Medication Use

The “Minimizing Antibiotic Resistance in Colorado” Project: Impact of Patient Education in Improving Antibiotic Use in Private Office Practices

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Objective. To assess the marginal impact of patient education on antibiotic prescribing to children with pharyngitis and adults with acute bronchitis in private office practices.

Data Sources/Study Setting. Antibiotic prescription rates based on claims data from four managed care organizations in Colorado during baseline (winter 2000) and study (winter 2001) periods.

Study Design. A nonrandomized controlled trial of a household and office-based patient educational intervention was performed. During both periods, Colorado physicians were mailed antibiotic prescribing profiles and practices guidelines as part of an ongoing quality improvement program. Intervention practices ($n = 7$) were compared with local and distant control practices.

Data Collection/Extraction Methods. Office visits were extracted by managed care organizations using International Classification of Diseases-9-Clinical Modification codes for acute respiratory tract infections, and merged with pharmacy claims data based on visit and dispensing dates coinciding within 2 days.

Principal Findings. Adjusted antibiotic prescription rates during baseline and study periods increased from 38 to 39 percent for pediatric pharyngitis at the distant control practices, and decreased from 39 to 37 percent at the local control practices, and from 34 to 30 percent at the intervention practices ($p = .18$ compared with distant control practices). Adjusted antibiotic prescription rates decreased from 50 to 44 percent for adult bronchitis at the distant control practices, from 55 to 45 percent at the local control practices, and from 60 to 36 percent at the intervention practices ($p < .002$ and $p = .006$ compared with distant and local control practices, respectively).

Conclusions. In office practices, there appears to be little room for improvement in antibiotic prescription rates for children with pharyngitis. In contrast, patient education helps reduce antibiotic use for adults with acute bronchitis beyond that achieved by physician-directed efforts.

Key Words. Antibiotics, patient education, physician practice patterns, quality improvement

Multiple organizations have called for decreases in excess antibiotic use in ambulatory practice as an important component of strategies to combat antimicrobial resistance in the United States (Jernigan, Cetron, and Breiman 1996). This public health imperative is driven by two key observations from the past decade: (1) antibiotic resistance among community-acquired bacterial pathogens (e.g., *Streptococcus pneumoniae*, *Staphylococcus aureus*, and *Escherichia coli*) is rising rapidly (Herold et al. 1998; Chen et al. 1999; Gupta, Scholes, and Stamm 1999; Whitney et al. 2000; Hyde et al. 2001); and (2) recent antibiotic use is one of the strongest risk factors for carriage or infection with resistant bacteria (Nava et al. 1994; Hofmann et al. 1995; Arnold et al. 1996; Nuorti et al. 1998).

Strategies to reduce inappropriate prescribing of antibiotics in the ambulatory setting must focus on the management of acute respiratory tract infections (ARIs), which resulted in 76 million visits to office-based physician practices in the U.S. during 2000 (Source: National Ambulatory Medical Care Survey, public use datafiles). These infections account for the vast majority of ambulatory antibiotic prescriptions in the U.S. (McCaig and Hughes 1995). Yet, many of these prescriptions likely provided little clinical benefit since the overwhelming majority of ARIs have a viral etiology; particularly colds, unspecified upper respiratory tract infections, and acute bronchitis (Gonzales et al. 1997).

It appears that physicians and the public are beginning to heed the call to limit the over-use of antibiotics for ARIs in U.S. office-based practices. Between 1990 and 2000, the proportion of children with ARIs treated with antibiotics decreased by 14 percent (McCaig, Besser, and Hughes 2002). While this secular trend is promising, greater reductions are needed, since it has been estimated that over 50 percent of antibiotic prescriptions for ARIs are not necessary (Gonzales et al. 2001b).

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A number of controlled studies in the U.S. have confirmed the benefit of combined patient and physician educational interventions in reducing antibiotic use for ARIs beyond that attributable to secular trends (Gonzales et al. 1999; Belongia et al. 2001; Finkelstein et al. 2001; Perz et al. 2002). To date, however, there have been no community-based intervention trials, aimed at reducing excess antibiotic use, that have targeted adults in traditional fee-for-service, private office practices.

