Distinguished Paper From the 1999 North American Primary Care Research Group Meeting

An Evaluation of Statewide Strategies to Reduce Antibiotic Overuse

Arch G. Mainous III, PhD; William J. Hueston, MD; Margaret M. Love, PhD; Martin E. Evans, MD; Reginald Finger, MD, MPH

Background: *The rapid increase of antibiotic resistance poses a significant threat to human health. Overuse of antibiotics has been linked to rates of antibiotic resistance. This study assessed the utility of two common interventions—1) practice profiling and feedback and 2) patient education materials—implemented to decrease antibiotic prescribing for pediatric upper respiratory infections (URIs).* Methods: *Based on Medicaid regions in Kentucky, primary care physicians managing pediatric respiratory infections in Medicaid were randomized into four groups. Groups received either 1) performance feedback only, 2) patient education materials only, 3) both feedback and education materials, or 4) no intervention. Participating physicians had their antibiotic prescribing assessed for the period of July 1, 1996, to November 30, 1997, with an intervention in June 1997. The study included 216 physicians and 124,092 episodes of care.* Results: *All groups increased in proportion of episodes with antibiotics between the pre-intervention and post-intervention periods. Prescribing in the patient education group and the patient education and feedback group increased at a significantly lower rate than in the control group. Physicians did not change their coding of illness to justify antibiotics after the intervention, and there was no significant generalization of effect of the pediatric intervention on prescribing for adult URIs.* Conclusions: *These interventions demonstrate little if any impact on promoting appropriate antibiotic prescribing. Antibiotic prescribing for viral respiratory infections continues to increase, suggesting concomitant increases in antibiotic resistance.*

(Fam Med 2000;32(1):22-9.)

Upper respiratory infections (URIs) are quite common and are primarily of viral etiology.[1,2] Antibiotics are not indicated for the treatment of URIs and have no demonstrated benefit.[3-6] Despite this evidence, antibiotics are widely prescribed for URIs; it is estimated that more than 50% of URI episodes are being treated with antibiotics.[7,8]

The widespread use of antibiotics has been associated with an alarming rise in the frequency of antibiotic-resistant bacteria.[9,10] Also implicating the effects of antibiotic use on resistance is the observation that population-level reductions of antibiotic use are associated with a significant decrease in resistant bacteria.[10] Moreover, the use of antibiotics for URIs, an ineffective treatment, is costly.[11]

Two issues appear to drive the use of antibiotics for viral respiratory infections. One is patient expectations for antibiotics to treat their illness. Patients appear not to understand the normal presentation of a URI and believe in the effectiveness of antibiotics for certain symptom complexes characteristic of viral URIs.[12] Thus, educating patients may help physicians decrease patient beliefs in the effectiveness of and corresponding expectations for antibiotics for URIs.

Also, physicians may not appreciate the negative impact of antibiotic prescribing on the development of antibiotic resistance. Physicians tend to err on the side of providing an antibiotic when in doubt about the cause of an infection[13] and overdiagnose bacterial infections when symptoms suggest viral etiologies.[14] This suggests

From the Department of Family Medicine, Medical University of South Carolina (Drs Mainous and Hueston); the Department of Family Practice (Dr Love) and the Department of Internal Medicine (Dr Evans), University of Kentucky; and the El Paso County Department of Health and Environment, Colorado Springs, Colo (Dr Finger).

that an intervention to alter physician behaviors also would be essential to reduce antibiotic use.

However, the nature of an intervention to change behaviors is important. Literature on changing physicians' prescribing behavior suggests that passive educational interventions are generally ineffective.[15-17] While targeting individual physicians for face-to-face education (known as academic detailing) is remarkably effective,[16,18,19] this approach is labor-intensive and expensive. An alternative method that may be useful in changing physician behavior is the profiling of practice patterns and providing individual feedback to physicians on their performance.[20,21] Profiles are useful in providing information on medical practice because they focus on patterns of practice, are efficient and unobtrusive when developed from administrative databases, and provide information on a practice pattern within the context of a norm or group standard.[22]

Profiling and feedback, however, tend to be most effective in changing behavior when linked with money and with individuals who agree that a change is needed (eg, "physician buy-in"). For some interventions, however, provider practices may need to be changed in a way that is not initially universally accepted by all practitioners. Thus, interventions that have shown results in small systems using compliant participants, who may have some incentive to change even if it just to please their colleagues, do not provide information on the effectiveness of interventions to change the behaviors of large numbers of providers who may not necessarily want to change. This study examined the effect of statewide interventions that used both direct patient education and physician practice feedback on antibiotic prescribing for pediatric respiratory infections. The study also documented the use of antibiotics for presumably viral respiratory infections over an extended period, controlling for seasonal differences.

