

Epidemiologic and Clinical Features Among Patients Hospitalized in Wisconsin with 2009 H1N1 Influenza A Virus Infections, April to August 2009

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ABSTRACT

Background: During April 15 through July 23, 2009, Wisconsin reported the most confirmed and probable cases of 2009 influenza A (H1N1) virus (2009 H1N1) infection in the United States. Preliminary reports suggest that 2009 H1N1 infection disproportionately affected minority populations.

Methods: Prospective surveillance among all acute care hospitals in Wisconsin to detect patients hospitalized at least 24 hours with confirmed 2009 H1N1 infection during April 23 through August 15, 2009.

Results: During the study interval, 252 patients were hospitalized and 11 (4%) died. Statewide hospitalization rates by age, sex, and race/ethnicity categories were highest among patients aged <1 year (21.6/100,000), females (4.9/100,000), and African Americans (36.3/100,000). The median age was 28 years: Hispanics (median age=16 years) and African Americans (24 years) were younger than non-Hispanic whites (37 years) and Asians (38 years). African Americans were more likely to have a hematologic condition and be morbidly obese (BMI ≥ 40 kg/m²), and less likely to be admitted to an intensive care unit compared to other race/ethnicity groups ($P < 0.05$). Hispanics and non-Hispanic whites were more likely to have cancer, be non-morbidly obese (BMI 30–39.9 kg/m² or BMI percentile $\geq 95\%$), and be hospitalized for >5 days compared to African Americans and Asians ($P < 0.05$). There were no signifi-

cant racial/ethnic differences in time from illness onset to admission or receipt of antiviral therapy, need for mechanical ventilation, acute respiratory distress syndrome, or death.

Conclusions: The first wave of the 2009 H1N1 pandemic in Wisconsin disproportionately affected hospitalized patients who were African Americans, Asians, and Hispanics compared to non-Hispanic whites. Preventive measures focused on these populations may reduce morbidity associated with 2009 H1N1 infection.

INTRODUCTION

During April 15 through July 23, 2009, an estimated 1.8 million to 5.7 million cases of 2009 influenza A (H1N1) virus (2009 H1N1) infection and 9000–21,000 related hospitalizations occurred in the United States.¹ During this same time period, there were 6222 confirmed and probable cases of 2009 H1N1 infection reported among Wisconsin residents, more than in any other state.² Collaboration between the Wisconsin State Laboratory of Hygiene (WSLH), City of Milwaukee Public Health Laboratory (CMPHL), Midwest Respiratory Virus Program Laboratory (MRVPL), and Marshfield Laboratories facilitated confirmatory testing of over 15,000 suspected case specimens during April 15 through July 23 (R.T. Heffernan, unpublished data, March 2010).

Because of the emergence of the novel 2009 H1N1 virus, the Wisconsin Division of Public Health (WDPH) greatly expanded its existing influenza surveillance program. This included a heightened surveillance for cases of 2009 H1N1 infection among hospitalized patients. The ability to accommodate the increased demand for testing, in combination with enhanced surveillance for hospitalized cases, resulted in a high degree of ascertainment of severe cases of 2009 H1N1 infection in Wisconsin.

This report summarizes the epidemiologic and

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clinical features among all patients hospitalized at least 24 hours with confirmed 2009 H1N1 infection in Wisconsin during April 23 through August 15, 2009.

METHODS

Study Design

Prospective surveillance was conducted at all acute care hospitals in Wisconsin to detect patients hospitalized with confirmed 2009 H1N1 infection. Because novel influenza virus infections are reportable in Wisconsin, all hospitals, healthcare providers, and laboratories were required to report confirmed and probable cases of 2009 H1N1 infection to the WDPH. To maximize ascertainment of all hospitalized cases of 2009 H1N1 infection, WDPH staff were in weekly contact with local health departments and infection preventionists (IP) at Wisconsin acute care hospitals.