The present study was designed to assess the impact of adding patient education to an existing physician-centered intervention directed at reducing antibiotic prescribing for children with pharyngitis and adults with acute bronchitis. In the first phase of the Minimizing Antibiotic Resistance in Colorado Project, we designed and launched this trial of a household- and office-based patient education intervention, known as the "Be S.M.A.R.T. about Antibiotics" campaign (S.M.A.R.T. = Strategies for *Minimizing Antibiotic Resistance Together*) in November 2001. The major hypothesis was that a combined patient and physician intervention would be more effective than a physician-centered intervention alone in reducing excess antibiotic use in private office practices.

METHODS

The Colorado Medical Society Joint Data Project on Careful Antibiotic Use is a physician-centered quality improvement program that includes as partners: the Colorado Medical Society, the Colorado Clinical Guidelines Collaborative, the Colorado Department of Public Health and Environment, and four commercial and one Medicaid managed care organizations (MCOs). Since November 1999, primary care physicians have been mailed individual prescribing profiles depicting: (1) the proportion of adult bronchitis patients receiving antibiotic treatment (target = 10 percent or less); (2) the proportion of these antibiotics belonging to a first-line group (erythromycin, doxycycline, tetracycline) (target = 70 percent or more); and (3) the proportion of these antibiotics that are ineffective against proven bacterial causes of uncomplicated acute bronchitis (target = 0 percent).

Similarly, physicians providing care to children with pharyngitis were mailed profiles depicting: (1) the proportion of all pharyngitis patients having a group A streptococcus identification test performed; (2) the proportion of pharyngitis patients *not* receiving a group A streptococcal identification test who were treated with antibiotics (target = 0 percent); and (3) the proportion

of antibiotics belonging to a first-line group (penicillin, amoxicillin, erythromycin) (target = 70 percent or more). The practice guidelines included with the patient profiles for adults with bronchitis and children with pharyngitis were compatible with those produced by the Centers for Disease Control and Prevention (CDC) (Schwartz et al. 1998; Gonzales et al. 2001a).

Patient Education Intervention

Household- and office-based patient education materials from an intervention that successfully reduced antibiotic treatment of adults with acute bronchitis in a group-model MCO setting were modified for this study (Gonzales et al. 1999). Focus groups with parents were conducted to develop and obtain feedback on pediatric materials prior to distribution. In the first week of November 2001, campaign packets were mailed to “regular” households (see below for definition) identified by the participating practices. Each household packet consisted of a bilingual introductory letter from the Colorado Department of Public Health and Environment explaining the “Be S.M.A.R.T. about Antibiotics” campaign, CDC brochures on antibiotic resistance, a refrigerator magnet, and a reference card providing easy-to-read facts about symptoms and treatments for ARIs. All materials were provided in Spanish and English, except the magnet (English only). Office-based materials, produced in English and Spanish versions, consisted of waiting room materials (CDC posters and patient reference cards) and examination room posters (containing “talking points” for providers to use in discussing appropriate antibiotic use for pharyngitis in children, and bronchitis in adults). The office reference cards were the same as those included in the mailings. Office materials were delivered personally to each practice. All educational materials may be viewed on the project Web site (<http://www.getsmartcolorado.com>). The study’s intervention and evaluation were approved by the University of California, San Francisco Committee for Human Research, and the University of Colorado, Denver, Institutional Review Board.

Intervention Cost

We used a cost-accounting approach to determine replication costs of the household- and office-based intervention. The costs measured consisted primarily of staff time, supplies, equipment, and materials production. Costs related to research and evaluations were excluded from this analysis. Project staff kept records of the time they spent designing and developing materials

and in managerial meetings to oversee both the intervention approach and materials development. Costs were incurred during a 2-year period and were therefore discounted.

