Emergency Department Visits for Influenza A(H1N1)pdm09, Davidson County, Tennessee, USA

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To determine the number of emergency department visits attributable to influenza A(H1N1)pdm09 in Davidson County, Tennessee, USA, we used active, population-based surveillance and laboratory-confirmed influenza data. We estimated ≈10 visits per 1,000 residents during the pandemic period. This estimate should help emergency departments prepare for future pandemics.

The 2009 pandemic influenza (H1N1) strain, hereafter referred to as influenza A(H1N1)pdm09, had the potential to substantially increase visits to emergency departments, many of which operate at or near capacity (1–5). Surges in emergency department patient volume cause treatment delays, low quality care, and increased risk for medical error (6). Understanding the number of visits associated with influenza A(H1N1)pdm09 should help emergency departments prepare for future influenza epidemics. We therefore estimated population-based emergency department visit rates attributable to influenza A(H1N1)pdm09 during the first year it circulated in Davidson County, Tennessee, USA. The Vanderbilt University Institutional Review Board approved this study.

The Study

As part of the Influenza Vaccine Effectiveness network (Flu-VE) (7), we conducted active, prospective, population-based influenza surveillance among residents of Davidson County. We included those who had visited Vanderbilt University adult or pediatric emergency departments for acute respiratory infection (ARI) or fever/feverishness for <14 days during May 1, 2009–March 31, 2010. Nasal and throat swabs were tested for influenza with reverse transcription PCR (RT-PCR) by using primers and probes provided by the Centers for Disease Control and Prevention (Atlanta, GA, USA) (8). Specimens were classified as A(H1N1)pdm09 virus if results were positive on both pandemic subtyping assays (pandemic A and pandemic H1) or positive for influenza A, negative for seasonal subtypes H1 and H3, and positive on 1 pandemic subtyping assay.

We obtained the number of emergency department visits associated with ARI or fever (International Classification of Diseases, Ninth Revision, Clinical Modification, codes 381–382, 460–466, 480–487, 490–493, 786, and 780.6) from the Tennessee Hospital Discharge Data System (HDDS) (9), which is required to include a record of every hospital-based health care encounter. We combined data from Flu-VE RT-PCRs, influenza test results obtained clinically in the surveillance emergency departments, and HDDS discharge diagnoses to calculate age-specific visit rates attributable to influenza A(H1N1)pdm09. We used 2 epidemiologic methods: surveillance sampling and capture-recapture.

For surveillance sampling, we enrolled 826 (52%) of 1,589 eligible patients in the Flu-VE study who had visited surveillance emergency departments; 88 (11%) had positive RT-PCR results for A(H1N1)pdm09 virus (Figure). We divided the pandemic period into 3 intervals according to prevalence of A(H1N1)pdm09 among Flu-VE participants: prepeak (May–July 2009), peak (August–November 2009), and postpeak (December 2009–March 2010). Within each period, we assumed that the proportion of ARI- or fever-associated visits caused by A(H1N1)pdm09 virus among enrolled county residents was the same as that for such emergency department visits among all county residents. Estimated influenza A(H1N1)pdm09–associated emergency department visits were thus calculated by multiplying age- and time-specific counts of total county ARI- or fever-associated emergency department visits by these proportions (Table 1). We divided age-specific counts by age-specific county population estimates for July 2009 (10) and calculated rates per 1,000 residents (Table 2). We used the binomial Wilson method to calculate 95% CIs for the proportions of ARI- or fever-associated emergency department visits caused by A(H1N1)pdm09 virus.

We developed a capture-recapture model (11) by linking 2 independent data sources for influenza testing from the same population: the Flu-VE RT-PCRs, performed in a research laboratory and not reported to patients or clinicians, and influenza tests performed as routine care in the surveillance emergency departments. Unlike the research laboratory tests, not all clinical tests included
Table 1. Estimated total number of emergency department visits for influenza A(H1N1)pdm09, calculated by surveillance sampling method, Davidson County, Tennessee, USA, May 1, 2009–March 31, 2010†

| Patient age, year | No. ARI or fever visits countywide† | % ARI or fever visits to surveillance emergency departments for influenza A(H1N1)pdm09‡ | Estimated no. visits for influenza A(H1N1)pdm09 countywide |
|------------------|-------------------------------------|--------------------------------------------------|----------------------------------------------------------|
|                  | Prepeak | Peak | Postpeak | Prepeak | Peak | Postpeak | |
| <5               | 3,135    | 6,461 | 5,219    | 0        | 19.0 | 0        | 1,249         |
| 5–17             | 1,599    | 5,269 | 2,324    | 15.0     | 24.0 | 0        | 1,528         |
| 18–49            | 7,322    | 11,523| 10,486   | 2.4      | 23.0 | 15.3     | 3,455         |
| ≥50              | 5,085    | 6,832 | 7,046    | 0        | 6.2  | 1.5      | 503           |