All cases included in the hospitalized cohort occurred in patients who were hospitalized for at least 24 hours and had 2009 H1N1 infection confirmed using a real-time reverse-transcriptase polymerase chain reaction (RT-PCR) assay. These assays were conducted at 1 of 4 laboratories in Wisconsin that were certified by the Centers for Disease Control and Prevention (CDC) to conduct confirmatory testing. The MRVPL developed and validated primers for detection of 2009 H1N1 infection,^{3,4} and the other certified laboratories used primers provided by the CDC.

Patient medical records were reviewed and abstracted by an IP or 1 of 2 investigators (JKD, ST) initially using a 16-page case report form developed by CDC staff.⁵ Later, an abridged version of the form developed by WDPH staff was used. Both forms included data on age, sex, race (eg, white, black, Asian, etc) and ethnicity (Hispanic or non-Hispanic), residential ZIP code, clinical signs and symptoms at presentation, underlying medical conditions, radiographic findings, treatment course, and dates of hospitalization, discharge, onset of symptoms, and initiation of antiviral therapy. This surveillance study was approved by the WDPH as a public health response to a novel influenza virus investigation and did not require approval by an institutional review board.

Data Analysis

Data analysis was conducted using SAS version 9.1. Incidence rates were calculated for Wisconsin residents using 2008 population estimates from the United States Census Bureau. Ninety-five percent confidence intervals for rate ratios were calculated using Poisson regression. For time calculations, the date of illness onset or date of hospital admission was considered to be day 0. The body

mass index (BMI) was calculated for all non-pregnant patients aged at least 2 years for whom height and weight were available. Obesity is defined as a BMI ≥ 30 kg/m² among patients aged at least 18 years, or a BMI percentile $\geq 95\%$ among patients aged 2 through 17 years. Obesity was further classified as non-morbid (BMI 30–39.9 kg/m² among patients aged at least 18 years, or obesity in patients aged 2 through 17 years) or morbid obesity (BMI ≥ 40 kg/m² among patients aged at least 18 years).

Differences in proportions were evaluated using either a Fisher's exact test or Pearson's chi-square test. A Student's t-test was used to compare differences in continuous variables. Analyses of trend were conducted using a Cochran-Mantel-Haenszel test. All reported *P*-values are 2-sided and were not adjusted for multiple testing.

RESULTS

Hospitalization Rates

During April 23 through August 15, 2009, 252 patients were hospitalized at least 24 hours with confirmed 2009 H1N1 infection in Wisconsin; 98% of these cases occurred among Wisconsin residents. Among age, sex, and race/ethnicity categories, statewide rates of hospitalization resulting from confirmed 2009 H1N1 infection were greatest among infants aged <1 year, females, and African Americans (Table 1). The median age among all patients in this cohort was 28 years (range=11 days - 85 years).

One hundred sixty-three (66%) patients with 2009 H1N1 infection were residents of the city of Milwaukee, where hospitalization rates were 17-fold greater overall and 5- to 8-fold greater among certain race/ethnicity groups compared to all other Wisconsin residents (Table 1). Among Wisconsin residents living within or outside the city of Milwaukee, hospitalization rates were several-fold greater among African Americans, Asians, and Hispanics compared to non-Hispanic whites.

Epidemiologic and Clinical Characteristics

Among the 252 hospitalized patients, 56% were female, 76% were aged <50 years, 48% were African American, 80% had a fever, 71% had a cough on admission, and 50% presented to a hospital within 48 hours after illness onset (Table 2). Patients aged <18 years were more likely than patients aged 18 to 49 and ≥ 50 years to be male (56%, 37%, 34%; $P=0.01$), have a fever (91%, 73%, 73%; $P=0.004$), or have vomiting or diarrhea (46%, 27%, 17%; $P<0.001$) at presentation, and were less likely to have nausea at presentation (1%, 13%, 11%; $P=0.01$).

