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Unnecessary Antibiotic Prescribing in US Ambulatory Care Settings, 2010–2015

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Abstract

The proportion of antibiotic prescriptions prescribed in US physician offices and emergency departments that were unnecessary decreased slightly, from 30% in 2010–2011 to 28% in 2014–2015. However, a greater decrease occurred in children: 32% in 2010–2011 to 19% in 2014–2015. Unnecessary prescribing in adults did not change during this period.

Keywords

antimicrobial stewardship; antibiotic; outpatients

Unnecessary antibiotic prescribing increases the risk of antibiotic-resistant infections [1] and adverse events, including *Clostridioides difficile* infections [2]. In 2015, the National Action Plan for Combating Antibiotic-Resistant Bacteria set a goal of reducing inappropriate outpatient antibiotic use by 50% by 2020 [3]. In 2016, a study by the United States (US) Centers for Disease Control and Prevention (CDC) established a method to evaluate unnecessary outpatient antibiotic prescriptions and found that 30% of antibiotics prescribed in 2010–2011 in physician offices, emergency departments (EDs), and hospital outpatient departments were unnecessary [4]. Subsequent studies have also found that unnecessary outpatient antibiotic prescribing remains common [5, 6]. Our objective was to examine national trends in unnecessary antibiotic prescriptions in physician offices and EDs to quantify progress toward the National Action Plan goal.

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Supplementary Data

Supplementary materials are available at *Clinical Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Potential conflicts of interest. L. M. K. is a contractor employed by Northrop Grumman Corporation to fulfill research needs at the CDC. All other authors report no potential conflicts of interest. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

METHODS

We identified visits and antibiotic prescriptions from the National Ambulatory Medical Care Survey (NAMCS) and the National Hospital Ambulatory Medical Care Survey (NHAMCS), nationally representative samples of visits to non–federally employed, office-based physicians (NAMCS) and hospital-based EDs (NHAMCS) [7]. Data were divided into 2-year periods (2010–2011, 2012–2013, and 2014–2015) to ensure adequate sample sizes. We did not include 2016 data in this analysis as 2017 data were not yet available. We excluded visits to hospital-based outpatient departments, which were only available in NHAMCS prior to 2012. These de-identified data are considered nonhuman subjects and not subject to institutional review board review.

We used the prior CDC study's tiered diagnosis system to assign a single diagnosis to each visit based on the most likely indication for antibiotics (Supplementary Table 1) [4]. We categorized diagnoses into acute respiratory infection (ARI: sinusitis, pneumonia, acute otitis media [AOM], pharyngitis, asthma, allergy, bronchitis, bronchiolitis, influenza, nonsuppurative otitis media, viral upper respiratory infection, and viral pneumonia) and other conditions. Antibiotic-inappropriate ARIs included asthma, allergy, bronchitis, bronchiolitis, influenza, nonsuppurative otitis media, viral upper respiratory infection, and viral pneumonia.

We calculated mean annual population using US Census estimates of the civilian noninstitutional population from 1 July 2010 to 1 July 2015 (obtained via special request) [8].

For each period, we calculated the mean annual number of visits and antibiotic prescriptions per 1000 population (ie, population-based rates) using the corresponding US Census estimate and the percentage of visits with antibiotic prescriptions. Rates and percentages were calculated overall, for ARIs, antibiotic-inappropriate ARIs, other conditions, and for each condition for all ages and by age group (0–19, 20–64, and ≥ 65 years).

We used the previous CDC study methods to assess the percentage of antibiotic prescriptions that were unnecessary overall and by condition and age [4]. We calculated the mean annual number of unnecessary antibiotic prescriptions per 1000 population as the difference between actual and necessary rates [4]. For conditions for which antibiotics are almost always indicated, we considered all prescribing necessary. All antibiotic prescribing for antibiotic-inappropriate ARIs was considered unnecessary [4]. For pharyngitis, we estimated necessary prescribing rates based on group A streptococcal prevalence among pharyngitis cases estimates: 37% in children, 18% in adults [9, 10]. For all remaining conditions, the 2010–2011 target antibiotic prescription rate was based on the lowest antibiotic prescription rate by US Census region for that condition and age group (Supplementary Table 2). When insufficient sample sizes precluded estimate calculation for all Census regions, we used the lower value between the lowest calculable regional rate and national rate as the target. For AOM, sinusitis, and all other conditions in 2012–2013 and 2014–2015, if observed prescription rates exceeded the 2010–2011 targets, we considered the difference unnecessary. If antibiotic prescription rates in 2012–2013 and 2014–2015 were below