Methods

This study, which was approved by the Medical Institutional Review Board of the University of Kentucky, examined two specific interventions for reducing inappropriate antibiotic prescribing. The first intervention was feedback about antibiotic prescribing. The second was providing education materials to patients about antibiotic use. Patient education materials were examined as a tool for physicians to deal with patients who might have expectations for antibiotics. Based on the eight Medicaid administrative regions in Kentucky, four study groups were created, each composed of two regions. Because Kentucky is primarily nonmetropolitan, each study group included a region that contained a metropolitan statistical area. The physicians in the four groups were randomized to receive either 1) performance feedback only, 2) patient education materials only, 3) both feedback and education materials, or 4) no intervention (control group).

The Medicaid population was selected for study for several reasons. First, Medicaid claims data offer a reasonable assurance of capturing a universe of utilization and charges over a defined period. Second, Medicaid in Kentucky was, at the time of this study, transitioning toward a managed care delivery system. Physicians were aware that costs would be tracked in the near future, so behavior with implications for costs should have generated significant interest among physicians.

Subjects

Physicians were selected by matching data from the Kentucky Medical Licensure Board (KMLB) to the Medicaid billing provider information. Physicians were included in the study if they had billed for at least 75 episodes of any combination of the pediatric respiratory infections shown in Table 1 and at least 25 URI episodes between July 1, 1995, and June 30, 1996. Individuals with this level of service were initially included in the study; however, individuals were kept in the study if they managed at least five URI/purulent rhinitis/acute bronchitis episodes in each of the three study periods of fall 1996, winter/spring 1997, and fall 1997. All included individuals, therefore, had some documented experience managing pediatric respiratory infections.

The physicians had to be either in private or hospital-based practice. Included physicians were classified as pediatricians, family physicians, and "other primary care," based on the specialty listing with the KMLB.

Table 1

Codes for Pediatric Upper Respiratory Morbidities

Infection	*ICD-9 Codes*	*Treated With Antibiotics*
Nonsuppurative otitis media (acute/with effusion)	381.0, 381.4	Data equivocal on use of antibiotics
Suppurative otitis media (acute)	382.0, 382.4, 382.9	Yes
Sinusitis (acute)	461	Yes
Streptococcal pharyngitis	034.0	Yes
Pharyngitis/tonsillitis	462,463	Dependent on streptococcal screening test
Rhinitis (includes purulent)	472.0	No
Common cold/URI	460, 465	No
Bronchitis (acute)	466.0, 490	No

ICD-9—*International Classification of Diseases, Ninth Edition*
URI—upper respiratory infection

Other primary care was defined as physicians whose specialty was not identified as otolaryngology (eg, general practice, general internal medicine) but who met the other disease management criteria.

Episodes of Care

Prescribing for an illness was attributed to an individual physician. However, a specific respiratory infection may result in more than one physician contact. Therefore, it was necessary to create an episode of care for any particular respiratory infection. Individuals could have more than one episode of care in the data set.

To create these episodes of care, we selected episodes for all pediatric (individuals < age 18) respiratory infections (Table 1). Upper respiratory tract infections were defined by the *International Classification of Diseases, Ninth Edition* (ICD-9-CM) codes under the diagnostic stem of 465 and 460.[23] Both of these codes were used to define URIs because variation may exist among physicians in the codes used for this condition. Purulent rhinitis and acute bronchitis were also defined as conditions for which evidence does not suggest a treatment benefit from antibiotics (Table 1).[5,24]

Each episode began with a physician claim for outpatient evaluation and management with a primary diagnosis of one of the specified respiratory infections in Table 1. *Current Procedural Terminology* (CPT) codes indicating physician evaluation and management in an outpatient setting are 99201-5 and 99211-5.[25] All claims on the date of service with the specified diagnosis were considered to be part of the encounter.

