HHS Public Access

Author manuscript

J Adolesc Health. Author manuscript; available in PMC 2024 September 09.

Published in final edited form as:

J Adolesc Health. 2016 February ; 58(2): 241–244. doi:10.1016/j.jadohealth.2015.10.012.

Economic and Social Impact of Pertussis Among Adolescents in San Diego County

Aiden K. Varan, M.P.H.[a,b,c,*], **Kathleen H. Harriman, Ph.D., M.P.H., R.N.**[d], **Kathleen Winter, M.P.H.**[d], **Melissa D. Thun, R.N.**[b], **Eric C. McDonald, M.D., M.P.H.**[b]

[a]CDC/CSTE Applied Epidemiology Fellowship, Atlanta, Georgia

[b]County of San Diego Health and Human Services Agency, San Diego, California

[c]Division of Global Migration and Quarantine, Centers for Disease Control and Prevention, San Diego, California

[d]California Department of Public Health, Richmond, California

Abstract

Purpose: During recent pertussis epidemics, adolescents have experienced a large burden of disease. We assessed the impact of pertussis among San Diego adolescents and their households.

Methods: Parents of pertussis patients aged 13–17 years were surveyed about health care utilization, missed work and school, and other factors. Costs of medical visits, medication use, and lost wages were estimated.

Results: The parents of 53 (of 108 [49%]) eligible 2013 pertussis patients were interviewed; 51 (96%) of these patients previously received tetanus, diphtheria, and acellular pertussis vaccine. Medical visits included primary care (81%), urgent care (11%), and emergency department (9%); all patients received antibiotics. Forty-seven households (89%) received a post-exposure prophylaxis recommendation, and five (9%) reported ≥1 unpaid parental leave day. Thirty-eight patients (72%) missed ≥1 school day (mean = 5.4 days). Societal costs were estimated at $315.15 per household and $236,047.35 in San Diego during 2013–2014.

Conclusions: Even among vaccinated adolescents, pertussis can result in considerable societal costs.

Keywords

Pertussis; Adolescent; Cost of illness; Health care utilization; Absenteeism; Immunization; San Diego

Pertussis has resurged in recent years [1]. Although pertussis incidence and disease severity are greatest among infants [1], the burden among adolescents is substantial. Based on two

*Address correspondence to: Aiden K. Varan, M.P.H., Division of Global Migration and Quarantine, Centers for Disease Control and Prevention, 3851, Rosecrans Street, Suite Y15, San Diego, CA 92110. vvl5@cdc.gov (A.K. Varan).

Conflicts of Interest: No authors have any financial conflicts to disclose.

Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of CDC.

cohorts from 1998 to 2003, societal costs of adolescent pertussis were estimated at $397 per case [2].

Tetanus, diphtheria, and acellular pertussis vaccine (Tdap) was licensed in 2005 and mandated for all students entering seventh grade in California in 2011. Pertussis incidence among adolescents has increased despite high Tdap vaccination coverage [3,4]. After receipt of Tdap, pertussis immunity is initially high but wanes within 2–4 years [3,5]. In San Diego County, California, during the 2013–2014 pertussis epidemic, 749 (40%) of 1,873 reported confirmed and probable cases were aged 13–17 years (County of San Diego Health and Human Services Agency, unpublished data). We assessed the contemporary societal and economic impact of pertussis among San Diego adolescents.

Methods

Sample

Eligible patients had illnesses that met confirmed or probable pertussis case criteria [6] and were San Diego residents aged 13–17 years at the time of symptom onset. To capture school-associated impact, onset dates were restricted to September 1–December 31, 2013.

Survey

Parents (or other caregivers) of eligible patients were contacted via telephone during May–October, 2014 (≥3 call attempts) and invited to complete an interview in English or Spanish. Questions included symptom duration, medical visits, medication use, and missed work, school, and sports activities. Demographic, vaccination status, and laboratory testing data were obtained from California Department of Public Health case reports.

Analysis

We used the 2012 Red Book (Truven Health Analytics, Ann Arbor, MI) to identify pertussis management medications. To estimate clinical, laboratory, and prescription costs, we pooled 2010–2012 MarketScan data (Truven Health Analytics) for outpatient pertussis clinical consultations. Lost wages were estimated from 2013 Department of Labor data [7]. To assess societal costs, we applied cost estimates to per-household averages for health care utilization, prescription medications, and lost wages. Missing responses for health care, medications, or missed activities were assigned a zero value.

