

National Prevalence of Influenza Diagnoses and Vaccination Rates Among Patients Presenting to United States Physician Offices and Hospital Outpatient Departments, 2009 to 2016

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Background. Influenza health resource utilization studies are important to inform future public health policies and prevent outbreaks. This study aimed to describe influenza prevalence, vaccination, and treatment among outpatients in the United States and to evaluate population-level characteristics associated with influenza health resource utilization.

Methods. Data were extracted from the National Ambulatory and National Hospital Ambulatory Medical Care Surveys (2009 to 2016). Prevalence rates were described as influenza visits (defined by *International Classification of Diseases, Ninth Revision, Clinical Modification* or *International Classification of Diseases, Tenth Revision* code) per 1000 total visits overall and by flu year, month, region, race, and age group. Influenza vaccination and antiviral treatments were identified by Multum code(s) and presented as vaccination visits per 1000 total visits and the percentage of patients diagnosed with influenza receiving antiviral treatment.

Results. In more than 19.2 million patient visits, an influenza diagnosis was made with rates ranging from 1.2 per 1000 during 2014–2015 to 3.7 per 1000 during 2009–2010. Rates were highest in the South (3.6 per 1000), in December (5.2), among black patients (2.8), and those less than 18 years (6.8). Vaccination rates were highest during 2014–2015 (29.3 per 1000) and lowest during 2011–2012 (15.5 per 1000), in the West (23.4), in October (69.2), among “other race” patients (26.2), and age less than 18 years (51.4). Overall, 39.4% of patients with an influenza diagnosis received an antiviral.

Conclusions. Overall, there were no major changes in influenza diagnosis or vaccination rates. Patient populations with lower vaccination rates had higher influenza diagnosis rates. Future campaigns should promote influenza vaccinations particularly in underserved populations.

Keywords. influenza; influenza diagnosis; influenza vaccination rates; influenza treatment; prevalence of influenza.

Influenza is a contagious viral illness and one of the most common causes of human respiratory infections worldwide [1]. Although seasonal influenza is often self-limiting in healthy adults, the virus can lead to more severe complications such as pneumonia and influenza-associated encephalopathy, particularly in the elderly population [2]. According to the World Health Organization, approximately 250 000 to 650 000 people die annually from the seasonal influenza virus, predominantly in patients over the age of 75 years [3].

The influenza virus is characterized by its ease of transmission from human to human through small and large droplets

[4]. Transmissibility coupled with the ability to mutate can lead to large outbreaks, epidemics, and even pandemics, as seen from the most recent H1N1 pandemic in 2009 [2]. Typically, the influenza season spans 3 to 6 months, peaking in colder months [5]. The 2018–2019 season saw a rise in activity between September 2018 and May 2019, with a peak during mid-February [6].

Currently, the most effective preventable method against the influenza virus is the seasonal influenza vaccine. The vaccine requires annual reformulation to counteract the constantly changing virus leading to antigenic mismatch and imperfect effectiveness [7]; however, influenza vaccines still offer significant protection against mismatched strains [8]. Despite this, vaccination rates in the United States have not significantly changed since 2013, with vaccination rates ranging from 41.7% in 2015–2016 to an estimated 37.1% in 2017–2018 among adults [9, 10]. These numbers fall below the goal set by Healthy People 2020, a nationwide program set to improve overall health, which aimed to have 70% of Americans over 6 months of age vaccinated against influenza [11]. Lower vaccination rates can be linked to a myriad of factors, including overall perception and knowledge of receiving the influenza vaccine, access to care, and provider

Received 4 December 2020; editorial decision 22 March 2021; accepted 23 March 2021.

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Open Forum Infectious Diseases® 2021

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DOI: 10.1093/ofid/ofab148

recommendations [12]. Although the availability of the influenza vaccine has been expanded to include community pharmacies, outpatient physician offices and hospital outpatient departments remain a critical site for vaccination and treatment of patients with influenza; however, it is unclear the extent to which patients are seeking care for these health resources in these settings. Specifically, identifying certain patient characteristics associated with higher influenza diagnosis and lower vaccination rates could help to inform future public health campaigns, allocation of resources, and prevention of outbreaks in underserved communities. Therefore, the objectives of this study were to (1) describe the prevalence of influenza, influenza vaccination rates, and treatment among US outpatients and (2) evaluate population-level characteristics associated with health resource utilization for influenza.

