Improvements in Antimicrobial Prescribing for Treatment of Upper Respiratory Tract Infections Through Provider Education

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BACKGROUND: Inappropriate use of antimicrobials to treat acute upper respiratory tract infections (URIs), which usually have a viral etiology, contributes to emergence and spread of antimicrobial resistance in *Streptococcus pneumoniae* and other human bacterial pathogens.

OBJECTIVE: To reduce antimicrobial use for management of acute URIs in adult and pediatric patients.

DESIGN: Prospective, nonrandomized, controlled trial.

SETTING: Four primary care clinics within a staff model HMO in Detroit, Mich.

PARTICIPANTS: Twenty-one primary care physicians at clinics where the educational intervention was implemented, and 9 primary care physicians at control clinics where no educational programs were implemented.

MEASUREMENTS: Antibiotic prescribing for acute URIs during the baseline and study years among the intervention and control groups.

RESULTS: A generalized linear mixed-effects model was used and showed that antimicrobial prescribing among the intervention group physicians decreased 24.6% from the baseline to the postintervention period ($P < .0001$) for both pediatric and adult medicine physicians. From the baseline to the study period, there was no significant decline in rates of antimicrobial prescribing by the control group of physicians (pediatricians, $P = .35$; internists, $P = .42$). The rates of decline in antimicrobial prescribing differed significantly between the intervention and control groups ($P < .0003$ for pediatricians and $P < .01$ for Internists).

CONCLUSIONS: An interactive, case-based educational program for physicians and their staff proved effective for reducing unwarranted prescribing of antibiotics in the treatment of URIs by primary care physicians in a Medicaid HMO setting.

KEY WORDS: antimicrobial resistance; antimicrobial prescribing; upper respiratory tract infections (URIs); Medicaid; HMO.

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The rise in resistance to penicillin and other antibiotics in *Streptococcus pneumoniae*¹ is principally owing to selection of strains with decreased susceptibility to penicillins resulting from exposure to antibacterial agents.² Each year, *S. pneumoniae* infections in the United States lead to over 100,000 hospitalizations for pneumonia, 6 million cases of otitis media, and 3,300 cases of meningitis.³ As recently as 10 years ago, *S. pneumoniae* was susceptible to an array of anti-

biotics. Currently, 20% to 30% of *S. pneumoniae* isolates in Michigan are resistant to β -lactam drugs, such as penicillin.⁴ An estimated 75% of all outpatient antibiotic usage in the United States is for upper respiratory tract infections (URIs)^{5,6} that are caused by viruses, and antimicrobials are not indicated.⁷ The Centers for Disease Control and Prevention has estimated that more than 50% of antibiotic courses for URIs are unnecessary.⁸ Although some improvement is evident in antimicrobial use in the ambulatory care setting,⁹ recent incidents, including the 2002 report of clinical isolation of highly vancomycin-resistant *Staphylococcus aureus*, underscore the need for aggressive efforts to address the growing public health crisis of antimicrobial resistance.¹⁰

Opportunities for reducing unnecessary antibiotic treatment of respiratory infections exist, principally through education of clinicians and the public. A 1996 Icelandic study demonstrated that an educational intervention for physicians and the community resulted in reduction of penicillin resistance by 25% in *S. pneumoniae* isolates carried by children in day care centers.¹¹ An educational intervention on appropriate antibiotic use that included practice profiling, academic detailing, and patient education showed a 35% decline in the prescription of antibiotics for bronchitis at the full intervention site.⁶ And an educational program on prudent antibiotic use for URIs, coupled with public education, decreased antibiotic use by 10% during the first 6 months following the intervention, and resulted in a nearly 30% shift from second- to first-line antibiotics.¹² Finally, a peer-leader health care provider educational intervention that included public distribution of educational pamphlets resulted in an 11% intervention-attributable reduction in antibiotic prescriptions for children.¹³

These studies have documented changes in antimicrobial use for treating URIs through education, and primarily utilized population-based evaluations to determine their efficacy in changing antimicrobial prescribing. Where individual physician practice has been evaluated, it has been limited to 1 disease. In this study, we examine the effectiveness of an educational program on antibiotic prescribing for bronchitis, otitis media, pharyngitis, and URI not otherwise specified (nos) among individual physicians for pediatric and adult patients.

STUDY DESIGN

The Wellness Plan (TWP) is a staff model HMO with 4 primary care clinics and an outpatient urgent care center in Detroit, Mich. The Wellness Plan includes 50,000 covered lives, with a population that is more than 90% African American. Members

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receive primary care services from TWP physicians, staff, and laboratories. Clinicians and patients are assigned to 1 of the 4 clinics. Patients with acute illnesses are given same-day appointments and are seen at the urgent care center only when clinics are closed.

