ARTICLE

A Randomized Controlled Trial to Change Antibiotic Prescribing Patterns in a Community

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Background: Excessive and inappropriate use of antibiotics has been identified as a leading cause of the emergence of multiply resistant strains of pneumococci.

Objective: To examine the effects of academic detailing and a parental education program on community pediatricians' prescription of antibiotics for young children.

Methods: Physician leaders in study practices prepared educational modules and presented the modules to their practices. The control groups received only practice-specific report cards. Using a time-series analysis, we collected data on office visits and antibiotic prescriptions filled between May 1, 2000, and April 30, 2001 (baseline period), and between May 1, 2001, and April 30, 2002 (intervention period). Antibiotic prescription rate was defined as the ratio of antibiotic prescriptions filled to the number of office visits.

Results: The antibiotic prescription rate decreased to 0.82 (95% confidence interval, 0.71-0.95) of the baseline rate for the study group (6 practices) and to 0.86 (95% confidence interval, 0.77-0.95) of the baseline for the control group (5 practices). Similar patterns for antibiotic prescription rates were seen for study and control groups both before and after the intervention. Wide variations in prescription rates were observed among the practices, but, in general, the control practices had lower antibiotic prescribing rates during both the baseline and the intervention periods. Use of amoxicillin increased slightly in the study group and decreased slightly in the control group. The use of cephalosporins increased slightly in both groups.

Conclusion: Overall, academic detailing appeared to be no more effective in reducing antibiotic use than the practice-specific report cards alone.

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ANTIBIOTICS ARE ARGUABLY the most important advance in the history of medicine. Unfortunately, indiscriminate use of antibiotics has been one of the causes of the emergence of resistant pathogens. The recent dramatic emergence of multiply resistant strains of bacteria has focused the attention of the medical community and the public on the problem of antimicrobial resistance.[1-5] Because children receive a significant proportion of the total antibiotics prescribed each year, pediatric populations are important targets for efforts aimed at reducing unnecessary antibiotic use.[6-9]

Academic detailing and parental education have been suggested as 2 promising behavior-change strategies to address the problem of overuse of antibiotics. Academic detailing is an educational strategy based on face-to-face contact with a credible messenger.[10-14] These educational outreach programs can address physicians' existing beliefs and concerns while taking advantage of the power of a personal encounter with a credible source who provides easily understood materials and practical advice. Many studies have shown that education at an individual or small-group level and peer education are effective strategies to change physicians' antibiotic prescribing behavior.[10,13,15-18]

Strategies to empower parents often emphasize differences between viruses and bacteria, describe how resistant bacteria emerge, review appropriate indications for antibiotics, counsel parents that all infections do not require antibiotics, and suggest alternative treatments.[19] If parents can better understand the role of antibiotics in the treatment of disease, they may exert less pressure on physicians to dispense antibiotics inappropriately.[20,21] Patient or parental educational handouts have been reported to clarify misunderstandings and promote better patient-physician communication.[22]

The purpose of this study was to use a time-series analysis to examine the effects of academic detailing and a parental education program on the prescription rates of community pediatricians caring for young children.

METHODS

RESEARCH DESIGN

We used a time-series analysis to estimate the effects of the intervention on the prescription of antibiotics for young children. This study was approved by the Cincinnati Children's Hospital Medical Center (CCHMC) institutional review board, and informed consent was obtained from all participating physicians.

STUDY PARTICIPANTS

We identified all pediatric practice groups in the greater Cincinnati area (consisting of portions of southwest Ohio and northern Kentucky) that had a minimum of 2 full-time pediatricians. The practices were stratified by state (Ohio, 129 practices with a total of 286 physicians; Kentucky, 16 practices with a total of 55 physicians) and by practice type (traditional private practice or federally qualified health center accepting Medicaid). Each practice was assigned a random number and then sorted to prepare a contact list. The practices were then contacted in their order on the contact list until 12 practices agreed to participate. This resulted in 10 participating practice groups in Ohio (2 federally qualified health centers and 8 traditional private practices) and 2 traditional private-practice groups in Kentucky. The stratified practices were then separately randomized to a study group or control group. The result was 6 practices assigned to the study group and 6 to the control group. One study practice had 3 offices, and 1 study practice and 1 control practice had 2 offices each. For all practices, every physician in the practice was included in the group to which the practice was randomized.