Recruitment of Practices

Office practices located in a prespecified geographical area in the Denver metropolitan area were invited to participate as intervention practices. Practices eligible for the intervention were required to have 20 or more patient visits for ARIs (see International Classification of Diseases-9-Clinical Modification [ICD-9-CM] codes below) present in administrative claims data when aggregated across the MCOs participating in the Colorado Medical Society Joint Data Project during the baseline observation period of November 1, 2000–February 28, 2001. In this manner, 10 private office practices were identified as possible participants. Recruitment procedures included an initial telephone call, follow-up letter, and face-to-face meetings. To participate, practices were also required to provide a mailing and telephone list of regular clinic patients (defined as any individual adult having at least two office visits based on the clinic’s visit records during the preceding 24 months, or any child having at least two office visits during the preceding 12 months), and to review and approve final educational materials to be used in the intervention.

Five practices within the prespecified geographical area agreed to participate. In addition, two metropolitan Denver practices, outside the prespecified geographical area, were selectively recruited in order to ensure adequate sample size for a separate analysis of Medicare beneficiaries (Gonzales et al. 2004). Two practices (one multiple provider family medicine practice; one solo practitioner) declined because they were “not interested,” two practices (one single provider family medicine practice; one single provider osteopathic medicine practice) declined because they were “too busy,” and one multiple provider pediatric practice declined without providing a reason.

Office practices in the surrounding metropolitan Denver area served as “local control” practices ($n = 362$). In addition, practices located in a geographically distinct metropolitan area 60 miles south of Denver metropolitan area (Colorado Springs) served as “distant control” practices ($n = 65$). To maintain comparable eligibility criteria with the intervention practices, local and distant practices were also required to have at least 20 ARI visits during the baseline period.

Measurements

Office visits and antibiotic prescriptions for ARIs were identified using administrative claims data from four of the five largest commercial MCOs in Colorado. Incident office visits for ARIs (where ARI condition was listed as first diagnosis) were determined using the ICD-9-CM codes for otitis media (382.0, 382.4, 382.9), sinusitis (461, 473), pharyngitis (034, 462, 463), bronchitis (466, 490), pneumonia (481, 482, 483, 485, 486), and nonspecific upper respiratory tract infection (URI) (460, 465). Chronic lung disease comorbidity was defined as ICD-9-CM codes 491, 492, or 496 in the second or third diagnosis field. Additional data collected from the administrative databases included patient age, patient gender, physician specialty, and physician practice location.

Office visit records were merged with pharmacy data using unique patient identifiers. Antibiotic prescriptions (based on National Drug Codes) were considered to be associated with a visit if the prescription was dispensed within 2 days of the visit. The accuracy of using administrative data from the MCOs in this study has been described previously (Maselli and Gonzales 2001). Office visits for pharyngitis and bronchitis based on administrative claims data were verified in 83 and 79 percent of cases, respectively. The sensitivity of antibiotic treatment for pharyngitis based on administrative claims data was 68 percent, and the specificity was 91 percent; for bronchitis, the sensitivity was 79 percent, and the specificity was 84 percent.

Statistical Analyses

Patient-level office visits and antibiotic prescriptions served as the units of analysis. To assess crude differences in patient characteristics across practice groups χ^2 - and *t*-tests were used. Change in the proportion of office visits for pediatric pharyngitis or adult bronchitis treated with antibiotics during baseline to study periods was compared among intervention, local control, and distant control practices using mixed-effects models (PROC MIXED procedure in SAS statistical software; version 8.2, SAS Institute; Cary, NC). Unique office practices, individual physician, and MCO were classified as random effects to account for the clustered nature of antibiotic prescription rates within practice, physician, and health plan. Time period, practice site, patient age, and physician specialty were treated as covariates. The model also included a variable indicating whether the physician had received an individual antibiotic prescribing profile as part of Colorado's ongoing quality improvement

program. Statistical significance ($p < .05$) of the interaction between time period and intervention exposure was used to assess a significant change in antibiotic prescription rates between time periods among the intervention practices while controlling for secular changes measured among control practices. The sample size in this study was designed, a priori, to be sufficient to detect an approximate 10 percent decrease in antibiotic prescription rates for pharyngitis or bronchitis with 80 percent power and 95 percent confidence, assuming no change in prescription rates at the control practices.