Seventy-four percent of patients had at least 1 medical condition that was a risk factor for seasonal influenza, most commonly asthma (32%), diabetes (17%),

Table 1. Rates of Hospitalization Resulting from 2009 H1N1 Infection by Age, Sex, and Race/Ethnicity, Wisconsin and City of Milwaukee, April 23 - August 15, 2009

Category	Number (%) ^a	Rate ^b	Rate Ratio (95% CI) ^c
Wisconsin	(N = 246)	4.4	
Age			
<1 year	16 (7)	21.6	—
1-9 years	48 (20)	7.5	—
10-17 years	28 (11)	4.7	—
18-49 years	97 (39)	3.9	—
50-59 years	39 (16)	4.9	—
≥60 years	18 (7)	1.7	—
Sex			
Females	140 (57)	4.9	1.00
Males	106 (43)	3.8	0.77 (0.60-0.99)
Race/ethnicity^d			
White, non-Hispanic	68 (28)	1.4	1.00
Black, non-Hispanic	120 (49)	36.3	25.56 (18.98-34.42)
Hispanic	39 (16)	13.6	9.60 (6.48-14.24)
Asian	19 (8)	16.8	11.85 (7.13-19.70)
City of Milwaukee	(n = 163)	27.9	
Race/ethnicity^d			
White, non-Hispanic	14 (9)	6.0	1.00
Black, non-Hispanic	109 (67)	49.5	8.19 (4.70-14.29)
Hispanic	31 (19)	33.7	5.57 (2.96-10.47)
Asian	9 (6)	50.8	8.42 (3.64-19.45)
Wisconsin, excluding city of Milwaukee	(n = 83)	1.6	
Race/ethnicity^d			
White, non-Hispanic	54 (65)	1.2	1.00
Black, non-Hispanic	11 (13)	10.0	8.42 (4.40-16.09)
Hispanic	8 (10)	4.1	3.48 (1.66-7.32)
Asian	10 (12)	10.5	8.86 (4.51-17.40)

^a Number of patients hospitalized for ≥24 hours with confirmed 2009 H1N1 infection. Total patient counts only include patients who were Wisconsin residents. Excluded were 6 non-Wisconsin residents who were hospitalized in Wisconsin hospitals.

^b Rate per 100,000 population of hospitalization resulting from 2009 H1N1 infection.

^c 95% Confidence Interval (CI) calculated using Poisson regression.

^d No additional racial/ethnicities were reported among hospitalized patients during the study period.

or a chronic lung disorder (12%) (Table 2). Patients aged <18 years were more likely than patients aged 18 to 49 and ≥50 years to have no medical conditions that are risk factors for seasonal influenza (39%, 21%, 14%; $P < 0.001$). Patients aged ≥50 years were more likely than patients aged <18 and 18-49 years to have a cardiac condition (3%, 7%, 25%; $P < 0.001$) or diabetes (2%, 19%, 37%; $P < 0.001$).

BMI was calculated for 199 (84%) of 237 patients who were at least 2 years old and not pregnant. Non-obesity, non-morbid obesity, and morbid obesity were detected in 112 (56%) of 199 patients, 57 (29%) of 199 patients, and 30 (22%) of 136 patients, respectively (Table 2). Forty-three (75%) non-morbidly obese and

25 (86%) morbidly obese patients had at least 1 medical condition that was a risk factor for seasonal influenza. Patients aged <18 years were less likely to be non-morbidly obese compared to patients aged 18-49 and ≥50 years (22%, 32%, 31%; $P < 0.001$), and females were more likely to be morbidly obese than males (28%, 13%; $P = 0.03$). Thirty-nine percent of patients received the 2008-2009 seasonal influenza vaccine, and females were more likely to receive the vaccine than males (45%, 32%; $P = 0.04$).

Racial/ethnic differences in epidemiologic and clinical characteristics among individuals hospitalized with 2009 H1N1 infection are presented in Table 2. Hispanics (median age=16 years) and African Americans

Table 2. Epidemiologic and Clinical Characteristics by Race/Ethnicity Among Patients Hospitalized with Confirmed 2009 H1N1 Infection in Wisconsin, April 23 - August 15, 2009