Statistical analyses were performed using SAS 9.3 (SAS Institute, Cary, NC). Bivariate comparisons were performed using Mantel–Haenszel exact chi-square tests assessed at $\alpha = .05$. This study was reviewed by the Committee for the Protection of Human Subjects, California Health and Human Services Agency, and deemed exempt from review.

Results

Among 108 eligible households, 63 were reached: 53 (49%) parents/caregivers agreed to participate and 10 refused. More participating than nonparticipating eligible households had female pertussis cases (66% vs. 40%; $p = .008$), but no significant differences in case classification, age, race/ethnicity, or Tdap vaccination were detected ($p > .05$).

Patient demographic features are presented in Table 1. The patients attended 29 San Diego schools. Median interval from symptom onset to interview was 9.3 months (range: 5.6–12.4 months). All patients had recovered from illness at the time of interview, except three with lingering cough. No patients had ever previously been diagnosed with pertussis. Fifty-one (96%) patients had previously received Tdap; one unvaccinated patient had a medical vaccination exemption. Among Tdap-vaccinated patients, median interval from vaccination to symptom onset was 3.3 years (range: 1.3–8.9 years). All except two (96%) patients had ≥4 doses of diphtheria, tetanus toxoids, and acellular pertussis vaccine during childhood: one received only three diphtheria, tetanus toxoids, and acellular pertussis vaccine doses and one had a medical vaccination exemption.

Forty-three patients (81%) had 1 primary care provider visit (mean ≥1.79 visits; range: 0–5 visits) during their pertussis illness. Other consultations included urgent care (6, 11%), emergency department (5, 9%), and medical specialists (3, 6%; radiology, pulmonology, and orthopedics). No patients were hospitalized. Laboratory testing included polymerase chain reaction (51, 96%), IgM antibody (1, 2%), and no testing (1, 2%); no patients were cultured. All patients received antibiotics; six (11%) were prescribed an albuterol inhaler. Thirty patients (57%) obtained ≥1 over-the-counter medication, including cough syrup (14, 26%) and throat lozenges (12, 23%).

Forty-seven households (89%) were recommended for post-exposure prophylaxis (PEP); 0–7 persons per household (mean = 2.77 persons) received PEP requiring 0–3 additional clinical visits (mean = .32 visits). Parents in five (9%) households took ≥1 unpaid leave day (mean = .47 days; range: 2–10 days). Overall, 17 (32%) households reported ≥1 leave day, including sick leave (10, 19%) and personal leave (6, 11%). Thirty-eight (72%) patients missed ≥1 day of school (mean = 5.4 days; range: 0–60 days), and 28 (53%) missed ≥1 day of sports (mean = 15.4 days, range: 0–150 days). No patients missed any paid work.

We estimated per-household societal costs of pertussis at $315.15 (Table 2). When applied to all 749 San Diego County adolescent cases occurring during 2013–2014, we estimated a total societal cost of $236,047.35.

Discussion

Pertussis incidence among adolescents, particularly those who only received acellular pertussis vaccines [8], has increased. Our findings provide a contemporary cost-burden assessment of adolescent pertussis. In an earlier study conducted prior to Tdap licensure [2], societal costs of adolescent pertussis exceeded our estimates by 26%. Pertussis vaccination reduces illness severity and duration [9] and may have reduced health care utilization in this highly vaccinated population. Unlike the prior study, no patients assessed were hospitalized. In addition, we did not include childcare, transportation, and over-the-counter medication costs, as previously assessed. We also assigned zero-cost values for missing responses. Hence, the true cost of adolescent pertussis likely exceeds our estimate.

Nearly half the adolescents assessed had pertussis symptoms lasting ≥3 months. Upper respiratory infections can substantially impact student health and productivity [10].

Although almost all patients had previously received Tdap, most (63%) were vaccinated ≥3 years prior, suggesting waning immunity as a contributing factor to their infection.