INTERVENTION

From July 2000 through June 2001, a physician-advisory group, composed of local leaders, developed the academic-detailing program. Local opinion leaders were identified by a survey of local physicians and recruited to conduct the physician detailing and serve as change agents. Focus group interviews with local physicians were conducted to identify reasons for current prescribing practices and barriers to recommended therapies. Focus groups of local parents were convened to identify their expectations, ascertain barriers to change, and develop effective educational methods to address the identified barriers.

Members of the 6 study practices were asked to identify 1 person in their group to serve as a leader and contact. The 6 practice leaders were invited to attend a kick-off dinner meeting on May 21, 2001, that featured a guest speaker from the Centers for Disease Control and Prevention (CDC).

Each practice received a binder containing all of the evidence-based clinical-practice guidelines developed by CCHMC. They also received CDC-developed educational material to be distributed to parents that provided information on illness prevention, when to seek care, what to expect from office visits, the limited role of antibiotic treatment for some conditions, and the dangers of unnecessary antibiotic use, plus our recommendations for the prescription of antibiotics for common disorders affecting young children. These materials included pamphlets, posters, and flyers. Each practice decided how best to use each item. In several practice sites, the physicians and nurses preferred to personally hand the materials to parents. Nurses who performed telephone triage used the material as scripts in their daily activities.

Every other month between June 2001 and April 2002, each practice leader met with local experts to develop an educational seminar that was presented to physicians in their practice group during alternate months. The topics included local antibiotic resistance and its implications, evidence-based information about antibiotic use for common disorders affecting young children, tools to reduce antibiotic use, alternative treatments, results of the parental focus groups, and advice on how to say "no" to parental demand for antibiotics. A study investigator also attended each practice meeting. Report cards detailing antibiotic-prescribing data from their practices were provided to the physicians quarterly (**Figure 1**).

The 6 practices in the control group received copies of guidelines developed at CCHMC and twice received practice-specific report cards by mail.

DATA COLLECTION AND SOURCES

The primary outcome of interest was prescriptions filled for antibiotics for young children. Data were collected on the office visits and antibiotic prescriptions filled between May 1, 2000, and April 30, 2001 (baseline period), and between May 1, 2001, and April 30, 2002 (intervention period), for both study and control groups. Study and control practices provided data on the total number of visits that occurred each month. Data on the number of prescriptions filled were purchased from NDCHealth, a health-information provider centered in Phoenix, Ariz, that captures 70% of all retail prescriptions nationwide (internal company document from May 2001). To limit data to prescriptions for young children, only data on prescriptions for liquid and chewable antibiotics were obtained.

DATA ANALYSES

Antibiotic prescription rates were defined as the ratio of antibiotic prescriptions filled to the number of office visits. Overall antibiotic prescription rates per month per practice site were compared for study practices vs control practices and for the baseline period vs the intervention period. Variations in prescription rates by practice site and patient characteristics were also examined.

Because this study used repeated measures of the practices and the dependent variable was based on count data, a generalized estimating equation Poisson regression model was used to test the impact of the intervention (PC-SAS software, Release 8.0; SAS Institute Inc, Cary, NC). This method has provisions to adjust for the autocorrelation between samples caused by the repeated measures, and it allows use of the Poisson distribution to model the error term.[23] The monthly antibiotic prescription ratio was the dependent variable. Binary variables were created for the independent variables to indicate (1) study or control group, (2) baseline or intervention period, and (3) interaction of study group–intervention period to test if the intervention had more effect on the study group than the control group. The parameter estimates in this model are the log of the rate ratio for each variable and its 95% confidence interval (CI).