Because Kentucky Medicaid drug claims do not have a corresponding diagnosis, medications needed a logical linking in the algorithm. The medication was assumed to have been prescribed for treatment of the respiratory infection if the drug claim date was the same as the physician visit or up to and including 4 days after the physician visit. This time frame surrounding the physician visit should account for the possible time lag between seeing the physician and filling the prescription. Encounters were excluded if any additional visit (whether inpatient, outpatient, or emergency department) for another condition occurred sometime within the 4 days after the visit for the respiratory infection. This was done to provide a window of drug acquisition uncontaminated by other conditions. Further, if another visit for a respiratory infection was reported within the time frame, the second visit was eliminated from the data set, since this visit was presumed to be part of the initial episode.

The episodes were further defined by linking the identification number of the attending physician with the physician drug claim identification number. Any drug claims that did not match the physician visit were eliminated. Topical or ophthalmic medications and antifungal, anthelmintic, and antiprotozoan agents were excluded.

Interventions

The interventions were implemented in the first week of June 1997. The feedback intervention consisted of providing the physicians with a profile of their prescribing practices for pediatric URIs, acute bronchitis, and purulent rhinitis for the period of July 1, 1995, to June 30, 1996. These three diagnoses were profiled because of the lack of evidence of a benefit of treatment with antibiotics.

The prescribing profile included 1) a listing of the total number of episodes of care for these pediatric respiratory conditions, 2) the number that received antibiotics, 3) the corresponding proportion that received antibiotics, 4) the total cost of the episode, and 5) the proportionate cost of antibiotics in the cost of evaluating and managing these conditions. The costs were based on paid claims to Medicaid for the physicians' evaluation and management and all medications filled in the episode. Additionally, physicians were provided with their percentile rank for antibiotic prescribing compared to their peers. A letter that accompanied the feedback indicated that these conditions were being evaluated because little evidence supported antibiotics for their treatment, and as Medicaid moves to managed care and pharmaceutical capitation, each physician would be fiscally responsible for their prescribing.

The patient education intervention consisted of a letter without information on costs and profiling and patient education pamphlets, "Your Child and Antibiotics." The pamphlets were produced in 1997 by the American Academy of Pediatrics with cosponsorship by the Centers for Disease Control and Prevention (CDC) and the American Society for Microbiology. Each physician received 25 pamphlets and instructions that additional pamphlets could be obtained from the CDC.

The group of physicians who received the combined information received feedback on prescribing and the 25 patient education pamphlets. The control group physicians received nothing.

Study Period

Prescribing for pediatric respiratory infections was monitored for the period July 1, 1996, to November 30, 1997, with a 5-month study period immediately prior to the intervention (January 1, 1997 to May 31, 1997) and after the intervention (July 1, 1997, to November 30, 1997). It also enabled us to control for seasonal effects by allowing us to compare fall 1996 (July 1, 1996, to November 30, 1996) to fall 1997 (July 1, 1997, to November 30, 1997). June 1997 is excluded from the analysis because that was the time of the intervention.

Analysis

Descriptive statistics were computed for measures of antibiotic prescribing for the combined diagnoses of URI, rhinitis, and acute bronchitis. Proportions of episodes with antibiotics were computed for each individual, and means were computed for the group. Gain scores were computed comparing mean prescribing rates for the four groups before and after the intervention, using the general linear model. Gain scores were computed by subtracting the mean prescribing rate for the pre-intervention period from the mean prescribing rate for the post-intervention period. Because of possible seasonal variation, we performed analyses using two different baseline sets of data (winter/spring 1997 and fall 1996) in comparison to the post-intervention fall 1997 prescribing behavior. To determine which groups differed from the control group, Dunnett's *T* post-hoc multiple comparison analyses were computed.

A data validation issue concerned the possible change in coding practices of the participating physicians in response to the interventions. That is, individuals may change their coding to justify prescribing antibiotics. For example, a condition may be coded as a URI prior to the interventions but later coded as acute otitis media to justify the use of antibiotics. Consequently, antibiotic prescribing was examined for changes according to individual diagnoses within the range of investigated diagnoses.

A potential additional benefit of the interventions was that changes in physicians' prescribing patterns for children could generalize to their adult patients. Therefore, changes in prescribing patterns were analyzed for both child and adult patients of family physicians, who are likely to see many children as well as adults for these conditions.