RESULTS

Pediatric Pharyngitis

The distribution of patient and physician characteristics between the three practice groups during the baseline and study periods is shown in Table 1. In general, groups showed similar distributions of patient age, gender, and physician specialty. The proportion of visits managed by physicians who were mailed (in November of corresponding period) individual pediatric pharyngitis prescribing profiles increased equally within each study group, from about 70 percent in the baseline period to about 90 percent during the study period.

Adjusted antibiotic prescription rates during baseline and study periods increased from 38 to 39 percent for children at the distant control practices, decreased from 39 to 37 percent for children at the local control practices, and decreased from 34 to 30 percent for children at the intervention practices ($p = .18$ and $p = .48$ for intervention practice compared with distant and local control practices, respectively) (Figure 1A). Patient age was an independent predictor of antibiotic prescribing for children with pharyngitis (increased age corresponded with decreased antibiotic prescribing; $p < .001$).

The majority of antibiotic prescriptions at all sites belonged to first-line, narrow-spectrum antibiotic groups (penicillin, amoxicillin, erythromycin) (Table 2A). The intervention practices had a higher proportion of first-line antibiotics prescribed (80 percent) compared with distant (62 percent) and local (74 percent) control practices, and these levels did not change substantially between baseline and study periods.

Adult Bronchitis

The distribution of patient and physician characteristics between the three practice groups during the baseline and study periods is shown in Table 1.

Table 1: Patient and Provider Characteristics by Study Site

	<i>Baseline Period</i>			<i>Study Period</i>		
	<i>Distant Control</i>	<i>Local Control</i>	<i>Intervention</i>	<i>Distant Control</i>	<i>Local Control</i>	<i>Intervention</i>
<i>(A) Pediatric population</i>						
Practices (number)	53	288	6*	47	234	5*
Providers (number)	113	655	25	86	475	17
Patient visits (number)	1,152	8,575	401	996	8,234	356
Visits per practice						
Mean	22	30	66	21	35	71
Median	7	12	54	6	12	68
(Interquartile range)	(2, 18)	(4, 27)	(1, 87)	(3, 14)	(3, 30)	(23, 82)
Age (%)						
0–5 (years)	22	24	18	25	26	19
6–12 (years)	51	51	55	50	51	50
13–17 (years)	27	25	27	25	23	31
Female (%)	51	52	54	55	53	55
Provider specialty (%)						
Family practice	34	34	31	20	25	26
Pediatrics	64	60	59	79	73	74
Other	2	6	10	1	2	0.3
Visits to profiled provider (%)	70	70	74	91	92	90
Pharyngitis visits percent of total ARI visits	32	34	35	31	36	32
<i>(B) Adult population</i>						
Practices (number)	59	297	6	52	248	6
Providers (number)	117	693	26	91	505	19
Patient visits (number)	763	5,575	220	656	4,239	167
Visits per practice						
Mean	13	19	37	13	17	28
Median	9	12	29	9	11	17
(Interquartile range)	(3, 17)	(5, 24)	(1, 38)	(4, 15)	(5, 23)	(7, 27)
Age (%)						
18–44 (years)	57	60	60	52	51	56
45–64 (years)	43	40	40	48	49	44
Female (%)	62	57	54	62	61	60
Chronic lung disease (%)	1	1	0	1	1	0
Provider specialty (%)						
Family practice	75	71	73	76	72	75
Internal medicine	22	26	24	22	27	24
Other	3	3	3	2	1	1
Visits to profiled provider (%)	51	59	69	81	84	88
Bronchitis visits percent of total ARI visits	17	18	21	18	17	17

*The change in practices represented going from 6 to 5 is because of a single internal medicine practice providing care to one patient less than 18 years of age during the baseline period, but to none during the intervention year.

