American Journal of
Preventive Medicine

RESEARCH ARTICLE

Vaccination Coverage of Adolescents With Chronic Medical Conditions

Annika M. Hofstetter, MD, PhD, MPH,[1,2,3] Stewin Camargo, MS,[1] Karthik Natarajan, PhD,[4,5] Susan L. Rosenthal, PhD,[1,5,6] Melissa S. Stockwell, MD, MPH[1,5,7]

Introduction: Adolescents with chronic medical conditions (CMCs) are at increased risk of vaccine-preventable infections. Little is known about their vaccine uptake.

Methods: This retrospective cohort study included 3,989 adolescents aged 11–17 years receiving care at academically affiliated pediatric clinics between August 2011 and June 2013. Data were abstracted from the medical center's electronic health record and immunization registry in 2014. Vaccination coverage, timeliness, and missed opportunities were evaluated and analyzed in 2015–2016.

Results: Adolescents with CMCs had lower human papillomavirus vaccination initiation than those without CMCs (81.3% vs 85.0%), although this difference was only observed in stratified analysis among males (adjusted relative risk=0.90, 95% CI=0.85, 0.96), aged 13–17 years (adjusted relative risk=0.94, 95% CI=0.91, 0.98), and those with more primary care visits (adjusted relative risk=0.94, 95% CI=0.91, 0.98). Adolescents with CMCs had greater influenza vaccination coverage and timeliness than those without CMCs (2011–2012 season: 66.9% vs 50.1%; adjusted hazards ratio=1.27, 95% CI=1.15, 1.40; 2012–2013 season: 73.8% vs 64.5%; adjusted hazards ratio=1.20, 95% CI=1.10, 1.31). Only 32.1% and 18.2% of eligible adolescents had received pneumococcal polysaccharide and 13-valent pneumococcal conjugate vaccines, respectively. Missed opportunities were higher among adolescents with versus without CMCs for human papillomavirus vaccination initiation (4.2 vs 2.7, $p<0.001$), meningococcal vaccination (4.0 vs 2.9, $p<0.001$), and influenza vaccination (2011–2012 season: 2.1 vs 1.7, $p<0.001$; 2012–2013 season: 2.0 vs 1.6, $p<0.001$). Missed opportunities for pneumococcal vaccination were common.

Conclusions: Pockets of undervaccination and missed opportunities exist among adolescents with CMCs. Greater, more timely influenza vaccination suggests that optimal vaccination of high-risk adolescents is possible.

Am J Prev Med 2017;53(5):680–688.

INTRODUCTION

An estimated one in every six to ten adolescents has a chronic medical condition (CMC).[1–4] Many are at increased risk of vaccine-preventable infection with high morbidity and mortality.[5–18] The Advisory Committee on Immunization Practices (ACIP) recommends that all adolescents, irrespective of CMC status, receive human papillomavirus (HPV), tetanus-diphtheria-acellular pertussis (Tdap), meningococcal, and seasonal influenza vaccines.[12,13,19,20] Because of increased risk, adolescents with certain CMCs may also

From the [1]Department of Pediatrics, Columbia University, New York, New York; [2]Department of Pediatrics, University of Washington, Seattle, Washington; [3]Seattle Children's Research Institute, Seattle, Washington; [4]Department of Biomedical Informatics, Columbia University, New York, New York; [5]New York-Presbyterian Hospital, New York, New York; [6]Department of Psychiatry, Columbia University, New York, New York; and [7]Department of Population and Family Health, Mailman School of Public Health, Columbia University, New York, New York

Address correspondence to: Annika Hofstetter, MD, PhD, MPH, Assistant Professor of Pediatrics, Department of Pediatrics, University of Washington, 1900 Ninth Ave, M/S JMB-9; Seattle WA 98101. E-mail: annika.hofstetter@seattlechildrens.org.

0749-3797/$36.00
https://doi.org/10.1016/j.amepre.2017.07.017

require early meningococcal vaccination, pneumococcal polysaccharide vaccination (PPSV), or catch-up 13-valent pneumococcal conjugate vaccination (PCV13).[12,21]

Previous studies suggest that adolescents with CMCs may have suboptimal uptake of routine, seasonal, and specially indicated vaccines.[22–33] However, many of these studies relied on parental report or insurance claims rather than documented vaccination, focused only on certain conditions (e.g., cancer, asthma, systemic inflammatory diseases) or vaccines (e.g., HPV, influenza), or lacked a healthy comparison population. Therefore, a comprehensive investigation of coverage, timeliness, and missed opportunities for all recommended vaccines using robust immunization registry data in a large sample of adolescents with a broad range of CMCs and a healthy comparison population is needed.