RESULTS

PRACTICE CHARACTERISTICS

One of the control practices withdrew from the study owing to the inability to retrieve patient-visit data, leaving

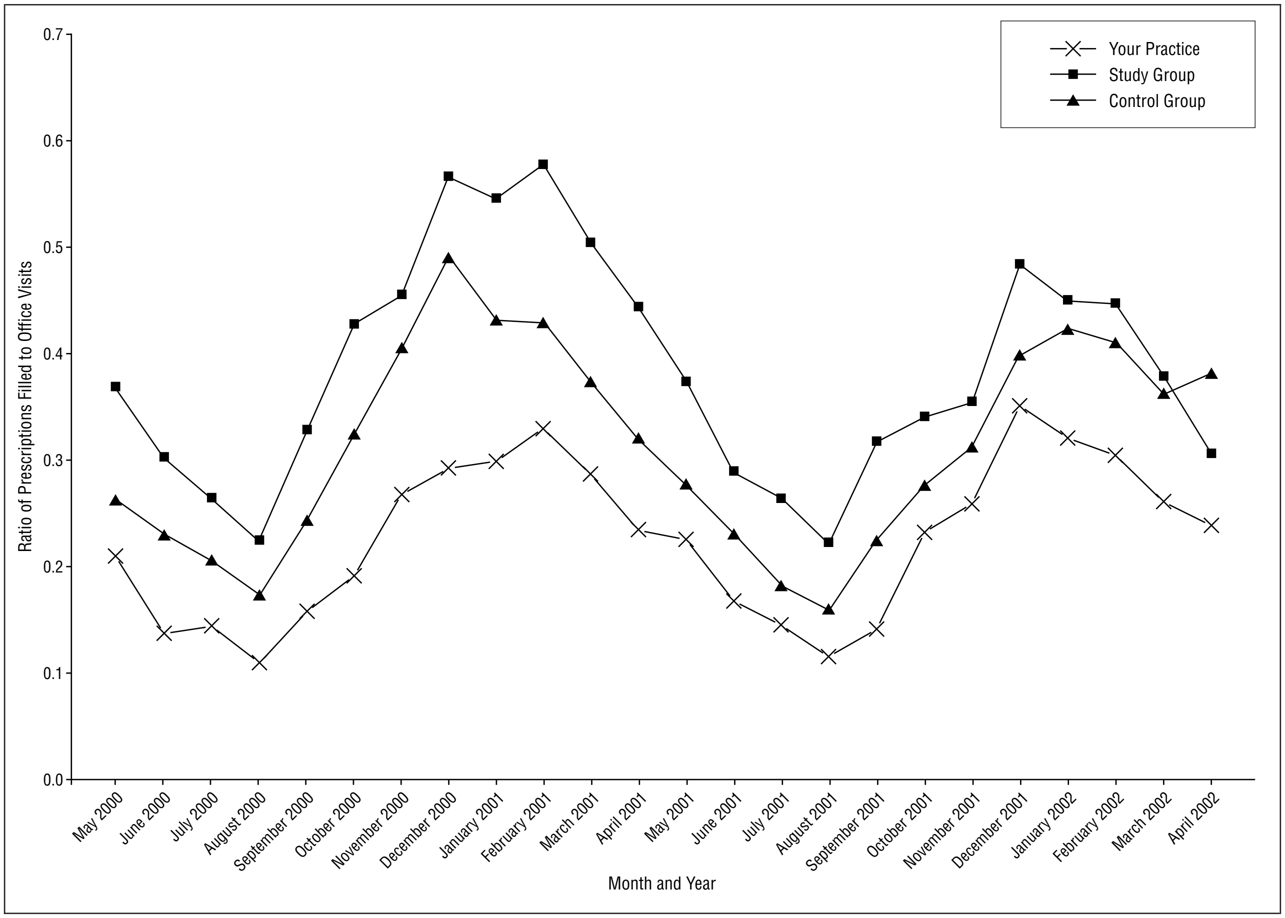

Figure 1. An example of the practice-specific report cards sent to participating physician groups. Antibiotic rates were defined as the ratio of antibiotic prescriptions filled to the number of office visits. The graph shows the antibiotic rates for combined study groups and control groups and for an individual practice.

6 study and 5 control physician groups. Characteristics of the practices are summarized in **Table 1**.

PRESCRIPTION RATES

The antibiotic prescription rate for the study group decreased to 0.82 (95% CI, 0.71-0.95) of the baseline rate following the intervention. In the control group, the antibiotic prescription rate decreased to 0.86 (95% CI, 0.77-0.95) of the baseline rate. The intervention in the study group had no statistically significant impact above the change in the antibiotic prescription rate that occurred in the control group.