2010–2011 targets, no (0%) prescriptions were considered unnecessary. We summed target antibiotic prescriptions by condition to calculate total necessary antibiotic prescription rates, which allowed estimation of the percentage of total antibiotic prescriptions that were unnecessary.

National estimates were generated by applying NAMCS/NHAMCS sampling weights, and 95% confidence intervals (CIs) were calculated using methods appropriate for complex samples. We did not include estimates for strata with < 30 sampled visits or relative standard error > 30% [7]. We estimated 95% CIs for visit and prescription rates using upper and lower limit NAMCS/NHAMCS estimates divided by corresponding census estimates. We used separate Poisson models to calculate rate ratios (RRs) for point estimates and associated upper and lower 95% CIs. Analyses were performed using Stata version 14 (StataCorp, College Station, Texas) and SAS version 9.4 (SAS Institute, Cary, North Carolina) software.

RESULTS

The estimated number of visits (regardless of antibiotic prescription) to US physician offices and EDs per 1000 population was 3548 (95% CI, 3068–4028) in 2010–2011, 3342 (95% CI, 3252–3431) in 2012–2013, and 3356 (95% CI, 3180–3533) in 2014–2015 (Supplementary Table 3). The number of visits per 1000 population did not change significantly from 2010–2011 to 2014–2015 (RR, 0.95 [95% CI, .88–1.04]). The number of visits per 1000 patients aged 0–19 years declined by 20% (RR, 0.80 [95% CI, .77–.85]) from 2010–2011 to 2014–2015. No changes were observed for other age groups. For ARIs, the number of visits per 1000 population declined from 411 (95% CI, 352–470) in 2010–2011 to 307 (95% CI, 279–336) in 2014–2015, a 25% decrease (RR, 0.75 [95% CI, .71–.79]).

There was an 8% decline (RR, 0.92 [95% CI, .87–.98]) in the overall number of antibiotic prescriptions from these settings per 1000 population from 2010–2011 to 2014–2015, and a 26% (RR, 0.74 [95% CI, .72–.76]) decline for ARIs (Table 1). Reductions in antibiotic prescriptions per 1000 population for ARIs occurred for all age groups, but was greatest for patients aged 0–19 years, with a 32% decline (RR, 0.68 [95% CI, . 67–.70]) from 2010–2011 to 2014–2015.

The percentage of visits that resulted in antibiotic prescriptions remained unchanged overall (12.7% during 2010–2011, 11.8% during 2012–2013, and 12.3% during 2014–2015) (Supplementary Table 3). The percentage of antibiotic-inappropriate ARI visits with antibiotic prescriptions was similar in 2010–2011 and 2014–2015 overall and in all age groups.

Thirty percent of antibiotic prescriptions in 2010–2011 were unnecessary compared to 28% in 2014–2015. Unnecessary antibiotic prescriptions declined among children aged 0–19 years, from 32% of antibiotic prescriptions in 2010–2011 to 19% in 2014–2015 (Table 1), but did not change among adult age groups.

DISCUSSION

We found that the percentage of antibiotic prescriptions considered to be unnecessary in offices and EDs changed only minimally, from 30% in 2010–2011 to 28% in 2014–2015. Among children, however, unnecessary antibiotic prescriptions declined from 32% to 19%, a 41% relative reduction, but did not change among adults.

The decrease in unnecessary antibiotic prescriptions in children is likely driven by multiple factors. The introduction of stricter diagnostic and treatment criteria for AOM [11], a major driver of antibiotic use in children, may have resulted in fewer prescriptions. Increased awareness of antibiotic stewardship among parents [12] and clinicians treating children likely contributed to reductions due to changes in social norms and desire for antibiotic treatment. Improvements in prescribing for antibiotic-inappropriate ARIs have been greatest among clinicians who exclusively treat children [13]. This may be in part due to early public health efforts to improve antibiotic use targeting parents and clinicians who treat children [14].