Results

A total of 269 physicians were included in the initial sample. Fifty-three of those physicians were excluded from the final analysis because we could not document that each had five or more episodes of care for children for URIs, purulent rhinitis, or acute bronchitis in each of three study periods. This left a total of 216 physicians in the final analysis pool. The patient education group included 53 physicians and data from 29,562 episodes of care. The feedback group included 49 physicians and data from 34,810 episodes of care. The patient education and feedback group included 52 physicians and data from 22,728 episodes of care. The control group included 62 physicians and data from 37,622 episodes of care. Table 2 compares the groups according to practice and background characteristics.

Contrary to expectations, mean antibiotic prescribing rates for URI/purulent rhinitis/acute bronchitis increased in all groups during the investigated time period (Figure 1). The results of the general linear model analysis showed that the gain scores were significantly different across the four groups, comparing fall 1997 to both fall 1996 (F=4.31, *P*=.006) and winter/spring 1997 (F=3.51, *P*=.02). Dunnett's *T* multiple comparison tests indicated that gain scores for the patient

Table 2

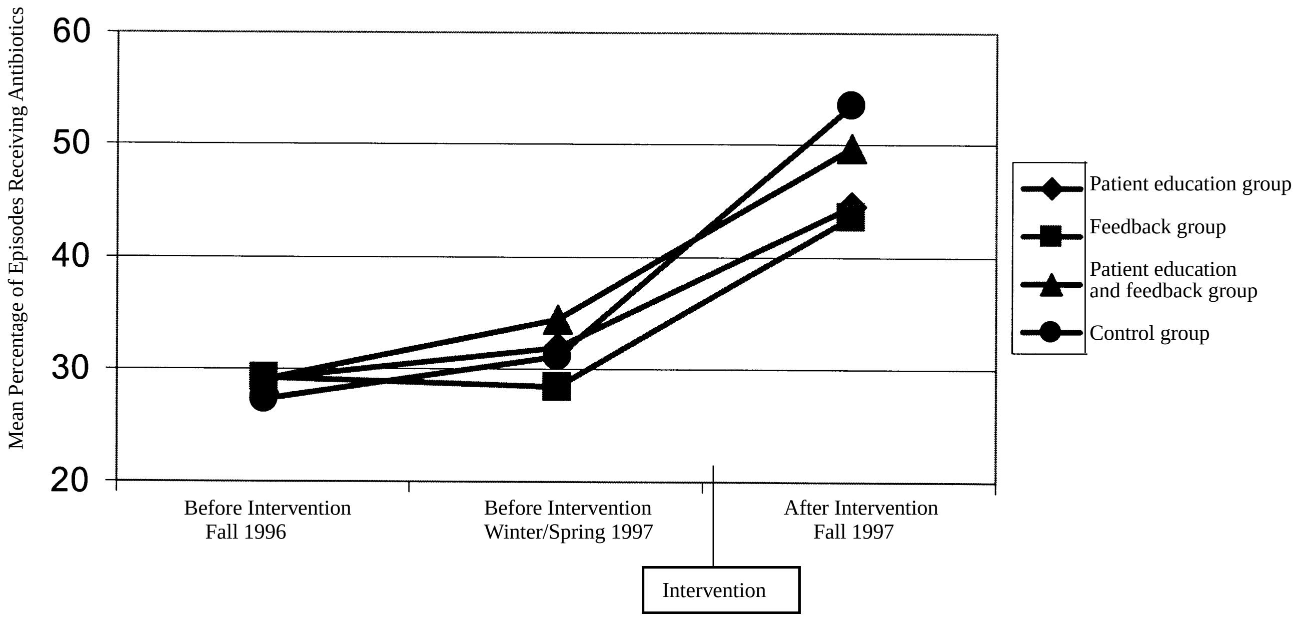
Characteristics of Participating Physicians