TEMPORAL VARIATION

Seasonal patterns for antibiotic prescription rates (lower rates in August and higher rates in December and January) were similar for study and control groups both before and after the implementation of the intervention.

PRACTICE VARIATION

While we observed overall reductions in antibiotic prescription rates, wide variations were observed among the practices (**Figure 2**). The minimum and maximum prescription rates also varied widely among practices (**Table 2**). For 10 of 11 practices, the mean antibiotic prescription rate decreased in the intervention period. In general, the control practices had lower antibiotic prescribing rates during both the baseline and the intervention periods.

ANTIBIOTICS PRESCRIBED

Antibiotic use patterns changed significantly for both the study group ($P < .001$) and the control group ($P < .001$), following implementation of the intervention (**Table 3**). In general, the antibiotic of choice (amoxicillin) was used slightly more often in the study group. The use of cephalosporins increased slightly in both groups, and amoxicillin/clavulanate potassium was prescribed slightly less often in both groups.

COMMENT

The successful use of academic detailing has been documented in the areas of hypertension,[24] tobacco-related performance,[25] antibiotic use in bronchiolitis,[26] and, recently, in 2 community-based studies targeting overall antibiotic use among physicians.[27,28] Evidence-based clinical practice guidelines, containing recommendations for diagnosis and treatment, are also a strategy for changing physician practice. Several national organizations have developed guideline programs that address the appropriate use of antimicrobial agents.[29-32] However, while physicians generally have a positive view of guidelines,[33-35] the guidelines' success in changing physician behavior has been mixed.[36-38]

While physicians may be aware of the evidence-based medicine presented in guidelines, the ultimate objective is not only awareness but also appropriate changes in behavior.[39] But changing physicians' behavior is seldom easy. A growing body of literature suggests that traditional continuing medical education,[40,41] the dissemination of printed materials,[10,42] and even the release of authoritative practice guidelines[36,37] may have little or no impact on the practice of local physicians. These educational methods can be overpowered by influences such as inertia, peer or patient pressures, economic advantage, malpractice concerns, or pharmaceutical marketing.[11]

Table 1. Practice Characteristics

	Mean ± SD	
	Study Group	Control Group
No. of physicians	6.3 ± 1.9	4.8 ± 1.6
Female physicians, %	40.9 ± 11.4	50.7 ± 20.2
Age of physicians, y	46.2 ± 6.0	43.6 ± 2.8
Visits paid by Medicaid, %	12.8 ± 13.3	<5

To change the state of practice, a dissemination program must offer a timely, scientifically grounded, and clinically relevant message, and the targets of the program must be willing and able to act on the message.[36] The impact of the guideline implementation process developed by CCHMC has been previously reported.[43-45] The social influence perspective, as proposed by Mittman et al,[46] that our process uses is based on the theory that physicians' tendencies to act on new information or to use new treatments may be significantly influenced by colleagues' judgments of the value and significance of the innovation and/or by colleagues' decisions to use or ignore it. Thus, social influence approaches point to habit, socially accepted norms of appropriateness, and peer acceptance as the motivators for change.

Educating parents about appropriate indications for antibiotics must also be part of any comprehensive plan to reduce inappropriate use. It is possible that if parents are educated about appropriate indications for antibiotics, they may not only pressure physicians less to dispense antibiotics but also influence physicians' behavior by appropriately questioning the role that antibiotics play in the treatment of some medical conditions.[47] Cates[48] reported that the monthly antibiotic prescriptions for otitis media in his practice decreased 20% after he instituted a program that included a parental handout summarizing the limited benefits of antibiotics, suggested alternatives to antibiotics, and a request not to fill an an-