The number of antibiotics prescribed from US physician offices and EDs per 1000 population declined by 8% from 2010 to 2015. This was greater than the decline of 5% seen in the national number of oral antibiotics dispensed from community pharmacies (inclusive of all outpatient settings) per 1000 population during this same period [15]. However, we found no meaningful changes in the percentage of visits with antibiotics and only slight changes in the percentage of unnecessary antibiotic prescriptions, suggesting that reductions in the number of antibiotics prescribed per 1000 population was driven by decreases in visits, rather than shifts in clinician prescribing behavior. Our findings are similar to other investigations estimating inappropriate antibiotic prescribing [5, 6]. Explanations for decreasing visits, especially for ARIs, to physician offices and EDs likely include shifts in outpatient care delivery with the growth of urgent care, retail health, and telemedicine and reduced disease incidence due to benefits of vaccines, including the influenza and 13-valent pneumococcal conjugate vaccines.

Our study shows from 2010 to 2015 that the relative reduction in unnecessary antibiotic use in children (41%) was on track to meet or exceed the National Action Plan goal of reducing inappropriate antibiotic prescribing by 50% by 2020, but not for adults. Targeted attention is needed to improve antibiotic prescribing among adults. The CDC Core Elements of Outpatient Antibiotic Stewardship provides a framework for implementing antibiotic stewardship in outpatient settings [16].

Our study has several limitations. We could not validate the actual reason for visits and antibiotic prescriptions. Visit and prescription patterns may have changed since 2014–2015. These data do not include all outpatient settings (eg, urgent and retail care). We focused only on unnecessary prescribing. If inappropriate antibiotic selection and duration were considered, estimates of inappropriate antibiotic prescribing would likely be higher.

In our study of physician office and ED visits and antibiotic prescriptions from 2010 through 2015, we found that unnecessary antibiotic prescribing decreased only slightly, from 30% in 2010–2011 to 28% in 2014–2015. Increased stewardship efforts are needed, especially

among clinicians who treat adults, to reach the National Action Plan goal of reducing inappropriate antibiotic prescribing by 50% by 2020.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1.

Annual Visit and Estimated Appropriate Numbers of Antibiotic Prescriptions per 1000 Population and Percentage Reduction Targets by Age Group and Condition, National Ambulatory Medical Care Survey and National Hospital Ambulatory Medical Care Survey, 2010–2011, 2012–2013, and 2014–2015

	2010–2011			2012–2013			2014–2015		
Diagnosis	**Estimated Annual No. of Antibiotic Prescriptions per 1000 Population[a] (95% CI)**	**Estimated Annual No. of Necessary Antibiotic Prescriptions per 1000 Population[b]**	**Percentage Unnecessary**	**Estimated Annual No. of Antibiotic Prescriptions per 1000 Population[a] (95% CI)**	**Estimated Annual No. of Necessary Antibiotic Prescriptions per 1000 Population[c]**	**Percentage Unnecessary**	**Estimated Annual No. of Antibiotic Prescriptions per 1000 Population[a] (95% CI)**	**Estimated Annual No. of Necessary Antibiotic Prescriptions per 1000 Population[c]**	**Percentage Unnecessary**
Children aged 0–19 y									
All ARIs[d]	370 (307–433)	225	39%	266 (240–292)	197	26%	252 (215–290)	173	31%
Sinusitis	60 (45–75)	52	13%	46 (39–54)	46	0%	37 (25–49)	37	0%
Suppurative OM	134 (108–160)	101	25%	93 (81–105)	93	0%	85 (68–102)	85	0%
Pharyngitis	77 (62–93)	53	31%	59 (51–67)	45	24%	65 (48–82)	40	39%
Antibiotic-inappropriate ARIs[e]	80 (59–100)	0	100%	55 (47–63)	0	100%	54 (40–68)	0	100%
Pneumonia	20 (14–25)	20	0%	12 (10–15)	12	0%	11 (8–15)	11	0%
Other conditions[f]	200 (166–233)	165	18%	167 (151–183)	157	6%	157 (135–179)	157	0%
UTI	20 (14–27)	20	0%	13 (11–16)	13	0%	17 (10–25)	17	0%
Miscellaneous bacterial infections	18 (11–24)	18	0%	16 (12–20)	16	0%	17 (11–23)	17	0%
Remaining other conditions[g]	162 (135–189)	127	22%	137 (123–151)	127	7%	123(104–141)	123	0%
Total[h]	570 (477–663)	390	32%	433 (396–470)	354	18%	409 (356–463)	330	19%
Adults aged 20–64 y									
All ARIs[d]	133 (109–157)	40	70%	108 (99–117)	39	64%	109 (87–131)	36	67%
Sinusitis	48 (38–59)	23	52%	36 (32–40)	23	36%	41 (30–53)	23	44%
Suppurative OM	7 (5–10)	5	29%	6(5–7)	5	17%	6 (3–9)	5	17%
Pharyngitis	25 (19–31)	6	76%	19 (16–22)	6	68%	18(11–24)	5	72%