	Patient Education (n=53)	*Feedback (n=49)*	*Patient Education and Feedback (n=52)*	*Control (n=62)*	P *Value*
	*(Mean ± SD)**	*(Mean ± SD)**	*(Mean ± SD)**	*(Mean ± SD)**	
URI episodes for children					
Winter/spring 1997	92.4 ± 97.7	113.0 ± 125.9	67.3 ± 84.9	130.6 ± 154.3	.04
Fall 1997	71.3 ± 84.2	70.9 ± 89.2	44.3 ± 48.5	89.5 ± 125.2	.08
% of episodes with antibiotics					
Winter/spring 1997	31.9 ± 16.8	28.4 ± 16.8	34.4 ± 13.8	31.0 ± 17.6	>.10
Fall 1997	44.5 ± 25.6	43.6 ± 28.0	49.7 ± 22.3	53.5 ± 26.8	>.10
Years since medical school graduation	22.2 ± 9.6	25.4 ± 10.6	23.3 ± 11.8	25.1 ± 11.7	>.10
	%	*%*	*%*	*%*	
Gender—male	84.9	93.9	78.9	88.7	>.10
Specialty					>.10
Pediatrics	30.2	34.7	21.2	30.7	
Family practice	47.2	38.8	50.0	40.3	
Other	22.6	26.5	28.9	29.0	
Practice—rural	81.1	49.0	76.9	80.7	.001

* For the pre- and post-intervention periods, the mean number of URI episodes for children was significantly different for the patient education plus feedback group, compared with the control group.

Figure 1

Change in Antibiotic Prescribing for Viral Respiratory Infections in Children



Before intervention versus after intervention yielded significant main effect differences (winter/spring 1997 versus fall 1997, *P*=.02. Fall 1996 versus fall 1997, *P*=.006)

education group (fall 1996, winter/spring 1997) and the patient education and feedback group (fall 1996) were significantly lower than for the control group (*T*=2.374, *P*<.05), indicating that the rate of antibiotic prescribing for pediatric URI/purulent rhinitis/acute bronchitis increased significantly more in the control group than in the patient education intervention groups.

Table 3 indicates that coding practices did not appear to change following the introduction of the interventions. Relative percentages of different diagnoses for upper respiratory tract infections were similar across time periods for all groups. This suggests that rates of antibiotic prescribing were not altered by reclassification of patients into other diagnostic categories.

For family physicians whose practices provided care for both adults and children, antibiotic prescribing for children with URIs had a greater rise than for adults. It should be noted that even with the rise among children, adults were still more likely to receive antibiotics in a URI episode managed by a family physician (fall 1997 mean for children=55%, mean for adults=62%). Among family physicians, the results indicated that gain scores for children differed significantly across groups (fall 1996, F=3.16, *P*=.03; winter/spring 1997, F=2.65, *P*=.05), with the education group increasing significantly less than the control group (Dunnett's *T*=2.393, *P*<.05). The adult gain scores did not significantly differ across groups (*P*>.10), suggesting no significant diffusion of the pediatric intervention into adult prescribing.

Discussion

The results of this study indicate that prescriber feedback that is unsolicited without a tangible reward or penalty for performance has little influence on prescribing practices. Although it is simple, inexpensive, and easy to do, it seems to have little effect. In fact, our study showed the continuing use of and, unfortunately, increase in the use of antibiotics for pediatric respiratory infections of likely viral origin following our intervention. Importantly, however, providing patient education materials to physicians did seem to have a positive effect on antibiotic prescribing practices. Rather than focusing on educating physicians, therefore, providing them with tools for educating patients may be a good way to help physicians change prescribing practices, and thereby confront the public health problem of antibiotic resistance.

Although this study attempted to maximize the strength of the feedback intervention by comparing practices to existing scientific evidence, peer practices, and the potential implications for loss of income, the ineffectiveness of the feedback intervention may not be particularly surprising.[26,27] Several recent studies have noted the lack of effect of feedback on changing physician behavior.[28,29] For example, a recent study in Australia gave mailed, unsolicited feedback on prescribing patterns to general practitioners and found no evidence that feedback changed prescribing in general or for the high and low prescribers.[28]

The results of the study have both positive and negative implications for future implementation of the tested interventions. First, the interventions could have caused a change in coding practices without a real change in prescribing. It was possible that if physicians were told not to prescribe antibiotics for pediatric URIs they would change their coding of the same constellation to a diagnosis for which antibiotics might be of benefit (eg, acute otitis media).[30] The present data suggest that there was no "coding creep" by physicians trying to justify the use of antibiotics. This is an important finding for studies using administrative data on diagnosis as outcomes.