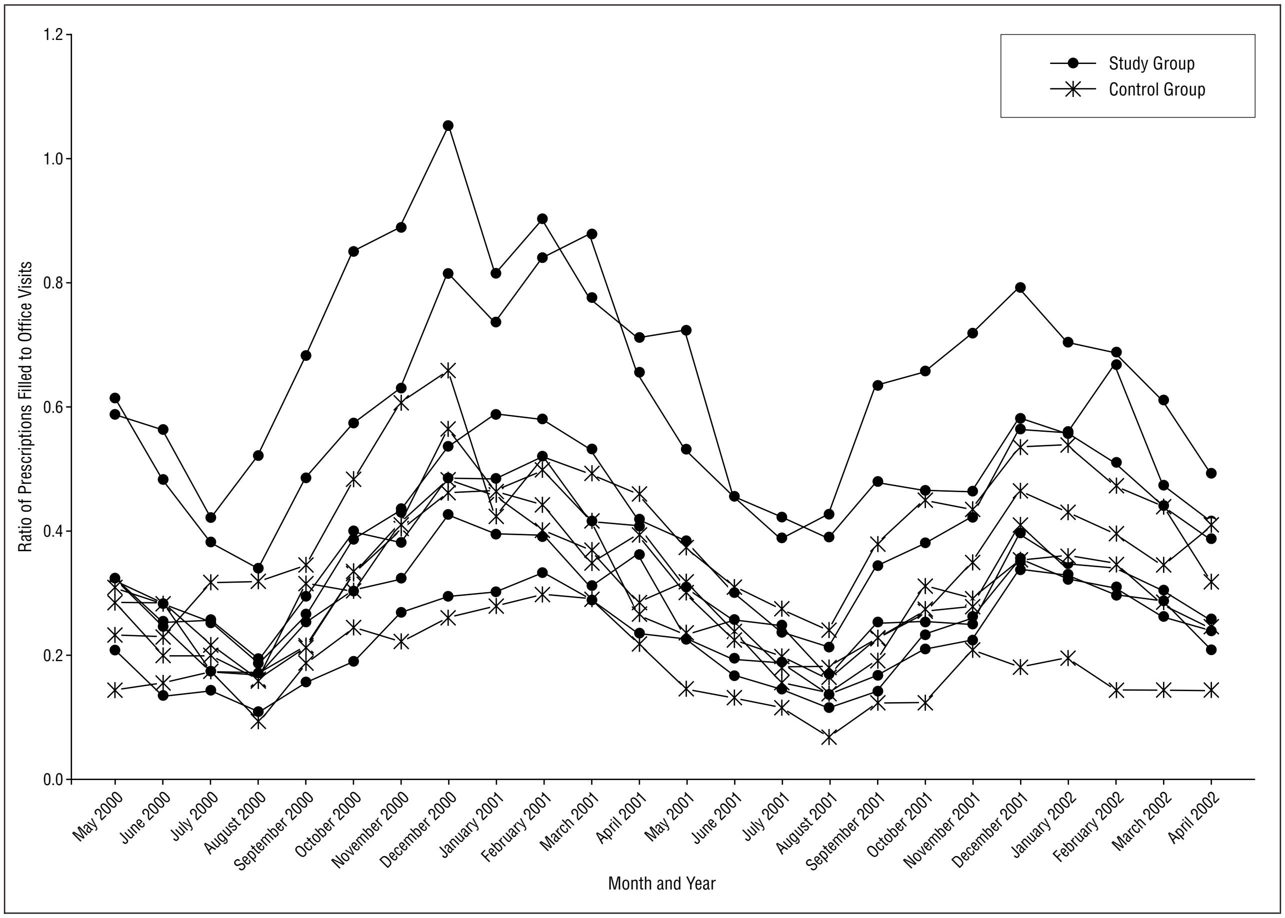

Figure 2. Antibiotic prescription rates data points by practice. The intervention was implemented in May 2001.

tibiotics prescription unless that child was not better in a day or 2.

Our study attempted to alter physician behavior in the area of antibiotic use through a multifaceted intervention emphasizing repetition, reinforcement, and physician and parental education. Despite this relatively labor-intensive effort, the 2 groups showed equal improvement. The explanations for our results probably include many factors. Our approach differed somewhat from the traditional academic-detailing model in that our experts were leaders identified within each practice who were accompanied by 1 of the study investigators to each office presentation. However, the practice leaders had been coached during our preparatory sessions by an acknowledged expert in the particular area of discussion. The effect of a report card appeared to be as potent as the intensive additional interventions. Coincidentally, the control group had an overall better practice profile at the onset. Two of the control groups vs 1 of the study groups were part of a large health maintenance organization that had instituted report cards and other educational interventions prior to the study period. The practices with the highest prescribing rates in both the baseline and the intervention periods were not significantly different from the other practices in the percentage of Medicaid patients, age of physicians, or male-female physician ratio. Interestingly, the 2 highest prescribing practices had both the lowest and the highest average ages for pediatricians. In addition, a significant media campaign was conducted by the CDC and other interested parties, such as managed care organizations, during the study phase (May 2001-April 2002).