There are some study limitations. Our sample was small but included 49% of San Diego pertussis cases meeting age and onset date eligibility criteria. We relied on self-reporting for provider visits, symptom duration, and information regarding missed activities. Missed school and sports estimates were obtained indirectly via parents. The delay between symptom onset and interview may have introduced recall bias but conversely enabled full capture of illness course and burden.

The impact of pertussis among adolescents can be considerable, even in a highly vaccinated cohort. Improved strategies to address waning immunity and mitigate the pertussis burden among adolescents are needed.

Acknowledgments

The authors thank Monica Kang for assistance with completing telephone interviews. The authors also thank three anonymous reviewers who provided comments and feedback on this article.

Funding Sources

Aiden K. Varan was supported in part by an appointment to the Applied Epidemiology Fellowship Program administered by the Council of State and Territorial Epidemiologists (CSTE) and funded by the Centers for Disease Control and Prevention (CDC) Cooperative Agreement Number 1U380T000143-01.

References

[1]. Clark TA. Changing pertussis epidemiology: Everything old is new again. J Infect Dis 2014;209:978–81. [PubMed: 24626532]

[2]. Lee GM, Lett S, Schauer S, et al. Societal costs and morbidity of pertussis in adolescents and adults. Clin Infect Dis 2004;39:1572–80. [PubMed: 15578353]

[3]. Koepke R, Eickhoff JC, Ayele RA, et al. Estimating the effectiveness of tetanus-diphtheria-acellular pertussis vaccine (Tdap) for preventing pertussis: Evidence of rapidly waning immunity and difference in effectiveness by Tdap brand. J Infect Dis 2014;210:942–53. [PubMed: 24903664]

[4]. Winter K, Glaser C, Watt J, et al. Pertussis epidemic—California, 2014. MMWR 2014;63:1129–32. [PubMed: 25474033]

[5]. Acosta AM, DeBolt C, Tasslimi A, et al. Tdap vaccine effectiveness in adolescents during the 2012 Washington state pertussis epidemic. Pediatrics 2015;135:981–9. [PubMed: 25941309]

[6]. Council of State and Territorial Epidemiologists. National surveillance for pertussis: CSTE position statement 09-ID-51; 2010. Available at: www.cste.org/resource/resmgr/PS/09-ID-51.pdf. Accessed June 19, 2015.

[7]. U.S. Bureau of Labor Statistics. May 2013 national occupational employment and wage estimates, United States; 2014. Available at: http://www.bls.gov/oes/2013/may/oes_nat.htm. Accessed May 22, 2015.

[8]. Liko J, Robison SG, Cieslak PR. Priming with whole-cell versus acellular pertussis vaccine. N Engl J Med 2013;368:581–2. [PubMed: 23388023]

[9]. Barlow RS, Reynolds LE, Cieslak PR, et al. Vaccinated children and adolescents with pertussis infections experience reduced illness severity and duration, Oregon, 2010–2012. Clin Infect Dis 2014;58: 1523–9. [PubMed: 24633685]

[10]. Nichol KL, Heilly SD, Ehlinger E. Colds and influenza-like illnesses in university students: Impact on health, academic and work performance, and health care use. Clin Infect Dis 2005;40:1263–70. [PubMed: 15825028]

IMPLICATIONS AND CONTRIBUTION

This study provides the first economic impact assessment of pertussis among adolescents since a booster vaccine was licensed in 2005. Among patients aged 13–17 years with confirmed or probable pertussis during 2013–2014, estimated societal costs of health care, medications, and missed wages exceeded $300 per household and $230,000 across San Diego.

Table 1

Demographic features, vaccination history, missed activities, and household leave among participating households with an adolescent pertussis patient,[a] San Diego County