METHODS

Data Source

This was a cross-sectional study of the Centers for Disease Control and Prevention (CDC) National Ambulatory Medical Care Survey (NAMCS) and the National Hospital Ambulatory Medical Care Survey (NHAMCS) from 2009 to 2016. The NAMCS collects medical information on a systematic random sample of outpatients seen in community physician offices in the United States, including private practice and free-standing clinics. In contrast, the NHAMCS collects medical information from hospital emergency and outpatient departments. Providers included within these surveys are assigned a 1-week reporting period to collect information on a sample of patient visits, including patient demographics, diagnoses, medications, diagnostic procedures, and future treatment plans. Each NAMCS and NHAMCS record, or patient visit, contains a single weight derived through a multistage estimation procedure. This single weight can be used to extrapolate each patient visit to national estimates [13].

Data Statement

Data are publicly available from the CDC's National Center for Health Statistics.

Patient Population and Study Definitions

All patient visits in the NAMCS and NHAMCS from 2009 to 2016 were eligible for inclusion. Influenza diagnosis was identified using the *International Classification of Diseases, Ninth Revision, Clinical Modification* codes (487.1) for survey years 2009 to 2015 and *International Classification of Diseases, Tenth Revision* codes (J10.1, J11.1) for 2016. From 2009 to 2013, only 3 diagnosis codes were collected for these surveys compared with 5 from 2014 to 2016.

Multum codes were used to identify orders for the influenza vaccination (d01164), oseltamivir (d04462), or zanamivir (d04443). Eight medications were collected from 2009 to 2011,

10 medications were collected between 2012 and 2013, and 30 medications were collected from 2014 to 2016. To maintain consistency in evaluating trends throughout all survey years, overall trends and rates included only the first 3 diagnosis codes and 8 Multum codes. Furthermore, due to an expansion diagnosis and Multum codes between 2014 and 2016, a sensitivity analysis between these years as well as the 2013–2014 to 2015–2016 flu seasons was performed to focus on more recent diagnosis, vaccination, and treatment rates.

Patient characteristics evaluated included age, sex, race, and ethnicity. Age was presented as a continuous variable and categorized into age group: less than 18 years, 18–64 years, and over 64 years. Race was categorized as white only, blacks, and “other race”, which included American Indian/Alaska Native only, Asian only, Native Hawaiian/Pacific Islander only, and more than 1 race. Ethnicity included Hispanic/Latino and non-Hispanic/non-Latino. Influenza season was defined as August to July of the following year. Geographic region was defined by the US Census Bureau as the Northeast, South, Midwest, West. Visit month was collected to evaluate seasonal variation in influenza.

Data and Statistical Analyses

Descriptive and statistical data analyses were performed using JMP Pro 14 (SAS Institute, Cary, NC). Data weights were used to extrapolate sample visits to national estimates for all analyses performed in this study. Baseline characteristics were compared between visits with and without an influenza diagnosis, as well as visits with and without an influenza vaccination using the χ^2 or Wilcoxon rank-sum tests as appropriate. Prevalence rates for influenza diagnoses were presented as influenza visits per 1000 total patient visits overall and by survey year, month, US geographic region, race, ethnicity, and age group. Similarly, influenza vaccination rates were calculated as visits that included an influenza vaccination per 1000 total patient visits. Diagnosis and vaccination rates in each subpopulation were calculated using population-specific denominators. Annual trends in influenza diagnoses and vaccinations were assessed using a logistic regression with influenza diagnosis (yes/no) and vaccination (yes/no) as the dependent variables and the year (ordinal) as the independent variable. These analyses were further reported as odds ratios (ORs). Antiviral treatment was described as the percentage of patients with an influenza diagnosis who received antiviral treatment.

RESULTS

Population Characteristics

Within 8 years of data (2009 to 2016), a total of 7.4 billion patient visits were included for analysis. Of those, 19 258 650 visits (2.6 per 1000 patient visits) included an influenza diagnosis, and 145 272 987 visits (19.5 per 1000) included an influenza

vaccination. Characteristics of patient visits between 2009 and 2016 are presented in Table 1. Overall, patients who were diagnosed with influenza were younger compared with those who were not diagnosed (median age 19 vs 49 years). Likewise, patients who received an influenza vaccine were also younger compared with those who did not receive an influenza vaccine (median age 19 vs 50 years). Sex, race, and ethnicity were numerically similar between groups; however, these were statistically different due to the large sample size.