Second, both the feedback and the patient education pamphlets were geared to antibiotic prescribing for pediatric URIs. It was uncertain whether any effect that could be observed in pediatric care might generalize to the care of adults, a group that is more likely than children to receive antibiotics for URIs.[7] The present results do not indicate any effect of the pediatric focused interventions on prescribing patterns for adult URIs.

Although a significant effect was found for the intervention of patient education pamphlets to physicians in contrast to the control group, the effect was only that the rate of increase in inappropriate antibiotic prescribing from before the intervention to after the intervention was not as steep. The effect of rising rates of antibiotics is particularly disturbing because of the already high rate of antibiotics prescribed for pediatric URIs.

Table 3

Comparison of Diagnosis Before and After June 1997 Intervention: Percentage of Episodes Per Time Period Per Group

Diagnosis	*Patient Education*	*Feedback*	*Patient Education and Feedback*	*Control*
Fall 1996: July–November	(n=9,393)	(n=11,596)	(n=7,697)	(n=12,232)
Winter/spring 1997: January–May	(n=11,895)	(n=13,638)	(n=8,828)	(n=15,021)
Fall 1997: July–November	(n=8,274)	(n=8,946)	(n=6,203)	(n=10,369)
Common cold/URI	%	%	%	%
Fall 1996	32.2	29.7	38.0	39.8
Winter/spring 1997	27.8	27.8	35.8	37.2
Fall 1997	29.6	25.4	35.6	39.1
Nonsuppurative otitis media				
Fall 1996	1.0	2.9	3.6	2.6
Winter/spring 1997	1.1	3.2	4.4	3.3
Fall 1997	1.4	3.7	4.2	2.5
Rhinitis (includes purulent)				
Fall 1996	2.0	2.7	1.1	2.4
Winter/spring 1997	2.2	1.6	1.0	2.3
Fall 1997	2.5	1.6	0.9	1.6
Bronchitis (acute)				
Fall 1996	14.2	11.8	9.7	14.3
Winter/spring 1997	13.9	13.4	11.1	15.1
Fall 1997	14.0	12.9	10.5	15.0
Suppurative otitis media (acute)				
Fall 1996	21.8	22.8	25.6	16.1
Winter/spring 1997	27.5	24.7	26.1	18.6
Fall 1997	23.7	23.4	25.8	16.2
Sinusitis (acute)				
Fall 1996	3.1	4.8	2.8	2.9
Winter/spring 1997	3.8	5.5	2.6	3.9
Fall 1997	4.5	5.6	3.5	4.0
Pharyngitis/tonsillitis				
Fall 1996	24.4	21.2	16.9	20.4
Winter/spring 1997	21.4	19.3	15.6	18.1
Fall 1997	22.7	22.4	15.4	20.3
Streptococcal pharyngitis				
Fall 1996	1.4	4.1	2.3	1.4
Winter/spring 1997	2.3	4.6	3.3	1.6
Fall 1997	1.5	5.0	4.0	1.3

This finding has substantial implications for the problem of antibiotic resistance and the apparent lack of a judicious use of antibiotics. A recent analysis using population genetic and epidemiologic methods indicated that the selective pressure imposed by the volume of antibiotics on the temporal changes in resistance resulted in emergence of resistance in a much shorter time than the time to see decreases in resistance after cessation or decline in drug use.[31] This implies that unless decreases in antibiotic prescribing occur, a significant problem of antibiotic resistance will be even more difficult to manage.

Explanations for the Increase in Antiobiotic Use

Several potential explanations were investigated to understand why prescribing of antibiotics might have increased. One possible cause could have been the introduction of a new medication during the study period. There was an indication that azithromycin, which was introduced during the study period, showed significant increases (73% increase in number of prescriptions filled between winter/spring 1997 and fall 1997). However, this one drug did not account for the general upward trend in antibiotic prescribing. A second potential explanation lies in the decrease in the number of respiratory infection episodes after the intervention. The media coverage about antibiotic resistance may have educated parents about not seeking care and antibiotics for URIs. Thus, parents seeking care in the post-intervention period were those with the highest expectations for antibiotics.