Diagnosis	2010–2011			2012–2013			2014–2015		
	Estimated Annual No. of Antibiotic Prescriptions per 1000 Population[a] (95% CI)	Estimated Annual No. of Necessary Antibiotic Prescriptions per 1000 Population[b]	Percentage Unnecessary	Estimated Annual No. of Antibiotic Prescriptions per 1000 Population[a] (95% CI)	Estimated Annual No. of Necessary Antibiotic Prescriptions per 1000 Population[c]	Percentage Unnecessary	Estimated Annual No. of Antibiotic Prescriptions per 1000 Population[a] (95% CI)	Estimated Annual No. of Necessary Antibiotic Prescriptions per 1000 Population[c]	Percentage Unnecessary
Antibiotic-inappropriate ARIs[e]	47 (37–57)	0	100%	42 (37–47)	0	100%	41 (31–50)	0	100%
Pneumonia	5(3–7)	5	0%	5 (4–6)	5	0%	3 (2–4)	3	0%
Other conditions[f]	237 (199–276)	203	14%	231 (215–247)	201	13%	272 (235–309)	207	24%
UTI	31 (25–38)	31	0%	28 (24–31)	28	0%	32 (25–40)	32	0%
Miscellaneous bacterial infections	9 (7–12)	9	0%	10 (8–13)	10	0%	12 (7–16)	12	0%
Remaining other conditions[g]	197 (164–229)	163	17%	193 (179–207)	163	16%	228(197–259)	163	29%
Total[h]	370 (311–429)	243	34%	339 (318–361)	240	29%	381 (331–431)	243	36%
Adults aged ≥65 y									
All ARIs[d]	123 (95–151)	63	49%	111 (98–125)	55	50%	96 (76–115)	44	54%
Sinusitis	40 (28–51)	40	0%	36 (28–44)	36	0%	25(18–33)	25	0%
Suppurative OM	…	…	…	…	…	…	…	0	…
Pharyngitis	…	…	…	5(3–7)	…	…	…	…	…
Antibiotic-inappropriate ARIs[e]	60 (40–79)	0	100%	56 (46–65)	0	100%	52 (36–69)	0	100%
Pneumonia	11 (6–16)	11	0%	12 (8–15)	12	0%	9(5–12)	9	0%
Other conditions[f]	445 (364–525)	413	7%	430 (393–468)	405	6%	453 (401–505)	411	9%
UTI	59 (43–73)	59	0%	55 (46–65)	55	0%	63 (44–83)	63	0%
Miscellaneous bacterial infections	…	…	…	11 (6–16)	11	0%	…	0	…
Remaining other conditions[g]	371 (302–440)	339	9%	364 (330–398)	339	7%	381 (334–428)	339	11%