Overall Influenza Diagnosis, Vaccination, and Treatment Rates

A total of 2.6 per 1000 patient visits included an influenza diagnosis over the study period (Figure 1). Overall, compared to 2009, subsequent years showed a decline in influenza diagnosis rates, with an OR ranging from 0.14 in 2015 to 0.56 in 2016. In addition, influenza diagnosis rates varied by flu season, with the lowest rate occurring during the 2014–2015 season (1.2 per 1000) and highest during the 2009–2010 season (3.7 per 1000). Overall, a total of 19.5 per 1000 visits included an influenza vaccination. When comparing vaccination rates to 2009, rates were higher in survey years 2010 to 2011 (OR = 1.27 and 1.15, respectively) and 2013 to 2015 (OR = 1.27, 1.44, and 1.15, respectively). However, survey years 2012 and 2016 (OR = 0.91 and 0.7, respectively) showed lower rates compared to 2009. By flu season, vaccination rates were highest during the 2014–2015 season (29.3 per 1000) and lowest in during the 2011–2012 season (15.5 per 1000). Of patients with an influenza diagnosis, 39.4% received antiviral treatment, but this varied over the study period. Antiviral treatment ranged from 20.2% in 2010 to 56.8% in 2011.

When incorporating additional data between the 2013–2014 and 2015–2016 seasons, influenza diagnosis increased in 2014–2015 and 2015–2016 to 1.5 and 2.5 per 1000, respectively, whereas they remained consistent in 2013–2014 (1.5 per 1000, respectively). In addition, vaccination rates increased for all 3

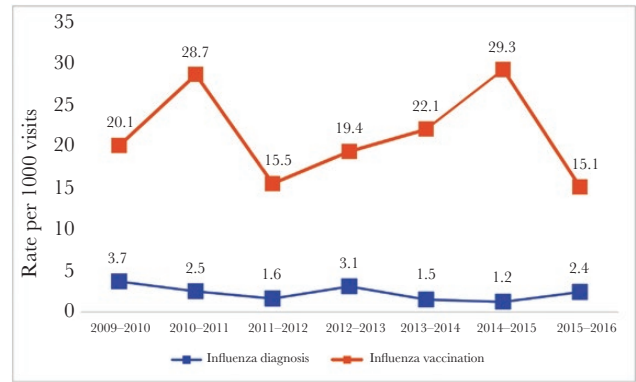


Figure 1. Influenza diagnosis and vaccination rates by survey year.

seasons—2013–2014 increased to 23.3 per 1000, 2014–2015 increased to 34.7 per 1000, and 2015–2016 increased to 16.0 per 1000. Antiviral treatment also ranged from 43.3% in 2013–2014 to 52.7% in 2014–2015.

Regional and Seasonal Variation in Influenza Diagnosis, Vaccination, and Treatment

Influenza diagnosis was highest in the South (3.6 per 1000), followed by the Midwest (2.4 per 1000), West (2.0 per 1000), and Northeast (1.5 per 1000) (Figure 2). In contrast, influenza vaccination rates were highest in the West and Northeast (23.4 and 22.1 per 1000, respectively). Influenza treatment was most common in the South (45.6%), followed by the Northeast (36.5%), Midwest (33.4%), and West (24.9%).

A sensitivity analysis between 2014 and 2016 showed that both the Midwest and South had the highest influenza diagnosis rates (2.2 per 1000). Vaccination rates were also highest in the Northeast (25.3 per 1000), whereas influenza treatment was also most common in the Midwest (59.3%).