INTERVENTION

This evaluation was conducted as a prospective, nonrandomized, controlled trial of an educational intervention program at 2 of TWP's clinics. The clinics were assigned to the intervention group based on geographic proximity in order to limit the overlap of both physicians and patients between the intervention and control locations. This program was developed and conducted by Partners for Appropriate Anti-Infective Community Therapy, a physician-pharmacist group based in Port Perry and Toronto, Canada in collaboration with the Michigan Antibiotic Resistance Reduction Coalition. The program consisted of half-day educational sessions covering antimicrobial resistance, and utilized guidelines and case study presentations to review appropriate treatment and diagnosis of bronchitis, pharyngitis, sinusitis, and otitis media. Because the occurrence and treatment of the diseases differ among pediatric and adult populations, the participants were divided into 2 groups for the case-study reviews. In addition to the presentations, the course participants received a number of patient educational materials,¹⁴⁻¹⁶ a guideline document,¹⁷ and various articles on antimicrobial resistance. Participants in the educational intervention included physicians, nurses, and pharmacists of the 2 intervention clinics. Participation in the program was supported by the Directors of TWP, who closed outpatient clinics for the day of these sessions. Physicians and staff at the other 2 TWP clinics served as concurrent controls.

MEASUREMENTS

We evaluated the effect of the intervention on improving antimicrobial prescribing for bronchitis, pharyngitis, otitis media, and URI nos between the baseline and study years and between physicians at the intervention and control clinics. Because our study targeted physicians who regularly treat patients with acute, uncomplicated URIs, we restricted our analysis to physicians who treated ≥ 10 patients in both the baseline and study years for the specific URI diagnosis under consideration. For these analyses, the intervention group included 10 Internists and 9 pediatricians, while the control group consisted of 3 Internists and 6 pediatricians. To evaluate overall changes in prescribing for treating URIs, regardless of specific diagnosis, all physicians who conducted at least 10 patient visits for URIs per year were included. For this analysis, 12 Internists and 9 pediatricians were included in the intervention group. The control group included 3 Internists and 6 pediatricians. The research design was approved by the Institutional Review Board of the Michigan Public Health Institute.

Data were extracted from administrative files of TWP as identified by International Classification of Diseases, 9th revision (ICD-9) codes recorded for medical billing, and were gathered on all incident office visits where a diagnosis was made of acute bronchitis (ICD-9 466.0), pharyngitis (ICD-9 462), and otitis media (ICD-9 382.0). Because sinusitis (ICD-9 461) was covered in the educational programs and is coded by TWP as "URI nos" on its patient encounter forms, URI nos is reported

Table 1. Demographics of Study Populations, Baseline and Study Years

	Baseline Year (1999–2000)		Study Year (2000–2001)	
	Intervention Group (n=4,429)	Control Group (n=1,970)	Intervention Group (n=3,338)	Control Group (n=1,688)
Females (%)	57.3	55.2	57.3	56.0
Patients < 15 y old (%)	78.1	86.4	79.8	85.6
Total physicians	21	9	21	9
Internists	12	3	12	3

here as a surrogate indicator of sinusitis. Data on 10,945 patient visits were evaluated and included both adult and pediatric populations. Prescribing data were extracted from a pharmacy database and linked to each patient visit by date of prescription. Patient gender, age, and attending physician were extracted, in addition to the year in which the attending physician completed residency training. Data were extracted for the periods November 16, 1999 to March 31, 2000 (baseline year) and November 16, 2000 to March 31, 2001 (study year). Incident visits were defined as representing the first office visit of a patient for the specified URIs. Return visits within 30 days of an incident visit were excluded from analysis. Patients were excluded if their records indicated any of the following comorbidities: asthma, chronic obstructive pulmonary disease, diabetes, HIV, congestive heart failure, or chronic ischemic heart disease. Antibiotic treatment may have been warranted for these conditions.

During the study, 1 of the intervention clinics suffered a fire, resulting in its temporary closure. Patients and physicians were relocated to the other intervention clinic and study results were not affected. Overlap of physicians among the control and study groups was evaluated, and 1 physician assigned to the intervention group saw 5 patients at a control clinic. Table 1 summarizes the characteristics of the study populations.