Characteristics	All Patients (N = 252)	White, non- Hispanic (n = 72)	Black, non- Hispanic (n = 121)	Hispanic (n = 40)	Asian (n = 19)	P-value ^a
Female, No. (%)	142 (56)	44 (61)	69 (57)	22 (55)	7 (37)	0.30
Age, median (range), years	27.5 (<1-85)	37.0 (<1-85)	23.5 (<1-72)	16.0 (<1-60)	38.0 (<1-79)	<0.001
Signs/presenting symptoms, No. (%)						
Fever (Temp ≥100.4°F)	201 (80)	64 (89)	88 (73)	33 (83)	16 (84)	0.05
Cough	178 (71)	59 (82)	73 (60)	29 (73)	17 (89)	0.003
Shortness of breath	137 (54)	42 (58)	52 (43)	12 (30)	9 (47)	0.03
Vomiting or diarrhea	77 (31)	18 (25)	31 (26)	21 (53)	7 (37)	0.008
Time from illness onset to admission, No. (%)^{b,c}						
< 48 hours	121/244 (50)	30/67 (45)	66/120 (55)	15/38 (39)	10 (53)	0.33
48-96 hours	52/244 (21)	15/67 (22)	27/120 (23)	8/38 (21)	2 (11)	
> 96 hours	71/244 (29)	22/67 (33)	27/120 (23)	15/38 (39)	7 (37)	
Medical history, No. (%)^b						
Asthma	81 (32)	20 (28)	45 (37)	14 (35)	2 (11)	0.10
Chronic lung disorders ^d	29 (12)	13 (18)	8 (7)	4 (10)	4 (21)	0.05
Diabetes ^e	43 (17)	13 (18)	15 (12)	11 (28)	4 (21)	0.16
Cancer ^f	17 (7)	9 (13)	4 (3)	4 (10)	0 (0)	0.04
Hematologic ^g	17 (7)	1 (1)	14 (12)	1 (3)	1 (5)	0.03
Pregnancy ^h	15/54 (26)	3/14 (21)	9/31 (29)	2/7 (29)	1/2 (50)	0.85
Obesity ⁱ						
Non-obese	112/199 (56)	33/60 (55)	48/91 (53)	20/33 (61)	11/15 (73)	0.04
Non-morbid obesity	57/199 (29)	21/60 (35)	21/91 (23)	11/33 (33)	4/15 (27)	
Morbid obesity	30/136 (22)	6/43 (14)	22/64 (34)	2/18 (11)	0/11 (0)	
No underlying conditions ^j	66 (26)	23 (32)	24 (20)	11 (28)	7 (37)	0.18
Influenza vaccination, seasonal ^k	93/237 (39)	27/63 (43)	38/118 (32)	21/38 (55)	7/18 (39)	0.08

^a Fisher's exact test was used to determine significance when a cell value was <5, Student's t-test was used to compare continuous variables, and Pearson's chi-square test was used for all other comparisons.

^b Includes cases with known information only.

^c Time from illness onset to admission was calculated using the difference between date of admission and date of illness onset, with date of onset as day 0. The calculated difference was an integer value for days and was converted into hours.

^d Chronic lung disorders include chronic obstructive pulmonary disease (14 patients), obstructive sleep apnea (8), congenital lung defects (7), in-dwelling tracheostomy (6), pulmonary hypertension (3), and cystic fibrosis (1).

^e Diabetes includes diabetes mellitus types 1 (12%) and 2 (88%).

^f Cancer types included acute lymphoblastic leukemia (3 patients), glioblastoma (1), multiple myeloma (3), myelodysplastic syndrome (1), myelocytic leukemia (1), renal (1), breast (2), hepatocellular (1), prostate (1), bladder (1), and unknown (3).

^g Hematologic conditions included sickle cell (14 patients), Osler-Weber-Rendu syndrome (1), and aplastic anemia (1).

^h Pregnant case denominators include all females of childbearing age (15 – 44 years) from the hospitalized populations.

ⁱ Obesity, non-morbid obesity, and morbid obesity were determined using body-mass index (BMI) in adults ≥18 years or BMI percentile in children 2 to 17 years old. Non-morbid obesity is defined as a BMI of 30-39.9 kg/m² in adults ≥18 years or a BMI percentile of 95-100 in children 2 to 17 years old. Morbid obesity was defined as a BMI ≥40 kg/m² in adults only (≥18 years). Denominators exclude pregnant women, patients <2 years for obesity and patients <18 years for morbid obesity.