Influenza diagnosis mostly commonly occurred in the winter months of December (5.3 per 1000), January (4.0 per

Table 1. Characteristics by Receipt or Influenza Diagnosis and Vaccination (2009–2016)

Characteristic ^a	Influenza (n = 19 258 650)	No Influenza (n = 7 424 388 645)	Vaccination (n = 145 272 987)	No Vaccination (n = 7 298 374 308)
Age (years), median (interquartile range)	19 (7–42)	49 (26–66)	19 (4–59)	50 (26–66)
Female sex, %	57.5	58.0	52.2	58.1
Race, %				
White only	58.3	60.4	54.5	60.5
Blacks only	9.4	8.7	6.9	8.7
Asian only	3.0	3.4	4.7	3.4
American Indian/Alaska Native	0.5	0.3	0.3	0.3
Native Hawaiian/Pacific Islander	0.3	0.2	0.2	0.2
More than 1 race	0.2	0.3	0.3	0.3
Hispanic or Latino ethnicity, %	11.9	10.3	13.5	10.2

^aAll comparisons between influenza vs no influenza groups and vaccination vs no vaccination groups statistically significant at *P* < .0001.

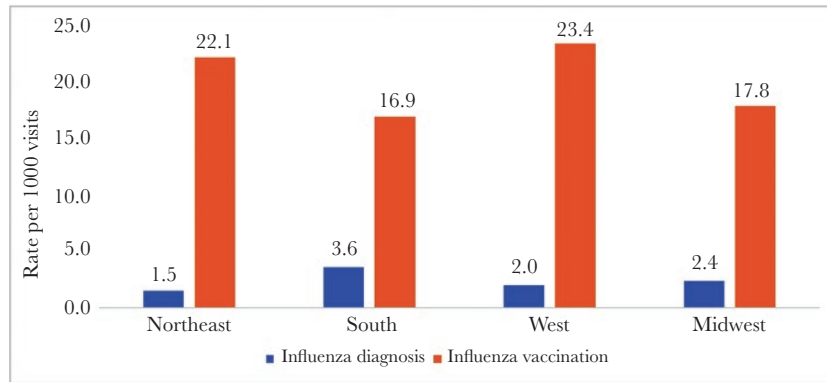


Figure 2. Influenza diagnosis and vaccination rates by geographic region (2009 to 2016).

1000), and February (5.2 per 1000) (Figure 3); however, rates began increasing in September (2.1 per 1000) and remained elevated through March (3.6 per 1000). Influenza vaccination rates peaked in October (69.2 per 1000). Influenza treatment was highest in November (49.5%), followed by March (46.9%), and February (44.8%). Between 2014 and 2016, influenza diagnosis was commonly seen in December (4.6 per 1000). October saw the highest vaccination rates (76.8 per 1000) and treatment (55.6%).

Population Characteristic Variation in Influenza Diagnosis, Vaccination, and Treatment

When stratifying patients by age group, patients less than 18 years old have the highest rates of influenza diagnosis (6.8 per 1000) and influenza vaccination (51.4 per 1000) (Figure 4). More pediatric patients received antiviral treatment (42.8%), compared with adults (35.4%) and older adults (33.0%). Between 2014 and 2016, pediatric patients had the highest influenza diagnosis and vaccination rates (4.3 and 43.9 per 1000,

respectively), whereas older adults most commonly received antiviral treatment (88.1%).

Influenza rates also varied by race and ethnicity. Blacks had the highest influenza diagnosis rates (2.8 per 1000), followed by patients of white and “other” race (2.5 per 1000) (Figure 4). Other race patients had the highest vaccination rates (26.2 per 1000), followed by white (17.7 per 1000) and black patients (15.6 per 1000). Blacks also most commonly received antiviral treatment (47.3%), compared with those of white race (35.0%). Hispanics/Latinos also had a higher diagnosis rate (3.0 per 1000) compared with non-Hispanic/non-Latinos (2.5 per 1000), despite having a higher vaccination rate (25.6 vs 18.3). When analyzing population characteristics between 2014 and 2016, other race patients had the highest diagnosis and vaccination rates (2.4 and 27.3 per 1000, respectively) compared with black (2.2 and 17.1 per 1000, respectively) and white patients (1.5 and 18.5 per 1000, respectively). Although Hispanic/Latino patients had higher diagnosis rates compared with non-Hispanic/non-Latinos (2.0 vs 1.7 per 1000, respectively), non-Hispanic/