Limitations

This study has several limitations. First, the study is based on assumptions of physician-prescribed antibiotics for a condition for which we obtained diagnoses from an administrative database. We did not review individual medical records. Although the medications could have been prescribed for other conditions, we have a high degree of confidence in the logic of our episode algorithm that was based on linking the patient, the attending physician, the prescribing physician, the type of drug, and time to the diagnosis. Second, although the diagnoses were based on claims, a consistency in diagnoses was discovered in tracking the pool of diagnoses over time. A third potential limitation of the study is the possibility that the mailings were not received and read by some or all of the physicians. Although we did not call the physicians to make sure that the materials were received and read, we were studying the effectiveness of this intervention with an "intention to treat" model; further, there was some evidence that physicians received study information, because several physicians in the feedback group called the principal investigator to complain about their reported prescribing profile. Similarly, one physician in the patient education group called the principal investigator to receive more pamphlets.

Conclusions

The threat to human health posed by antibiotic resistance is of growing concern. The interventions investigated here to encourage judicious use of antibiotics for presumably viral upper respiratory infections in children show little if any effect on promoting appropriate prescribing. Antibiotic prescribing for viral respiratory conditions continues to increase, suggesting a corresponding increase in antibiotic resistance.[31] Unless effective interventions are developed to decrease the widespread inappropriate use of antibiotics, the public health threat of antibiotic-resistant bacteria will likely grow.

Acknowledgments: The study was funded in part by the Department of Public Health, Commonwealth of Kentucky.

This paper was selected for a Distinguished Paper Presentation at the 1999 Annual Meeting of the North American Primary Care Research Group.

Correspondence: Address correspondence to Dr Mainous, Department of Family Medicine, Medical University of South Carolina, 295 Calhoun St, PO Box 250192, Charleston, SC 29425. 843-792-6986. Fax: 843-792-3598. E-mail: mainouag@musc.edu.

REFERENCES

1. Woodwell DA. National Ambulatory Medical Care Survey, 1995 summary. Advance Data from Health and Vital Statistics (286). Hyattsville, Md: National Center for Health Statistics, 1997.
2. Makela MJ, Puhakka T, Ruuskanen O, et al. Viruses and bacteria in the etiology of the common cold. J Clin Microbiol 1998;36:539-42.
3. Ackerman BD. Treatment of undifferentiated respiratory infections in infants. Clin Pediatr 1968;7:391-5.
4. Hardy LM, Traisman HS. Antibiotics and chemotherapeutic agents in the treatment of uncomplicated respiratory infections in children: a controlled study. J Pediatr 1956;48:146-56.
5. Todd JK, Todd N, Damato J, Todd WA. Bacteriology and treatment of purulent nasopharyngitis: a double blind placebo-controlled evaluation. Pediatr Infect Dis 1984;3:226-32.
6. Wald ER, Guerra N, Byers C. Upper respiratory tract infections in young children: duration of and frequency of complications. Pediatrics 1991;87:129-33.
7. Mainous AG III, Hueston WJ, Clark JR. Antibiotics and upper respiratory infection: do some folks think there is a cure for the common cold? J Fam Pract 1996;42:357-61.
8. Gonzales R, Steiner JF, Sande MA. Antibiotic prescribing for adults with colds, upper respiratory tract infections, and bronchitis by ambulatory care physicians. JAMA 1997;278:901-4.
9. Arason VA, Kristinsson KG, Sigurdsson JA, Stefansdottir G, Molstad S, Gudmundsson S. Do antimicrobials increase the carriage rate of penicillin-resistant pneumococci in children? Cross-sectional prevalence study. BMJ 1996;313:387-91.
10. Seppala H, Klaukka T, Vuopio-Varkila J, et al. The effect of changes in the consumption of macrolide antibiotics on erythromycin resistance in group A streptococci in Finland. N Engl J Med 1997;337:441-6.
11. Mainous AG III, Hueston WJ. The cost of antibiotics in treating upper respiratory infections in a Medicaid population. Arch Fam Med 1998;7:45-9.
12. Mainous AG III, Zoorob RJ, Oler MJ, Haynes DM. Patient knowledge of colds: implications for antibiotic expectations and unnecessary utilization. J Fam Pract 1997;45:75-83.
13. Hamm RM, Hicks RJ, Bemben DA. Antibiotics and respiratory infections: are patients more satisfied when expectations are met? J Fam Pract 1996;43:56-62.