^j Having no conditions considered risk factors for seasonal influenza infection, including pregnancy and excluding obesity.

^k Influenza vaccination refers to seasonal vaccination for the 2008-2009 season. These data were derived from hospital records and data from the Wisconsin Immunization Registry; data unknown for 15 patients.

(24 years) were younger than non-Hispanic whites (37 years) and Asians (38 years). African Americans were less likely to have a fever and cough at presentation compared to other race/ethnicity groups, and African Americans and non-Hispanic whites were less likely to have vomiting or diarrhea compared to Hispanics and

Asians. Non-Hispanic whites were more likely to have shortness of breath at presentation, while Hispanics were less likely, compared to African Americans and Asians. African Americans were more likely to have a hematologic condition and be morbidly obese compared to other race/ethnicity groups. African Americans and Hispanics

Table 3. Diagnostic, Treatment, and Hospital Course Related Features by Race/Ethnicity Among Patients Hospitalized with Confirmed 2009 H1N1 Infection in Wisconsin, April 23 to August 15, 2009

Features	All Patients (N = 252)	White, non- Hispanic (n = 72)	Black, non- Hispanic (n = 121)	Hispanic (n = 40)	Asian (n = 19)	P-value ^a
Diagnostics, No. (%)^a						
Positive bacterial cultures ^b	19/241 (8)	7/67 (11)	7/117 (6)	5/39 (13)	0/18 (0)	0.26
Abnormal radiographic imaging ^c	123/229 (54)	42/69 (61)	44/105 (42)	26/37 (70)	11/18 (61)	0.008
Treatment, No. (%)^a						
Antivirals ^d	215/250 (86)	58/70 (83)	109 (90)	35 (88)	13 (68)	0.07
Antibiotics ^e	204/249 (82)	61/71 (86)	89/119 (75)	37 (93)	17 (89)	0.04
Illness onset to antiviral medication^f						
	(n = 214)	(n = 58)	(n = 109)	(n = 34)	(n = 13)	
<48 hrs	82 (38)	22 (38)	43 (39)	10 (29)	7 (54)	
48-96 hrs	45 (21)	7 (12)	30 (28)	7 (21)	1 (8)	0.10
>96 hrs	87 (41)	29 (50)	36 (33)	17 (50)	5 (38)	
Admission to antiviral ≤ 24 hrs ^g	164 (77)	39 (67)	88 (81)	25 (74)	12 (92)	0.12
Illness severity, No. (%)						
	(n = 252)	(n = 72)	(n = 121)	(n = 40)	(n = 19)	
Admission to intensive care unit	59 (23)	23 (32)	19 (16)	11 (28)	6 (32)	0.05
Death	11 (4)	4 (6)	4 (3)	2 (5)	1 (5)	0.89
Length of stay, No. (%)^{a,h}						
	(n = 247)	(n = 70)	(n = 120)	(n = 38)	(n = 19)	
0-2 days	98 (40)	23 (33)	52 (43)	11 (29)	12 (63)	
3-5 days	85 (34)	21 (30)	45 (38)	14 (37)	5 (26)	0.03
≥6 days	64 (26)	26 (37)	23 (19)	13 (34)	2 (11)	

^a Fisher's exact test was used to determine significance when a cell value was <5, Student's t-test was used to compare continuous variables, and Pearson chi-square test was used for all other comparisons.

^b Pathogenic bacteria were isolated from cultures of urine (7 patients), sputum (5), throat (2), tracheal aspirate (2), stool (3), and blood (2).

^c Radiologist's report includes at least 1 of 3 findings: opacities or infiltrates (78%), consolidation (21%), or pleural effusion (15%), detected by chest X-ray or chest CT. Among the 96 patients with opacities or infiltrates, 70% had bilateral opacities or infiltrates.

^d The influenza antiviral medications prescribed were oseltamivir only (98%), zanamivir only (1%), or both (1%).

^e The antibiotic medications prescribed were azithromycin (44%), ceftriaxone (37%), fluoroquinolone (36%), vancomycin (17%), or an anti-pseudomonal beta-lactam or cephalosporin (16%). Among these 204 patients, 74% received 2 or more antibiotics.