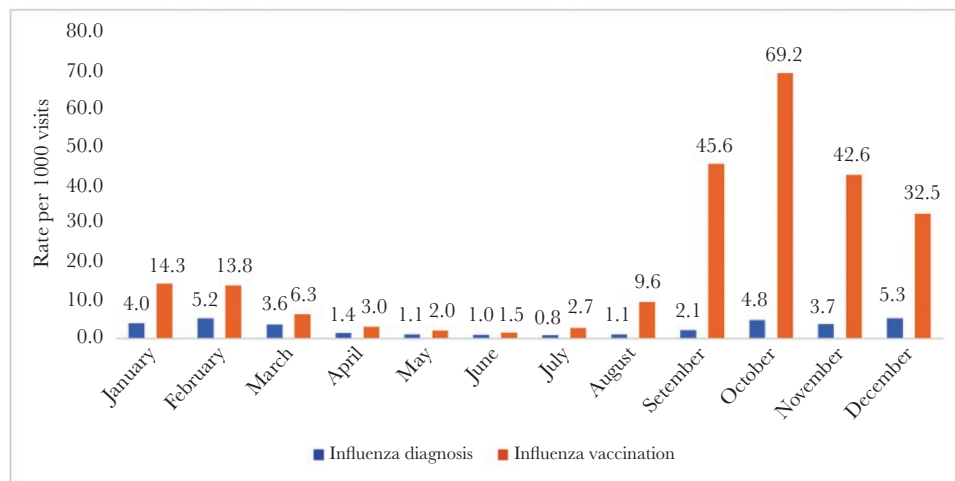


Figure 3. Influenza diagnosis and vaccination rates by month.

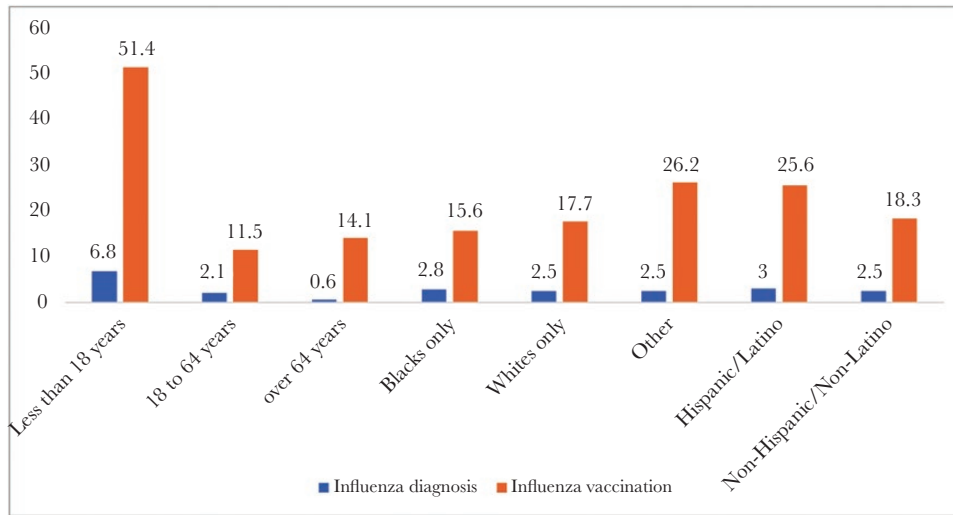


Figure 4. Influenza diagnosis and vaccination rates by age group, race, and ethnicity.

non-Latino patients had higher vaccination rates compared with Hispanic/Latino patients (19.7 vs 18.0 per 1000, respectively). Finally, black patients more commonly received antiviral treatment (55.7%) compared with white patients (39.1%), whereas Hispanic/Latino and non-Hispanic/non-Latino patients received similar treatment amounts (45.9%).

DISCUSSION

In this nationally representative study of US outpatients, influenza diagnoses and the provision of influenza vaccinations and treatment were relatively uncommon overall and did not significantly change over the study period. More importantly, certain patient populations were less likely to be vaccinated and more likely to be diagnosed with influenza, which could help inform future public health initiatives and allocation of resources to optimize influenza prevention and treatment.

Data from this study add to the growing body of influenza surveillance data collected and analyzed in various patient populations. Annually, the CDC reports approximate influenza vaccination coverage for all Americans using data collected from the National Immunization Survey-Flu and Behavioral Risk Factor Surveillance System. In line with our findings, the CDC reported relatively stable vaccination rates for Americans over the last decade and significant variation by state, season, and population characteristics [14]. Given that these surveys assess vaccination at various locations (including physician offices, hospitals, other medical clinics, and community pharmacies), overall vaccination estimates are higher than what was found in our study.