Variables[b]	n (%)
Participating households	53 (100)
Adolescent case	
Female gender	35 (66)
Age at symptom onset (years)	
13	13 (25)
14	13 (25)
15	15 (28)
16	10 (19)
17	2 (4)
Race/ethnicity (n = 45)	
White non-Hispanic	29 (64)
White Hispanic	13 (29)
Asian non-Hispanic	3 (7)
Born in United States (n = 51)	
Yes	50 (98)
No	1 (2)
Health insurance provider (n = 51)	
Employer provided or private insurance	43 (84)
Medicaid	7 (14)
Other	1 (2)
Received Tdap	51 (94)
Received ≥4 doses of DTaP	51 (94)
Pertussis case classification	
Confirmed	50 (94)
Probable	3 (6)
Reported symptom duration (months; n = 48)	
<1	12 (25)
1–2	13 (27)
3–4	16 (33)
>4	7 (15)
Missed school (days)	
None	15 (28)
1–5	23 (43)
6–10	11 (21)
>10	4 (8)
Missed sports activities (days)	
None or did not participate in any sports	25 (47)
1–7	11 (21)

Variables[b]	n (%)
8–30	10 (19)
>30	7 (13)
Household	
Interviewee	
Mother	46 (87)
Father	6 (11)
Other household caregiver	1 (2)
Interview language	
English	50 (94)
Spanish	3 (6)
Time spent on medical appointments for case (hours; n = 51)	
<2	13 (25)
2–5	21 (41)
6–10	16 (31)
>10	1 (2)
Household leave to care for case[c] (days)	
None	36 (68)
1–3	11 (21)
>3	6 (11)

DTaP = diphtheria, tetanus toxoids, and acellular pertussis vaccine; Tdap = tetanus, diphtheria, and acellular pertussis vaccine.

[a] Case definitions for confirmed or probable pertussis illness as per 2010 Council of State and Territorial Epidemiologists criteria [6].

[b] n = 53 respondents unless otherwise specified because of missing values.

[c] Includes sick leave, personal/holiday leave, and unpaid leave among parents or other household caregivers.

Table 2

Household health care utilization and lost-wage cost estimates associated with adolescent pertussis illness

Health care service or item	Per-household utilization[a] mean (SD)	Per-unit estimated cost[b,c] ($USD)	Average per-household cost[d] ($USD)
Adolescent case			
Clinical consultations			
Primary care	1.79 (1.35)	66.03	118.19
Urgent care clinic	.11 (.32)	77.90	8.57
Emergency department	.09 (.30)	194.02	17.46
Laboratory testing			
PCR	.96 (.19)	30.49	29.27
Prescription medications			
Antibiotics[e]	1.00 (.00)	14.15	14.15
Albuterol inhaler[f]	.11 (.32)	40.03	4.40
Household			
Clinical consultations			
Primary care	.32 (.78)	63.99	20.48
Prescription medications			
Antibiotics[e]	2.77 (1.68)	14.15	39.20
Unpaid leave days	.47 (1.71)	134.96	63.43
Societal cost per case			$315.15

PCR = polymerase chain reaction; SD = standard deviation; $USD = United States dollar.

[a]Per-household utilization, as averaged across participants. PCR testing and case antibiotic use were obtained from California Department of Public Health pertussis case reports. All other service or item use was self-reported. Participants that did not specify service or item use were assigned a value of zero.

[b]Unit cost estimates for clinical consultations, PCR testing (with a primary ICD-9 diagnosis of 033.0 or 033.9 [whooping cough]), and prescription medications for pertussis management were derived from 2010 to 2012 pooled MarketScan data. Payment data for clinical consultations are inclusive of procedure, facility, and provider fees and reflect total gross payment to providers for a specific service after applying pricing guidelines, such as fee schedules and discounts, and before applying deductibles, copayments, and coordination of benefits and other savings. For adolescent cases, payment data among patients aged <18 years for office and outpatient hospital, emergency department, urgent care consultations, and laboratory PCR testing were obtained. For household post-exposure prophylaxis consultations, payment data among patients of any age for office and outpatient hospital consultations were obtained. For prescription medicines, ingredient costs, administrative dispensing fees, and sales taxes for outpatient pharmacy encounters among patients of any age were obtained.

[c]Unit cost estimates for unpaid leave days derived from national median wage estimates ($16.87) from Department of Labor May 2013 Occupation Employment Statistics data [7], multiplied by the number of hours represented by unpaid leave days, assuming an 8-hour working day.

[d]Derived by multiplying per-household utilization by per-unit estimated cost.

[e]Assuming azithromycin-containing prescription, six tablets or capsules, 250 mg strength, as the standard of care.

[f]Assuming single-unit, albuterol-containing aerosol inhaler as the standard of care.