^f Time from illness onset to admission was calculated using the difference between date of admission and date of illness onset, with date of onset as day 0. The calculated difference was an integer value for days and was converted into hours.

^g Time from hospitalization to receipt of antiviral medication was calculated by finding the difference between the date of antiviral treatment initiation and the date of hospital admission. The calculated difference was an integer value for days and was then converted into hours.

^h Length of stay was calculated using the difference between dates of hospital discharge and hospital admission.

were less likely to have a chronic lung disorder compared to Asians and non-Hispanic whites. Hispanics and non-Hispanic whites were more likely to have cancer and be non-morbidly obese compared to African Americans and Asians. There were no significant racial/ethnic differences in time from illness onset to hospital admission.

Hospital Course

Among patients who had diagnostic testing or received either antiviral therapy or antibiotics during their hospital course, 8% had positive bacterial cultures, 54% had radiographic findings suggestive of pneumonia, 86% received an influenza antiviral medication, and 81% received an antibiotic (Table 3). Patients aged ≥50 years were more

likely than patients aged <18 and 18-49 years to have positive bacterial cultures (3%, 10%, 19%, $P=0.02$). Most patients received antiviral therapy within 72 hours from illness onset (52%) and within 24 hours after hospitalization (77%).

Fifty-nine (23%) patients were admitted to an intensive care unit (ICU) and 11 (4%) died (Table 3). Of the 59 patients admitted to an ICU, 34 (58%) required mechanical ventilation, and 29 (49%) had a clinical diagnosis of acute respiratory distress syndrome (ARDS). The median length of stay was 3 days (range=1-51 days). Patients aged ≥50 years were more likely than patients aged <18 and 18-49 years to have a length of stay of at least 6 days (24%,

Table 4. Illness Severity and Hospital Length of Stay by Time from Illness Onset and Hospitalization to Receipt of Antiviral Medication Among Patients Hospitalized with Confirmed 2009 H1N1 Infection in Wisconsin, April 23 - August 15, 2009

	Time from Illness Onset to Receipt of Antiviral				Time from Hospitalization to Receipt of Antiviral		
	<48 hour (n=82)	48-96 hour (n=45)	>96 hour (n=87)	P-value ^a	≤24 hr (n= 64)	>24 hr (n=50)	P-value ^b
Illness severity, No. (%)							
Admission to intensive care unit	15 (18)	10 (22)	28 (32)	0.04	30 (18)	23 (46)	<0.001
ARDS ^c	10 (12)	3 (7)	19 (22)	0.10	21 (11)	11 (22)	0.11
Mechanical ventilation ^d	6 (7)	4 (9)	24 (28)	<0.001	14 (9)	20 (40)	<0.001
Death	1 (1)	1 (2)	7 (8)	0.04	5 (3)	4 (8)	0.13
Length of stay, No. (%)^e	(n =82)	(n =42)	(n =85)		(n =160)	(n =49)	
0-2 days	43 (52)	14 (33)	18 (21)		69 (43)	5 (10)	
3-5 days	26 (31)	19 (45)	28 (33)	<0.001	60 (38)	14 (29)	<0.001
≥6 days	13 (16)	9 (21)	39 (46)		31 (19)	30 (61)	

a Cochran-Mantel-Haenszel test was used to assess for a trend.

b Fisher's exact test was used to detect differences in proportions.

c Acute respiratory distress syndrome.

d Invasive mechanical ventilation. Excludes non-invasive forms of mechanical ventilation (ie continuous positive airway pressure therapy [CPAP], BiPAP).

e Length of stay was calculated using the difference between dates of hospital discharge and hospital admission.

19%, 41%; $P=0.02$).

Among non-obese, non-morbidly obese, and morbidly obese patients, there were no statistically significant differences in the proportion of patients who were admitted to an ICU (26%, 29%, 21%, $P=0.73$), required mechanical ventilation (14%, 14%, 24%, $P=0.37$), or were hospitalized for at least 6 days (27%, 33%, 28%, $P=0.80$).