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Diagnosis	2010–2011			2012–2013			2014–2015		
	Estimated Annual No. of Antibiotic Prescriptions per 1000 Population[a] (95% CI)	Estimated Annual No. of Necessary Antibiotic Prescriptions per 1000 Population[b]	Percentage Unnecessary	Estimated Annual No. of Antibiotic Prescriptions per 1000 Population[a] (95% CI)	Estimated Annual No. of Necessary Antibiotic Prescriptions per 1000 Population[c]	Percentage Unnecessary	Estimated Annual No. of Antibiotic Prescriptions per 1000 Population[a] (95% CI)	Estimated Annual No. of Necessary Antibiotic Prescriptions per 1000 Population[c]	Percentage Unnecessary
Total[h]	568 (470–666)	476	16%	542 (501–583)	461	15%	549 (492–606)	455	17%
All ages									
All ARIs[d]	196(166–226)	93	53%	150(140–160)	83	45%	144 (126–163)	73	49%
Other conditions[f]	254(215–293)	220	13%	242 (227–256)	217	10%	268 (241–295)	224	16%
Total[h]	450 (383–516)	313	30%	392 (372–412)	301	23%	413 (374–451)	296	28%

Abbreviations: …, insufficient data for calculation; ARI, acute respiratory syndrome; Cl, confidence interval; OM, otitis media; UTI, urinary tract infection.

[a]Mean annual population from US Census estimates of the civilian noninstitutional population [8]. Children aged 0–19 years: 2010–2011, 82 713 408; 2012–2013, 82 090 200; 2014–2015, 81 844 000. Adults aged 20–64 years: 2010–2011, 182 973 664; 2012–2013, 185 346 064; 2014–2015, 187 477 760. Adults aged ц65 years: 2010–2011, 39 622 492; 2012–2013, 42 625 840; 2014–2015, 45 688 596. Total population (all ages): 2010–2011, 305 309 564; 2012–2013, 310 062 104; 2014–2015, 315 010 356.

[b]Target for sinusitis, acute otitis media (AOM), and remaining other conditions are based on lowest-prescribing regions for condition and age group (Supplementary Table 1). For pharyngitis, target is based on the estimated prevalence of group A streptococcal pharyngitis among all pharyngitis visits based on a large study (among adults) and a meta-analysis among children (37% of pharyngitis visits for children aged 0–19 years, 18% of pharyngitis visits adults aged 20–64 years; no change for adults aged ≥65 years) [9, 10],Target is no antibiotics for antibiotic-inappropriate ARIs.Target is no change in antibiotic prescribing rates for pneumonia, UTI, and miscellaneous bacterial infections.

[c]Targets for sinusitis, AOM, and remaining other conditions are based on 2010–2011 estimated appropriate rates, except where observed values are below the 2010–2011 estimated appropriate prescribing rates, in which case no further reductions are targeted. Target for pharyngitis is based on the estimated prevalence of group A streptococcal pharyngitis among all pharyngitis visits based on a large study (among adults) and a meta-analysis among children (37% of pharyngitis visits for children aged 0–19 years, 18% of pharyngitis visits adults aged 20–64 years; no change for adults aged ≥65 years) [9, 10], Target is no antibiotics for antibiotic-inappropriate ARIs, and no change in antibiotic prescribing rates for pneumonia, UTI, and miscellaneous bacterial infections.

[d]AII ARIs include AOM, nonsuppurative OM, sinusitis, pharyngitis, pneumonia, bronchitis, bronchiolitis, viral upper respiratory infection, influenza, asthma, allergy, and viral pneumonia.

[e]Antibiotic-inappropriate ARIs are defined as asthma, allergy, bronchitis, bronchiolitis, influenza, nonsuppurative OM, viral upper respiratory infection, and viral pneumonia. Bronchitis and bronchiolitis include visits with bronchitis (not specified as acute or chronic), acute bronchitis, and acute bronchiolitis, but exclude visits in which the second or third diagnosis was chronic bronchitis, emphysema, or chronic obstructive pulmonary disease.

[f]Other conditions excluding ARIs.

[g]Remaining other conditions exclude ARIs, UTIs, and miscellaneous bacterial infections.

[h]Sum of all ARIs and other conditions.