Season variation in influenza has been well described and has been attributed to seasonal decline in host health, ambient temperatures, and increased use of indoor heating creating an

ideal arid environment for viral particle persistence [15, 16]. In contrast, regional differences in influenza diagnoses may be partly explained by lower vaccination rates. For example, our study found that the highest influenza diagnosis rate and lowest vaccination rate both occurred in the South. The reason behind the lower rates of vaccination in certain regions (eg, South and Midwest) are not fully understood, but it may be associated with population vaccine perceptions and lower population density.

The present and previous studies support variation in influenza diagnosis and vaccination by age group. A study by Tokars et al [17] found that between 2010 and 2016, the highest proportion of vaccinated and unvaccinated patients with an influenza diagnosis were those less than 18 years (9.3%), followed by patients 18 to 64 years (8.9%), and those over 64 years (3.9%). Jayasundara et al [18] also noted significantly higher influenza attack rates among children (15.2%) were significantly higher than adults (3.5%). These variations may be explained by the underdevelopment of a child's adaptive immune response [19]. In our study, children had much higher vaccination rates than adults and older adults. This is likely explained by the availability of alternative locations for vaccinations for adults. Previous data from the CDC suggest that physician's offices are the primary source of vaccination for children, whereas adults seek vaccination more commonly at community pharmacies, which were not included in this analysis [20]. This could be in part due to some state laws that restrict community pharmacies from immunizing patients under a certain age [21].

Differences in influenza diagnoses and vaccination rates were also seen between racial and/or ethnic groups. In particular, blacks had the highest influenza diagnosis rates and lowest vaccination rates among all survey years studied. A prior study by Lu et al [22] found that non-Hispanic blacks were

significantly less likely to receive the influenza vaccination in adults 18–49 years (34.0%; 95% confidence interval [CI], 32.4–35.6), 50–64 years (38.4%; 95 CI, 34.1–42.9) and older adults 65+ years (53.4%; 95% CI, 48.5–58.1) after controlling for demographic and access-to-care characteristics (ie, education, employment status, health insurance, etc). These differences may be explained by attitude towards the influenza vaccine, occupation, and dependence on public exposure [23, 24].

Vaccine hesitancy due to misconceptions regarding its efficacy and safety remains a critical problem in the United States and may be contributing to population variations in vaccination rates found in our study [25]. A systematic review performed by Yeung et al [12] showed that a patients' likeliness to receive the influenza vaccine were dependent on several factors, including demographics (eg, age) (OR, 1.06–23.7), knowledge of the influenza vaccination (OR, 1.6–3.3), presence of other chronic disease states (OR, 1.38–13.7), vaccine efficacy (OR, 2.7–10.55), access to free vaccination (OR, 4.5–7.8), and advice from healthcare professionals (OR, 1.23–13.0). These are important factors to consider in the development of future public health initiatives to reduce the vaccine coverage gap among different population demographics.

Limitations

This study has potential limitations. First, the cross-sectional design of the NAMCS and NHAMCS provides information for a single patient visit; therefore, prior history and longitudinal follow-up are not available. Next, the number of diagnoses and medications collected varied by survey year. We assessed up to the minimum number of diagnoses and medications available for all survey years so that trend analyses would not be affected; however, certain diagnoses and medications may have been missed using this procedure. Next, the surveys used in this study collected data only on outpatient physician offices and hospital emergency and outpatient departments; therefore, the study findings are not representative and underestimate overall vaccine coverage in the United States, including inpatient settings and community pharmacies. The NAMCS and NHAMCS also exclude federal clinics, so results may not be generalizable to those populations.

CONCLUSIONS

In this nationally representative study, influenza diagnosis rates remained relatively stable from 2009 to 2016 among patients seen in US physician offices or hospital emergency or outpatient departments. Monthly influenza vaccination and diagnosis rates followed expected trends, peaking in fall and winter, respectively. Certain population characteristics (age group, region, race, and ethnicity) experienced higher influenza diagnosis rates and lower vaccination rates. Findings from this study support enhanced efforts to improve influenza vaccination efforts, particularly in underserved populations.

Acknowledgments

Potential conflicts of interest. All authors: no reported conflicts of interest. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest.

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