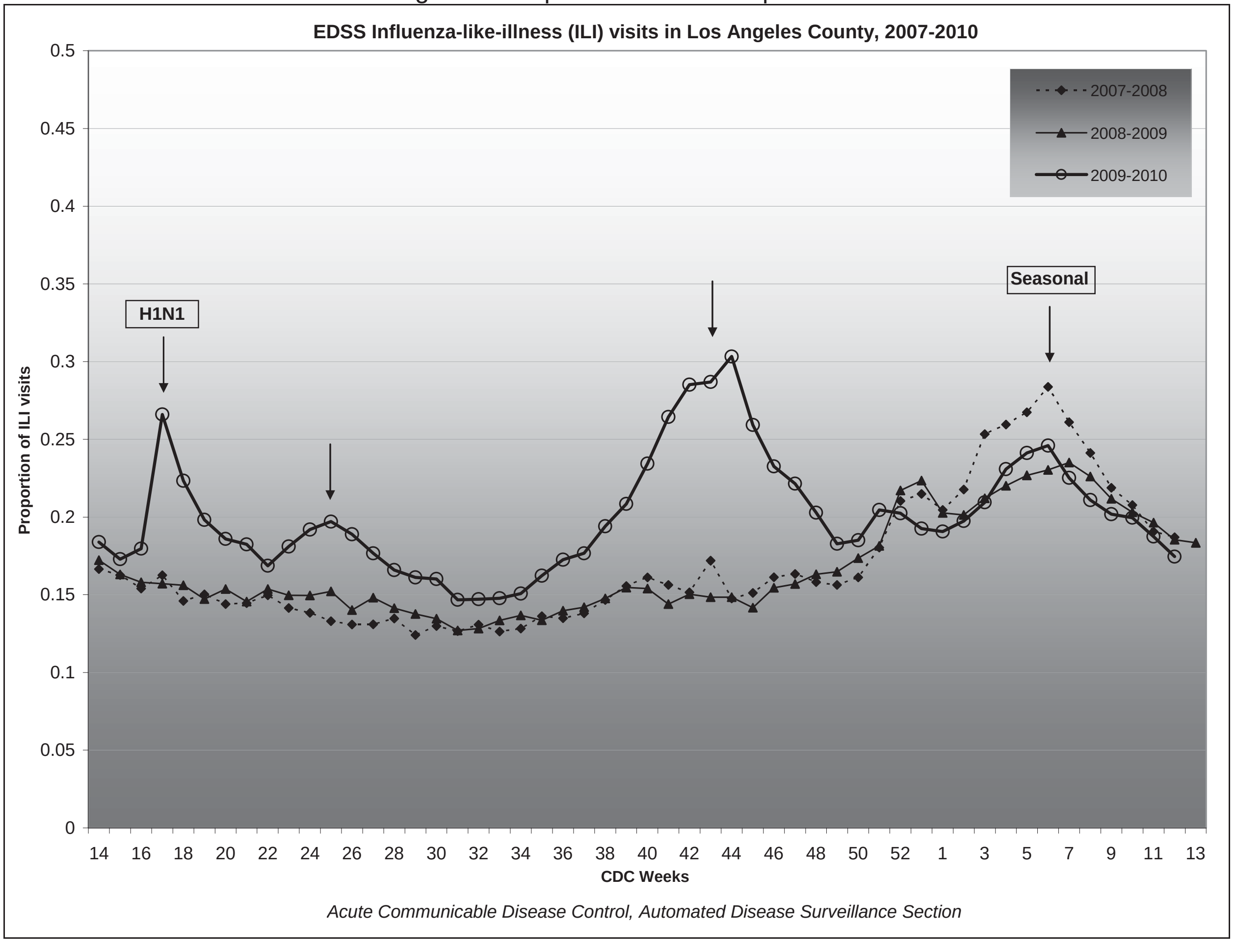


Figure 4. Age-stratified EDSS ILI trend graph from April through May, 2009



Further retrospective assessment of overall ILI activity as captured by the LAC EDSS system, revealed several notable findings upon review of annual trend in proportion of ILI-classified ED visits for the same period each year between 2007 and 2010[1]. The first being the sudden appearance of a large increase in ILI activity early on in the 2009-2010 season (Figure 5, CDC weeks 16-20) followed by two more significant peaks which are observed to be absent from the two previous years. While these sharp increases are not based upon confirmed H1N1 novel influenza counts, they are consistent and positively associated with H1N1 influenza activity through cross-referencing with other data sources[2]. In contrast, the final peak (weeks 1-13) is seen across all three years and has been attributed to annual influenza, as both the length and timing of increasing ILI activity correlates with that of recurring seasonal influenza. In summary, the presence of these atypical yet significant increases in ILI activity early on in the 2009-2010 season following several local reports of confirmed H1N1, in conjunction with annually anticipated seasonal influenza activity suggest that the additional peaks can more than likely be attributed to novel H1N1 influenza activity.

Figure 5. Proportion of ILI visits per CDC week



[1] Prior to 2009, the novel H1N1 influenza virus had never been detected in a single influenza virus (source: www.flu.gov). All laboratory positive influenza tests prior to the 2009-2010 season were recorded as seasonal influenza.
[2] California Department of Public Health: ***Influenza and Respiratory Disease Surveillance Report***

The case for the presence of a novel strain of influenza, in addition to yearly expected seasonal influenza, was further supported by the comparison of the total number of EDSS ILI signals generated annually by all participating hospitals from 2007 through 2010. Whereas, the total number of syndromic surveillance ILI signals for the year beginning in April 2007 through 2008 was 37, and for the same time period the following year 38, by contrast, during the final year (2009-2010) the total number of ILI signals generated by EDSS reached 80, indicating a twofold increase in the number of statistically significant ILI signals observed across all LAC EDs the final year in comparison to the two previous years. This information in combination with records of only laboratory positive seasonal influenza prior to 2009, again suggests that the sharp increase in number of ILI signals along with the observation of several additional ILI peaks (increasing proportion of ILI ED visits) during the 2009-2010 season are more than likely attributable to a novel form of influenza, or H1N1 (Figure 6).