One of the flaws in the study might be that the data source (NDCHealth) captured only 70% of the prescriptions filled during the study period. Other studies in this area have been able to use large-group information systems that were not available in this type of study, including many varied practices with a variety of information systems.[27,28] A labor-intensive chart review would have had to occur to get data that are more precise, and this was beyond the resources of this study. In addition, there was an assumption that capturing the data pertaining to antibiotic suspensions and chewables would include all of the age groups that were targeted. However, some younger children might accept swallowable tablets, and some older children might prefer the suspensions or chewables.

The improvement in prescribing behavior in both the control and the study practices should be analyzed in light of national trends that have been recognized recently. Oral antibiotics are being prescribed less in the United States,[49,50] and successful community interventions have been shown to be effective.[28,51,52] During the time frame of this study, there was an intense nationwide media campaign to promote the reduction in antibiotic use, and the references cited above demonstrate the trend downward in prescribing habits that was occurring simultaneously.

This study shows that an approach using labor-intensive academic detailing to change physician prescribing behavior was clearly not a valuable use of resources. Other investigators might be better served to focus on areas that might be more productive, such as analyzing purportedly effective media campaigns or other professional development tools that might also be more cost-effective.

This study was designed to determine the effects of academic detailing and a parental education program on antibiotic-prescribing behavior among community pediatricians. We concluded that these efforts were no more

Table 2. Practice Variation in Antibiotic Prescription Rates

Practice	Mean Prescription Rate	Minimum Rate	Maximum Rate
Study Group			
1			
Baseline period	0.366	0.184	0.581
Intervention period	0.278	0.166	0.391
2			
Baseline period	0.395	0.191	0.588
Intervention period	0.391	0.209	0.562
3			
Baseline period	0.618	0.337	0.874
Intervention period	0.488	0.384	0.667
4			
Baseline period	0.220	0.108	0.329
Intervention period	0.288	0.113	0.350
5			
Baseline period	0.304	0.172	0.422
Intervention period	0.231	0.135	0.334
6			
Baseline period	0.729	0.418	1.048
Intervention period	0.605	0.383	0.787
Control Group			
1			
Baseline period	0.328	0.165	0.467
Intervention period	0.261	0.179	0.404
2			
Baseline period	0.333	0.164	0.563
Intervention period	0.310	0.158	0.461
3			
Baseline period	0.213	0.092	0.296
Intervention period	0.142	0.067	0.206
4			
Baseline period	0.330	0.159	0.480
Intervention period	0.266	0.138	0.356
5			
Baseline period	0.422	0.229	0.658
Intervention period	0.394	0.237	0.538

Table 3. Antibiotics Prescribed*

Antibiotics Prescribed	Study Group		Control Group	
	Baseline	Intervention	Baseline	Intervention
Amoxicillin	46.1	49.6	48.2	47.8
Augmentin	17.2	13.7	17.3	14.2
Sulfas	3.5	4.2	4.6	4.1
Penicillins	1.9	1.1	0.2	0.1
Macrolides	12.8	11.9	12.6	14.8
Cephalosporins	18.5	19.5	17.1	19.0

*Values are expressed as percentages.

What This Study Adds

The recent dramatic emergence of multiply resistant strains of bacteria has focused the attention of the medical community and the public on the problem of antimicrobial resistance. Previous evidence has shown that academic detailing is a powerful tool for changing physician behavior. This study describes the difficulty of implementing a detailed multipractice intervention designed to reduce antibiotic use. The critical importance of a control group is shown by the significant behavior change found in both the study and the control groups, with the latter impacted as effectively by a nationwide media campaign conducted simultaneously with this study.

effective than a simple report card in changing prescribing habits among our participating physicians.

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