This retrospective cohort study aims to describe timely receipt and missed opportunities for all recommended vaccines among adolescents with and without CMCs from an urban underserved community. Hypotheses are that (1) adolescents with CMCs would have lower and less timely coverage and many missed opportunities for routine vaccines other than influenza, compared with adolescents without CMCs; (2) coverage for specially indicated vaccines would be markedly low with frequent missed opportunities; and (3) subpopulation differences would exist.

METHODS

Study Population

This retrospective cohort study was conducted in four pediatric primary care clinics that serve a low-income minority population and are staffed by faculty from an academic medical center in New York City (NYC). The clinics use a common electronic health record (EHR) and have the same vaccine-related policies and procedures. During the study period, they used no vaccine reminder/recall strategies other than reminder cards for the second and third HPV vaccine doses. Individuals were included if they were aged 11–17 years and had one or more visits to a participating clinic between August 1, 2011 and June 30, 2013 (N=3,989). Some subjects also received care in a pediatric subspecialty clinic at the medical center during the study period. This study was approved by the Columbia University Medical Center IRB with a waiver of consent.

Demographic, visit, and clinical data were obtained from the medical center's billing/registration system and EHR in 2014. Vaccine data were obtained from the medical center's immunization registry, EzVac, which includes all vaccines administered at the medical center and affiliated sites. EzVac also synchronizes consistently with the New York Citywide Immunization Registry. Providers are required to report to the Citywide Immunization Registry all vaccines administered to patients aged <19 years in NYC.[34] It is estimated that ≥95% of adolescents are captured in the Citywide Immunization Registry.[35] Both registries accept manual entry of historical vaccinations. Thus, vaccines given at non-affiliated locations, both in NYC and elsewhere, are included in the study data.

Measures

Primary outcome measures included receipt of (1) HPV vaccine: one or more doses (i.e., initiation); three doses; and three doses among HPV vaccine series initiators (i.e., completion or follow-through)[36,37]; (2) Tdap vaccine: one or more doses[20]; (3) meningococcal vaccine: one or more doses, and up-to-date, defined as one dose among adolescents aged 11–15 years and two doses among adolescents aged 16–17 years (one dose if first dose received at age ≥16 years)[12]; and (4) influenza vaccine (one dose) during the 2011–2012 and 2012–2013 seasons.[38,39] For adolescents with CMCs placing them at increased risk of meningococcal or pneumococcal disease and related complications, receipt and timing of meningococcal, PPSV, and PCV13 were examined.[12,21] Primary outcomes were assessed for routine and specially indicated vaccines as of June 30, 2013. HPV vaccination completion was only examined among those who had received their first dose ≥24 weeks before this date.[36,37,40] For influenza, the final date of vaccine administration at participating clinics was used (June 13, 2012 for 2011–2012 season; June 18, 2013 for 2012–2013 season). Secondary outcomes included influenza vaccination timeliness and missed vaccination opportunities. Missed opportunities were calculated as the number of primary care visits during which the patient was eligible for, but failed to receive, the vaccine of interest.

The main independent variable was the presence of one or more CMCs (Appendix Table 1, available online). CMCs were selected a priori based on existing literature[2,41–43] and ACIP recommendations.[12,20,21,36–39] They were identified using ICD-9 codes, previously shown to have a 90% accuracy in detecting high-risk children with vaccination needs.[42] Two or more ICD-9 codes in a pre-specified category were required during visits between August 1, 2010 and June 30, 2013.[43] Other independent variables included sex, age, parent language, insurance, primary care clinic, number of primary care visits, and any subspecialty clinic visit at the medical center (yes, no). Visits were evaluated between August 1, 2011 and June 30, 2013 for routine and specially indicated vaccines, and between August 10, 2011 and June 13, 2012 and August 14, 2012 and June 18, 2013 for influenza vaccine.

Statistical Analysis

Differences in demographic and visit characteristics by CMC status were examined using Pearson's chi-square, Fisher's exact, and Wilcoxon rank-sum tests. HPV, Tdap, meningococcal, and influenza vaccination coverage were each compared between adolescents with and without CMCs using Pearson's chi-square test. When coverage for a given vaccine differed by CMC status, bivariate analyses were conducted to assess vaccination by the most common CMCs and by demographic, clinic, and visit characteristics. Modified Poisson regression[44] was then used to (1) estimate the relative risk and 95% CIs of overall CMC status in relation to vaccination, adjusting for demographic, clinic, and visit characteristics associated with vaccination in bivariate analysis ($p<0.20$); and (2) identify characteristics associated with vaccination in separate "CMC" and "No CMC" models with the same covariates. Modified Poisson regression was also used to determine predictors of PPSV and PCV13 receipt among eligible adolescents. Time to influenza vaccination during the 2011–2012 and 2012–2013