Figure 6. Total number of ILI syndromic surveillance signals generated by participating hospitals

April 1, 2007- March 31, 2008	April 1, 2008- March 31, 2009	April 1, 2009- March 31, 2010
37	38	80

Overall, several observations unique to the 2009-2010 influenza season are notable. LAC DPH began conducting enhanced surveillance in April, 2009, utilizing several pre-existing surveillance systems following local reports of increased ILI activity from neighboring jurisdictions and abroad. These analysis results were then compiled into a daily ILI report for distribution among Public health stakeholders and DOC personnel as status updates for the duration of the declaration of emergency for novel influenza (H1N1).

Upon retrospective review of the daily ILI reports between April through May, 2009, several data sources displayed concurrent trend increases with that of proportion of total EDSS-ILI trend graphs. These data sources included EDSS fever-classified visits, EDSS age-stratified ILI visits, respiratory-classified nurse calls, and total ED volume biosurveillance data, suggesting these particular results may be useful as supplementary data sources for inclusion in future ILI surveillance reports. EDSS data provided very useful information due to the type of data captured, enabling analysts to subset observations further by chief complaint (e.g., the keyword “fever”), and additionally, to stratify data by ZIP code or age-group. This not only identified certain age-groups as being more susceptible to ILI during the outbreak, but also informed health officials as to location of clusters of ILI activity in the community.

Furthermore, comparison of annual trends in proportion of EDSS ILI visits from 2007-2010 revealed an unusually high proportion of ED ILI visits during traditionally non-ILI months, in addition to normal levels of seasonal influenza ED ILI visits during the 2009-2010 season, in contrast to the two previous years. This was complemented by the observation of twice as many EDSS ILI signals from 2009-2010 in comparison to annual totals of EDSS ILI signals seen in prior years. Overall, these data sources, used collectively, may help detect ILI activity, in near real-time, when conducting surveillance during the course of an ILI emergency.