Figure 1A: Adjusted Antibiotic Prescription Rates for Children with Acute Pharyngitis. The changes in antibiotic prescription rates from baseline to study period are compared between sites. There is no significant change ($p > .05$) between sites after controlling for patient age, gender, physician specialty, and clustering by office practice, physician, and managed care organization.

Again, groups showed similar distributions of patient age, gender, and physician specialty. During the baseline period, fewer office visits at distant control practices (51 percent) were managed by physicians who were mailed individual adult bronchitis prescribing profiles compared with intervention practices (69 percent). However, during the study period the differences between practice sites (81–88 percent) decreased, but remained significantly different ($p = .001$).

For acute bronchitis, adjusted antibiotic prescription rates during baseline and study periods decreased from 51 to 44 percent for adults at the distant control practices, decreased from 55 to 45 percent for adults at the local

Table 2A: Antibiotic Selection for Pediatric Pharyngitis

	Penicillin, Amoxicillin, or Erythromycin (%)	
	Baseline Period	Study Period
Distant Control	62	69
Local Control	74	73
Intervention	80	80

Table 2B: Antibiotic Selection for Adult Bronchitis

	<i>Penicillin, Amoxicillin, or Erythromycin</i>		<i>Second- Generation Macrolides</i>		<i>Cephalosporins</i>		<i>Quinolones</i>		<i>Sulfonamides</i>		<i>Tetracyclines</i>	
	<i>Pre (%)</i>	<i>Post (%)</i>	<i>Pre (%)</i>	<i>Post (%)</i>	<i>Pre (%)</i>	<i>Post (%)</i>	<i>Pre (%)</i>	<i>Post (%)</i>	<i>Pre (%)</i>	<i>Post (%)</i>	<i>Pre (%)</i>	<i>Post (%)</i>
Distant Control	17	16	56	60	10	8	5	6	4	1	8	4
Local Control	31	23	48	55	8	6	4	7	3	1	6	5
Intervention	61	56	25	24	2	6	0	0	7	7	4	3

control practices, and decreased from 60 to 36 percent for adults at the intervention practices ($p < .002$ and $p = .006$ for intervention practice compared with distant and local control practices, respectively) (Figure 1B). Independent predictors of antibiotic prescribing included physician specialty (family practice [52 percent] versus internal medicine [45 percent], $p < .001$) and physician

Figure 1B: Adjusted Antibiotic Prescription Rates for Adults with Acute Bronchitis. The change in antibiotic prescription rates from baseline to study period are compared between sites. After controlling for patient age, gender, physician specialty, and clustering by office practice, physician, and managed care organization, antibiotic prescription rates decreased a greater amount at the intervention site compared with distant ($p < .002$) and local ($p = .006$) control sites.

profiling (physicians receiving profiles in the previous year [50 percent] versus physicians not receiving profiles [47 percent], $p = .02$).

The intervention practices prescribed a much greater proportion of antibiotics belonging to narrow-spectrum antibiotic groups (penicillin, amoxicillin, erythromycin), and a lower proportion of antibiotics belonging to more expensive, second-generation macrolides (azithromycin, clarithromycin) compared with control practices (Table 2B). However, there were no substantial changes in antibiotic selection across practice sites between study periods.

Intervention Costs

The total cost to conduct the household intervention was \$1.64 per household in 2001 dollars for 37,375 households. The materials cost for office practices was approximately \$350 per practice.

DISCUSSION

The "Be S.M.A.R.T. about Antibiotics" patient education campaign had different effects on antibiotic prescribing for pediatric pharyngitis and adult bronchitis. The negligible effect on antibiotic prescribing for pediatric pharyngitis, compared with the considerable effect on prescribing for adult acute bronchitis, probably reflects the different magnitudes of excess antibiotic prescribing (or "quality gap") for each condition. For pediatric pharyngitis, antibiotic treatment is recommended only when the infection is because of group A *Streptococcus*. Because the prevalence of group A, *Streptococcus* in children has been estimated at approximately 30–35 percent of all visits for pharyngitis (Kaplan et al. 1971; Needham, McPherson, and Webb 1998; McIsaac et al. 2000) there appears to have been little room for improvement upon the existing antibiotic prescription rates in our study population.