ANALYSIS

Univariate measures were used to compare patient demographics among the control and intervention groups. Antibiotic prescribing rate was calculated as the proportion of incident office visits at which the patient received an antibiotic prescription. To evaluate the impact of the intervention on antibiotic prescribing rates within and between intervention and control groups, a generalized linear mixed-effects model was used to control for potential clustering (random effects) of physicians by group. Antibiotic prescribing rates were modeled using binomial error distribution and logit link function. The model included physician-specific random effects. Time (i.e., baseline vs study year), patient gender, and years since residency training (categorized as in practice ≥ 15 years or < 15 years) were included as fixed effects for within-group analysis. For between-group analysis, group (intervention or control) was added as a fixed effect. The interaction term between time and group was used to test whether changes in prescribing rates from baseline to study year differed between the intervention and control groups. Estimates of variance components were obtained using the restricted maximum likelihood method, and model fit was assessed using deviance. Analyses

Table 2. URI Diagnoses* in Intervention and Control Groups, Baseline, and Study Years

	Number of URI Diagnoses			
	Baseline Year 1999 to 2000		Study Year 2000 to 2001 Number of URI Diagnoses	
	Intervention Group (n=4,429)	Control Group (n=1,970)	Intervention Group (n=3,338)	Control Group (n=1,688)
Pharyngitis (%)	9.0	10.1	7.7	10.7
Bronchitis (%)	1.7	7.1	1.8	8.2
Otitis media (%)	15.6	18.7	12.9	19.1
URIs nos (%)	69.1	58.7	73.9	58.9
Excluded† (%)	4.6	5.4	3.6	3.0
Return office visits (mean ± SD)	1.54 ± 1.10	1.51 ± 1.05	1.26 ± 0.66	1.33 ± 0.67

*Bronchitis International Classification of Diseases, 9th revision (ICD-9) 466.0, pharyngitis (ICD-9 462), and otitis media (ICD-9 382.0).

†A total of 30 physicians were included in the analysis when all the diagnoses were aggregated, resulting in 11,425 encounters. When analyzing specific diagnosis, 2 physicians were excluded based on the criterion that a physician was included only if he/she conducted at least 10 patient visits in each of the baseline and study years for the specific diagnosis. Therefore, 480 encounters were excluded when analyzing specific diagnosis. URI, upper respiratory tract infection.

were performed using the GLIMMIX macro in SAS version 8.^{18,19} In addition to the overall (unstratified) analysis, stratified analyses were performed by physician specialty (pediatrics or adult medicine) and specific URI diagnosis (pharyngitis, bronchitis, otitis media, and URIs nos). Additionally, prescribing rates of intervention group physicians who attended the educational sessions versus those who did not were evaluated.

RESULTS

Table 1 presents a demographic comparison of the intervention and control populations. To determine whether the decreases in antibiotic prescribing rates were as a result of diagnostic shifting, percentage changes for each of the diagnoses from baseline to study year were evaluated. The results show that decreases for URIs nos were not associated with increases in antibiotic prescribing for any of the other URIs ($P < .05$ for all comparisons). Incident visits for URIs decreased during the study year at all clinics (Table 1). The decline was greater at the intervention clinics for all URI diagnoses than at the control clinics and was not associated with increases for any other diagnoses.

Table 2 presents the diagnoses of patient visits in each of the study groups. To evaluate whether decreases in rates of antibiotic prescribing resulted in complication of diseases, return office visits within 30 days of initial diagnosis were tracked. The follow-up visits of the study groups were similar and declined from the baseline to the study year.

Prescribing rates of antibiotics for treating URIs for the baseline and study periods are presented in Table 3. Among physicians in the intervention population, the overall prescribing rates of antibiotics declined 24.6% from 49.9% to 37.6%

($P < .0001$). Between the control and intervention groups, the decline in prescribing rates for antibiotics was significant ($P < .0001$).

Of the 21 physicians in the intervention population, 14 participated in the educational sessions. Although the baseline prescribing rate of physicians who attended the educational sessions was significantly lower ($P = .02$) than that of physicians who did not attend, there was no significant difference in percent change from baseline to postintervention in antimicrobial prescribing rates of attendees versus non-attendees ($P = .19$).

Consistent with the findings of a number of studies, pediatricians prescribed antibiotics less frequently for treatment of URIs than their adult medicine peers. An evaluation of the effect of patient gender showed that there was no effect on prescribing rates of antibiotics for URIs among the physicians in either the intervention or control groups. Similarly, an evaluation of the effect of years since residency training showed that years in practice had no effect on prescribing rates.

Table 4 presents the effects of the intervention program on rates of antibiotic prescribing for specific URIs. Statistically significant declines in prescribing of antibiotics were seen among physicians in the intervention group for pharyngitis ($P = .007$), otitis media ($P < .001$), and URIs nos ($P < .001$). For bronchitis, there was no significant change in prescribing of antibiotics in the intervention group ($P = .84$).