14. Mainous AG III, Hueston WJ, Eberlein C. Colour of respiratory discharge and antibiotic use. Lancet 1997;350:1077.
15. Davis DA, Thomson MA, Oxman AD, Haynes RB. Changing physician performance: a systematic review of the effect of continuing medical education strategies. JAMA 1995;274:700-5.
16. Schaffner W, Ray WA, Federspiel CF, Miller WO. Improving antibiotic prescribing in office practice: a controlled trial of three educational methods. JAMA 1983;250:1728-32.
17. Greco PJ, Eisenberg JM. Changing physicians' practices. N Engl J Med 1993;329:1271-4.
18. Avorn J, Soumerai SB. Improving drug therapy decisions through educational outreach: a randomized controlled trial of academically based "detailing." N Engl J Med 1983;308:1457-63.
19. Ray WA, Blazer DG II, Schaffner W, Federspiel CF, Fink R. Reducing long-term diazepam prescribing in office practice: a controlled trial of educational visits. JAMA 1986;256:2536-9.
20. Shapiro DW, Lasker RD, Bindman AB, Lee PR. Containing costs while improving quality of care: the role of profiling and practice guidelines. Annu Rev Public Health 1993;14:219-41.
21. Schoenbaum SC, Murrey KO. Impact of profiles on medical practice. In: Conference on Profiling. Washington, DC: Physician Payment Review Commission, no. 92-2, 1992:71-125.
22. Schoenbaum SC. Feedback of clinical performance information. HMO Practice 1993;7(1):5-11.
23. St Anthony's color-coded ICD-9-CM book for physician payment, volumes 1 and 2, 1996. Alexandria, Va: St Anthony Publishing, Inc, 1995.
24. Fahey T, Stocks N, Thomas T. Quantitative systematic review of randomised controlled trials comparing antibiotic with placebo for acute cough in adults. BMJ 1998;316:906-10.
25. Physicians' current procedural terminology: CPT 1996. Chicago: American Medical Association, 1996.
26. Eisenberg JM. Doctors' decisions and the cost of medical care: the reasons for doctors' practice patterns and the ways to change them. Ann Arbor, Mich: Health Administration Press, 1986.
27. Schlackman N. Evolution of a quality-based compensation model: the third generation. Am J Med Qual 1993;8:103-10.
28. O'Connell DL, Henry D, Tomlins R. Randomised controlled trial of effect of feedback on general practitioners' prescribing in Australia. BMJ 1999;318:507-11.
29. Fairbrother G, Hanson KL, Friedman S, Butts GC. The impact of physician bonuses, enhanced fees, and feedback on childhood immunization coverage rates. Am J Public Health 1999;89:171-5.
30. Vinson DC, Lutz LJ. The effect of parental expectations on the treatment of children with a cough: a report from ASPN. J Fam Pract 1993;37:23-7.
31. Austin DJ, Kristinsson KG, Anderson RM. The relationship between the volume of antimicrobial consumption in human communities and the frequency of resistance. Proc Natl Acad Sci USA 1999;96:1152-6.

Policy evaluation should be planned as part of implementation to assess the impact and effectiveness of intervention strategies and to identify targets for further activities. Robust study designs such as ITS analyses and mystery client surveys should be used to monitor policy impact. Open Peer Review reports. Background.Â Law enforcement activities to reduce non-prescription sales of antibiotics started in 2010 and focused on both pharmacists and the general public in Mexico. Pharmacies had to retain and register all prescription data for systemic antibiotics. The ministry of health (MoH) announced significant penalties and revocation of licenses in case of non-compliance [32]. Benedikt Huttner and Stephan Harbarth discuss the implications of a new study that examined the impact of a national campaign in France to reduce antibiotic overuse.Â Citation: Huttner B, Harbarth S (2009) â€œAntibiotics Are Not Automatic Anymoreâ€â€"The French National Campaign To Cut Antibiotic Overuse. PLoS Med 6(6): e1000080. https://doi.org/10.1371/journal.pmed.1000080. Published: June 2, 2009.Â Didier Guillemot and colleagues describe the evaluation of a nationwide programme in France aimed at decreasing unnecessary outpatient prescriptions for antibiotics.Â Since the ultimate goal of any campaign to reduce antibiotic use is to curb antibiotic resistance, more longitudinal and modeling studies are needed.