In contrast, antibiotic treatment for acute bronchitis (in the absence of chronic lung disease) is not routinely recommended because the vast majority of cases have a viral etiology, and randomized controlled trials show minimal or no clinical benefit (Fahey, Stocks, and Thomas 1998; Bent et al. 1999; Gonzales et al. 2001a; Evans et al. 2002). In the U.S., calls to limit antibiotic use for uncomplicated acute bronchitis through published reviews and dissemination of clinical practice guidelines have had only a modest effect (Gonzales et al. 2001a). Faced with this persistent quality gap, it is encouraging that the patient education intervention resulted in a substantial decrease in antibiotic use.

Our results add further weight to the mounting evidence that patient education strategies bolster efforts to decrease unnecessary antibiotic use in the U.S. In previous studies, only combined physician and patient education interventions have been successful at reducing antibiotic use, but none has been able to distinguish the relative effects of each target audience. The “Be S.M.A.R.T. about Antibiotics” campaign is the first to demonstrate that the *addition* of patient-focused education to an ongoing physician quality improvement program results in a much larger decrease in antibiotic use for adults with acute bronchitis than the physician program alone (even if one assumes that all of the secular change at control sites is because of the quality improvement program). However, our study cannot quantify the degree to which this effect results from a synergy between physician and patient education, or whether the patient education alone would have resulted in the same effect.

The rationale for using a patient education intervention was based on findings of earlier clinician surveys that parent and patient expectations of receiving antibiotics were major factors promoting unnecessary antibiotic use (Barden et al. 1998; Bauchner, Pelton, and Klein 1999; Mangione-Smith et al. 1999). Similarly, practice-based studies confirmed that patient desire for antibiotics was associated with higher antibiotic prescription rates for conditions unlikely to benefit from antibiotic therapy (Hamm, Hicks, and Bemben 1996; Mangione-Smith et al. 1999). Finally, community physicians have explicitly recommended patient education campaigns as the intervention with the greatest likelihood of reducing excess antibiotic use for ARIs (Deas et al. 2002).

There are limitations to using administrative MCO data to measure antibiotic prescribing behavior. Capture of an antibiotic prescription in the pharmacy database requires that the antibiotic be dispensed by an outpatient pharmacy, and further, that the pharmacy participates in the MCO pharmacy benefits program. Thus, administrative pharmacy data fail to detect antibiotics given to patients in the office as samples, antibiotic prescriptions that patients decide not to fill, and antibiotic treatment rendered in an alternative facility such as the emergency department or hospital. In the case of pharyngitis, this is also complicated by antibiotic prescriptions that are pending a positive throat culture or rapid group A *Streptococcus* test, which could account for the lower sensitivity of administrative claims for detecting an antibiotic prescription decision in the chart. Further, because we merged pharmacy data with office visit data, we were unable to account for telephone, facsimile, and Internet-based antibiotic prescribing for ARIs, which were not associated with an office visit.

In addition, selection bias because of the nonrandomized nature of our study could have affected the results of our study. The practices that agreed to participate in the "Be S.M.A.R.T. about Antibiotics" campaign may represent a group of practices more willing to modify their prescribing behaviors than the comparison practices. This bias could explain the lack of effect observed in pharyngitis treatment, as well as the large decrease in antibiotic use for bronchitis.

In conclusion, the findings from this interventional study suggest that antibiotic prescribing patterns and behavior can be positively affected by patient education campaigns. Determining whether more efficient and wide-scale patient and public education campaigns can be equally effective will be examined in the second phase of the Minimizing Antibiotic Resistance in Colorado Project.

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