Racial/ethnic differences related to the hospital course are presented in Table 3. African Americans were less likely to have abnormal radiographic imaging, received an antibiotic, and been admitted to an ICU compared to other race/ethnicity groups. Hispanics and non-Hispanic whites were more likely to be hospitalized for at least 6 days compared to African Americans and Asians. There were no significant racial/ethnic differences in time from illness onset or admission to receipt of antiviral therapy, need for mechanical ventilation, acute respiratory distress syndrome (ARDS) occurrence, or mortality.

Time to Receipt of Antiviral Medication

Increasing time from illness onset to receipt of antiviral therapy was significantly associated with increasing proportions of patients requiring ICU admission, mechanical ventilation, and longer lengths of stay, and with increasing mortality (Table 4). Receipt of antiviral therapy within 48 hours of onset provided the most benefit.

Similarly, patients who received an antiviral medication within 24 hours of hospitalization were significantly less likely to be admitted to an ICU, need mechanical ventilation, and be hospitalized for >2 days compared to patients who received an antiviral medication >24 hours after hospitalization (Table 4).

DISCUSSION

This cohort is inclusive of all patients hospitalized for at least 24 hours with 2009 H1N1 infection in Wisconsin during April 23 through August 15, 2009. This interval constituted the first wave of the 2009 H1N1 pandemic in Wisconsin, which was centered in the city of Milwaukee and led to disproportionately higher hospitalization rates among African Americans, Asians, and Hispanics compared to non-Hispanic whites. Despite finding differences in epidemiologic and clinical characteristics between racial/ethnic groups who were hospitalized with 2009 H1N1 infection, we found no racial/ethnic differences in illness severity or outcomes.

The lack of association between race/ethnicity and illness severity or outcomes among hospitalized patients with 2009 H1N1 infection is unexpected. Initial studies of critically ill patients in Canada⁶ and surveillance reports from Canada, Australia, New Zealand, and the United States⁷⁻⁹ noted that racial/ethnic minority populations with 2009 H1N1 infection had high rates of hospitalization, critical illness, and death. The causal mechanisms explaining these findings are unclear, but 1 possible explanation is the higher prevalence of underlying medical conditions that are risk factors for seasonal influenza among racial/ethnic minority populations.⁶⁻⁹ In our study, we found that African Americans were more likely to have hematologic conditions, Hispanics and non-Hispanic whites were more likely to have cancer, Asians and non-Hispanic whites were more likely to have a chronic lung disorder, and Asians were less likely to have 1 or more underlying conditions that are risk factors for sea-

sonal influenza compared to other racial/ethnic groups. Since relatively few patients had a hematologic condition, cancer, or a chronic lung condition, it is unlikely that the increased proportion of any of these medical conditions among any of the racial/ethnic groups accounts for the racial/ethnic differences in hospitalization rates of 2009 H1N1 infection in our study.

Other possible reasons for the racial/ethnic differences in rates of hospitalization for 2009 H1N1 infection in our study include delayed access to care, household size and socioeconomic status, and age of household members. Although our study did not include information on the insurance status of patients or the number of outpatient or urgent care visits prior to hospitalization, we did not find any racial/ethnic differences in time from illness onset to admission or receipt of antiviral therapy, and time from hospitalization to receipt of antiviral therapy. Previously reported studies of hospitalized patients with 2009 H1N1 infection have noted receipt of antiviral therapy within 48 hours of illness onset was associated with increased survival and fewer ICU admissions.^{10,11} The absence of racial/ethnic differences in the proportion of hospitalized patients who received antiviral therapy within 48 hours of illness onset and within 24 hours of admission may, in part, explain the lack of association between race/ethnicity and illness severity or outcomes in our study.