*ARI, acute respiratory infection.
†Data from Tennessee Hospital Discharge Data System (9).
‡Data from Influenza Vaccine Effectiveness Study (Vanderbilt University, Nashville, TN, USA).
if influenza viral load varied substantially among persons and higher viral loads increased the likelihood of detection by both systems. In this scenario, our method would underestimate the true number of emergency department visits (by increasing the number of matched cases). The proportions of ARI- and fever-associated emergency department visits for A(H1N1)pdm09 virus infection were extrapolated from surveillance emergency departments to the entire county population. If this proportion were higher (or lower) in the surveillance emergency departments than in other emergency departments, our rates would overestimate (or underestimate) true rates. Additionally, the small number of cases detected in adults $>$50 years of age precluded further age stratification among older adults. Because this study was conducted in an urban US county with high accessibility to emergency departments, we advise caution when extrapolating our estimates directly to other populations.

A modern influenza pandemic of mild severity can quickly cause large surges in emergency department visits. To minimize emergency department overcrowding and to maximize efficient use of resources, long-term preparation for these surges is vital. The high number of emergency department visits during the pandemic also illustrates the large effect a novel influenza strain can have on an unvaccinated, susceptible population and highlights the need for continued influenza vaccine development and use.

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References

1. Centers for Disease Control and Prevention. Update: novel influenza A (H1N1) virus infections—worldwide, May 6, 2009. MMWR Morb Mortal Wkly Rep. 2009;58:453–8.
2. Jain S, Kamimoto L, Bramley AM, Schmitz AM, Benoit SR, Sagerman DE, et al. Hospitalized patients with 2009 H1N1 influenza in the United States, April–June 2009. N Engl J Med. 2009;361:1935–44. http://dx.doi.org/10.1056/NEJMoa0906695
3. McDonnell WM, Nelson DS, Schunk JE. Should we fear “flu fear” itself? Effects of H1N1 influenza on ED use. Am J Emerg Med. 2012;30:275–82. http://dx.doi.org/10.1016/j.ajem.2010.11.027
4. Shapiro JS, Genes N, Kuperman G, Chason K, Richardson LD. Health information exchange, biosurveillance efforts, and emergency department crowding during the spring 2009 H1N1 outbreak in New York City. Ann Emerg Med. 2010;55:274–9. http://dx.doi.org/10.1016/j.annemergmed.2009.11.026
5. Institute of Medicine. Committee on the future of emergency care in the US health system, hospital-based emergency care: at the breaking point. Washington (DC): National Academy of Sciences; 2007.
6. Moskop JC, Sklar DP, Geiderman JM, Schears RM, Bookman KJ. Emergency department crowding, part 1—concepts, causes and moral consequences. Ann Emerg Med. 2009;53:605–11. http://dx.doi.org/10.1016/j.annemergmed.2008.09.019
7. Talbot HK, Griffin MR, Chen Q, Zhu Y, Williams JV, Edwards KM. Effectiveness of seasonal vaccine in preventing confirmed influenza-associate hospitalizations in community dwelling older adults. J Infect Dis. 2011;203:500–8. http://dx.doi.org/10.1093/infdis/jiq076
8. World Health Organization. CDC protocol of realtime RTPCR for swine influenza A (H1N1). 2009 Apr 28 [cited 2011 Jan 22]. http://www.who.int/csr/resources/publications/swineflu/realtimeptpcr/en/index.html
9. Talbot HK, Poehling KA, Williams JV, Zhu Y, Chen Q, McNabb P, et al. Influenza in older adults: impact of vaccination of school children. Vaccine. 2009;27:1923–7. http://dx.doi.org/10.1016/j.vaccine.2009.01.108
10. Annual estimates of the resident population by sex, and selected age groups for the United States: April 1, 2000 to July 1, 2009. Population estimates. National characteristics: vintage 2009 [cited 2011 Jan 22]. http://www.census.gov/popest/data/national/asrh/2009/index.html
11. Hook EB, Regal RR. Capture-recapture methods in epidemiology: methods and limitations. Epidemiol Rev. 1995;17:243–64.
12. Centers for Disease Control and Prevention. FluView: a weekly influenza surveillance report prepared by the Influenza Division [cited 2011 Dec 22]. http://www.cdc.gov/flu/weekly/weeklyarchives/2009-2010/09-10summary.htm
13. Wines JT. On the bias and estimated variance of Chapman’s two-sample capture-recapture population estimate. Biometrics. 1972;28:592–7. http://dx.doi.org/10.2307/2556173
14. Gjini A, Stuart JM, George RC, Nichols T, Heyderman RS. Capture-recapture analysis and pneumococcal meningitis estimates in England. Emerg Infect Dis. 2004;10:87–93.

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