DISCUSSION

To our knowledge, this is the first study to evaluate prescribing of antibiotics for pharyngitis, bronchitis, otitis media, and URIs nos, rather than aggregated data on overall prescribing

Table 3. Changes in Antibiotic Prescribing Rates Among Internists and Pediatricians

Prescribing Rate	Intervention Group				Control Group			
	Baseline Year	Study Year	% Change	P Value	Baseline Year	Study Year	% Change	P Value
All physicians	49.9	37.6	-24.6	<.0001	45	42.8	-4.9	.25
Internists	62.6	45.1	-27.9	<.0001	75.3	72.2	-4.1	.42
Pediatricians	37.1	27.5	-25.9	<.0001	31.4	29.9	-4.8	.35

Table 4. Changes in Antibiotic Prescribing Rates for the Treatment of Specific URIs

	Intervention Group				Control Group			
	Baseline Year	Study Year	% Change	P Value	Baseline Year	Study Year	% Change	P Value
Pharyngitis (12, 5)*	82.8	73.9	− 10.7	.007	82.6	74.5	− 9.8	.053
Bronchitis (5, 4)	79.6	78.2	− 1.8	.84	74.5	81.6	9.5	.15
Otitis media (10, 4)	84.3	74.1	− 12.1	<.0001	91.6	85.2	− 7.0	.007
URIsnos (19, 8)	26.1	16.9	− 35.2	<.0001	16.8	17.9	6.5	.58

*The numbers in parentheses denote the number of physicians who treated patients in the intervention and control groups, respectively, for that specific diagnosis.

URI, upper respiratory tract infection; nos, not otherwise specified.

for a group of patients. This study suggests that an educational intervention on appropriate antibiotic use reduced antibiotic use in the treatment of uncomplicated URIs. Notably, a significant difference in changes in prescribing rates between the intervention and control populations was found only for URIsnos. This may have been a result of diagnostic lumping of all URIs as URIs nos for 3 physicians. Despite the fact that only two thirds of the physicians in the intervention group participated in the educational program, improvements in antimicrobial prescribing for URIs were noted among all physicians in the intervention group. We conclude that education of all members of the health care staff, including staff nurses, pharmacists, and technicians, as well as peer influence of physicians who participated, contributed to these decreases. This finding is particularly interesting, given that baseline-prescribing rates of antibiotics to treat URIs among physicians who participated in the educational sessions were lower than those of physicians who did not participate.

We also found that the decreased prescription of antibiotics for treating URIs in the intervention group did not increase the number of return visits. Although the overall reduction of antimicrobial use by 24.6% among the intervention population is a large step forward in reducing inappropriate use, there is still much room for improvement. Following the educational intervention, nearly 80% of patients diagnosed with bronchitis received antibiotic prescriptions. This may be inappropriately high because bronchitis is largely a viral disease, and few patients benefit from antimicrobial therapy.^{20–22}

The decline in patient encounters and number of prescriptions for treating URIs between the baseline and study years was likely because of the mild flu and cold season during the study year. The decreases may also reflect the impact of other efforts to promote appropriate antibiotic use for treating URIs. The differences in prescribing of antibiotics by pediatricians and Internists may be influenced by the earlier release of practice guidelines by the American Academy of Pediatrics, which were published in January 1998.²³ Similar guidelines for treatment of URIs in adult patients were published in the spring of 2001 by the American College of Physicians.²⁴

Several limitations may have influenced the results of the study. The nonrandom assignment of the clinics to the study groups may have resulted in assignment of the clinics with the lowest prescribing rates to the intervention group. Coding errors may have occurred, as data were derived from files for medical billing. In fact, it was found that 2 physicians in the intervention group and 1 physician in the control group coded all URIs as URIsnos, likely under-representing other URIs. Because each of these physicians coded all URIs as URIsnos

throughout the study, the overall results are not affected, although there may have been differences for specific diseases. One control group pediatrician participated in the educational program. Baseline prescribing rates of antibiotics for treating URIs for this physician were very low (5%), and declined to 4% in the study year. The overall effect of this physician's participation is unknown, but any effects would have diminished the differences in prescribing rates between the study and control populations. Because this study was conducted in partnership with a Medicaid HMO, and most patients at these clinics are of low socioeconomic status (SES), it is unknown whether similar effects would be seen in clinics with a different practice model and among patients of higher SES. Antibiotic prescriptions that were measured included those that were filled at the TWP pharmacies, and we did not account for prescriptions filled at outside pharmacies. Finally, the intervention was conducted during the winter of 2000 to 2001, when anti-pneumococcal vaccine for children became widely available. Immunization rates could not be tracked and we cannot account for potential decreases in patient encounters or reductions in antimicrobial prescriptions resulting from the vaccinations. There are no indications that these omissions differed between the intervention and the control sites.

This study confirms previous studies of educational interventions to reduce antimicrobial use in treating URIs and demonstrates that a meaningful reduction is achievable when the program is applied to all staff members at a Medicaid HMO. Educational efforts to improve prescribing of antibiotics for treating uncomplicated viral URIs should be expanded, and should include all health care staff. Such programs should provide physicians and their staff with the tools to diagnose URIs appropriately and teach them the skills required to convey effectively to patients why antimicrobials may not be appropriate to treat their condition. To protect our antibiotic lifeline, physicians, and particularly adult medicine physicians, must be more diligent in utilizing antimicrobials only when warranted for the diagnosis.

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