Data regarding household size, socioeconomic status, and age of household members were not obtained in this study, and the influence these factors had in contributing to racial/ethnic differences in hospitalization rates of 2009 H1N1 infection could not be evaluated. Further studies examining the influence household factors have on the association between race/ethnicity and 2009 H1N1 infection are warranted. Although the reasons for racial/ethnic disparities among patients hospitalized with 2009 H1N1 infection have not been elucidated, strategies to reduce morbidity and mortality related to future waves of 2009 H1N1 infection among vulnerable populations are needed.¹²

Because racial/ethnic disparities in receipt of seasonal influenza vaccine¹³ can lead to disproportionate mortality,¹⁴ assuring equal access to influenza vaccines may reduce racial/ethnic disparities in morbidity and mortality caused by 2009 H1N1 infection. When the supply of the 2009 H1N1 influenza vaccine was sufficient, the CDC recommended that providers offer the vaccine to all patients in an attempt to reduce the complications associated with the 2009 H1N1 infection.¹⁵ To achieve these goals, providers and health departments will need to assure that influenza vaccination campaigns suffi-

ciently focus on racial/ethnic groups that have been disproportionately impacted by 2009 H1N1 infection.

Our study contributes to current literature regarding the clinical characteristics of 2009 H1N1 infection among hospitalized patients. The demographic features of our population confirm the downward shift in age among hospitalized patients with 2009 H1N1 infection compared to those typically hospitalized with seasonal influenza. The median age among our hospitalized population (28 years) was similar to those in previous studies among persons hospitalized with 2009 H1N1 infection,^{10,11} but lower than that for seasonal influenza.¹⁶ The lower median ages among Hispanics and African Americans compared to those among non-Hispanic whites and Asians in our study may contribute to the increased hospitalization rates among Hispanics and African Americans but not Asians. Similar to findings in California¹¹ and Chicago,¹⁷ we noted hospitalization rates were higher among children aged <1 year compared to patients aged ≥ 60 years. The decreased hospitalization rate among patients aged ≥ 60 years may be related, in part, to the presence of cross-reactive antibodies to 2009 H1N1 from a previous influenza virus infection or vaccination.¹⁸

The most prevalent risk factor for 2009 H1N1 infection in our study was asthma; 32% of all hospitalized patients in this cohort had a history of asthma. The estimated prevalence of asthma in Wisconsin is 9.3%, but among females and African Americans in Wisconsin, and among residents of Milwaukee County, it is 13% to 15%.¹⁹ These demographic features were prevalent among this hospitalized cohort and may partially account for the increased prevalence of asthma noted in our study. However, because we did not obtain data regarding asthma severity and current use of corticosteroids, we could not determine whether these factors also contributed to the increased prevalence of asthma among patients in our study.

The prevalence of obesity (44%) and morbid obesity (22%) among patients in our study was notably higher than the estimated prevalence of obesity (26.2%, 95% CI 24.6-27.8%) in 2007 among Wisconsin adults aged ≥ 20 years,²⁰ and morbid obesity (2%) in 2001 among Wisconsin adults aged ≥ 18 years.²¹ Although there were racial/ethnic differences among patients who were obese or morbidly obese, we did not find that obesity or morbid obesity was independently associated with measures of illness severity or outcomes. Other studies among hospitalized patients with 2009 H1N1 infection have also demonstrated a high prevalence of obesity and morbid obesity.^{6, 10,11} Nonetheless, there has been a lack

of data linking obesity as an independent risk factor to 2009 H1N1 infection or to increased complications associated with infection. Further studies investigating the association between obesity and 2009 H1N1 infection among hospitalized patients are needed.

Our study has several limitations. We did not obtain data regarding household size and socioeconomic status, and could not determine the influence these factors had in contributing to racial/ethnic differences in hospitalization rates of 2009 H1N1 infection. Also, because we examined only confirmed cases of 2009 H1N1 infection, we were unable to calculate the specificity or positive and negative predictive values of the reverse transcription-polymerase chain reaction assay among hospitalized patients. Additionally, our group of patients may not be representative of all hospitalized patients who were tested for 2009 H1N1 infection.

CONCLUSION

In summary, the first wave of the 2009 H1N1 pandemic in Wisconsin was centered in the city of Milwaukee and disproportionately affected African Americans, Asians, and Hispanics. Preventive measures that include focused educational campaigns to assure high rates of influenza vaccination among all racial/ethnic groups should help minimize the morbidity and mortality associated with future waves of 2009 H1N1 and other influenza virus infections.

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