Increasing Adherence to a Community-Based Guideline for Acute Sinusitis Through Education, Physician Profiling, and Financial Incentives

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Objectives: To implement a large-scale multifaceted intervention consisting of physician education, profiling, and a financial incentive, to improve treatment quality for acute sinusitis.

Study Design: Cohort trial using a historical control of treatment patterns among approximately 500 internists, 200 family practitioners, and 200 pediatricians in a northeastern community-wide individual practice association.

Participants and Methods: Episode treatment group methods were adapted to identify cases (episodes) and to assess care patterns for acute sinusitis among 420 000 health maintenance organization patients seen between January 1, 1999, and December 31, 2001. The intervention consisted of care pathway development, physician and patient education, physician profiling, and a financial incentive.

Results: A statistical process control chart showed a shift toward recommended treatment patterns after our intervention. The rate of exceptions per episode of acute sinusitis decreased 20%, from 326 exceptions per 1000 episodes between January 1, 1999, and October 31, 2000, to 261 between November 1, 2000, and December 31, 2001. Decreased use of less effective or inappropriate antibiotics accounted for most of the change (199 to 136 exceptions per 1000 episodes [32% change]). Azithromycin use decreased 30%, from 97 to 68 prescriptions per 1000 episodes. Firstline antibiotic (amoxicillin and doxycycline) use increased 14%, from 451 to 514 prescriptions per 1000 episodes. Inappropriate radiology use decreased 20%, from 15 to 12 per 1000 episodes. These changes were significant at $P < .005$.

Conclusion: A multifaceted program, including education, physician profiling with actionable recommendations, and a financial incentive, significantly increased physicians' adherence to a community-developed care pathway and was successful at improving adherence to recommended patterns of antibiotic use in acute sinusitis.

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For the past decade, the healthcare industry has struggled to identify methods to significantly modify clinical practice. A recent review of typical educational programs confirms the inability of traditional continuing medical education to change clinical behavior.[1] Introducing evidence-based clinical guidelines also has failed to improve clinical care.[2,3]

The need to identify reliable ways to improve clinical care has led several teams to prepare and test new types of interventions. Avorn and Solomon[3] identified specific interventions that improved appropriate antibiotic use. These approaches included reminders at the point of care, academic detailing, and order entry programs. In 2001, Grol[4] argued that the complexity of changing clinical practice behaviors requires more than a single intervention such as an educational program, financial incentive, or practice profile. To promote successful practice outcomes and adherence to guidelines, Grol proposed creating an integrated combination of self-reinforcing interventions such as evidence-based guidelines, professional education, assessment and accountability, patient empowerment, and total quality management. Bodenheimer, Wagner, and Grumbach[5,6] also recently endorsed a multiple intervention, multilevel model for improving chronic disease care.

The primary aim of this study was to demonstrate the ability of such a multifaceted intervention program to improve the evaluation and management (E&M) of acute sinusitis, especially in regards to appropriate antibiotic prescribing. Interventions included physician education, a locally developed acute sinusitis care pathway, feedback through a physician profiling system, a financial incentive for adherence to our care pathway, and patient education. The intervention was applied to a community-wide panel of more than 900 primary care physicians covering 420 000 health maintenance organization (HMO) members. The high penetrance of the HMO in the local market allowed us to examine and profile individual physicians on large numbers of cases without needing to pool data among multiple payers.

METHODS

Physicians

This project evolved from a collaboration between the Rochester Individual Practice Association, Inc

From the Rochester Individual Practice Association, Inc (RAG, HB, JC, GP), and Excellus BlueCross BlueShield of the Rochester Region (MM, DB, JK), Rochester, NY.

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(RIPA) and BlueCross BlueShield of the Rochester Area's HMO, Blue Choice. (BlueCross BlueShield of the Rochester Area has since been renamed Excellus BlueCross BlueShield of the Rochester Region.) The baseline measurement period was January 1, 1999, through October 31, 2000. The intervention period started November 1, 2000, and was measured through December 31, 2001. In 2000, RIPA was a community-wide panel of approximately 3000 practitioners and 900 primary care physicians (500 internists, 200 family practitioners, and 200 pediatricians) serving 420 000 HMO subscribers. Rochester Individual Practice Association, Inc, physicians were located in the 9-county region surrounding Rochester. The region includes urban, suburban, and rural communities.

Credentialing information was used to identify all internists, family physicians, and pediatricians. All credentialed physicians actively seeing patients were included in the program. Cases of acute sinusitis seen by nurse practitioners or physician assistants were assigned to their supervising physician.

Patients

Analysis included all HMO patients treated by the identified physicians or their nurse practitioners and physician assistants. The HMO provided an administrative data set with scrambled patient identification numbers. Because neither patient-specific information nor reviewed medical records were used, informed consent was not obtained.

Case Identification

Episode treatment group (ETG) methods were applied to claims data to identify cases, or "episodes," of acute sinusitis without sinus surgery and their related services (Episode Treatment Grouper, version 4.0; Symmetry Health Data Systems, Inc, Phoenix, Ariz; incorporated in Episode Profiler, version 4.6, CareEnhance Resource Management Software; McKesson Health Solutions, LLC, Cambridge, Mass). In the ETG model, an episode consists of a series of healthcare services related to a group of specific diagnoses for 1 patient. An episode of care may contain single or multiple services, including office visits, diagnostic tests, therapeutic interventions, emergency department visits, and prescribed medications. Episode treatment groups are structured so that each contains 1 disease entity (as is the case for acute sinusitis) or clinically similar diseases.

Analysis of each episode began by finding an anchoring E&M service. The anchoring E&M service could have an *International Classification of Diseases, Ninth Revision (ICD-9-CM)* code for acute sinusitis or for a more general illness such as a "viral upper respiratory tract infection." The software examined each subsequent claim by procedure per *Current Procedural Terminology* codes, by diagnosis per *ICD-9* codes, or by medication generic code number and national drug code. It also searched backward 1 month for antibiotics prescribed before the initial patient encounter. The software then decided whether to add the claim to the current episode of care and, if so, whether the episode should remain in the current ETG or be assigned to another ETG. For example, if the episode began with a viral upper respiratory tract infection and then later had an E&M service for acute sinusitis, it was removed from the former ETG into the sinusitis ETG. If sinus surgery occurred subsequent to the anchoring visit, the episode was transferred to the ETG for sinusitis with surgery. An episode was considered completed when no additional services were billed for the ETG for a fixed period (the "clean" period).

Acute sinusitis was ETG 0333 in the Symmetry grouper. The following *ICD-9* codes classified E&M services as acute sinusitis: 461, 461.0, 461.2, 461.3, 461.8, and 461.9. The clean period for ETG 0333 was 60 days.

The episode grouping software examined the complete database of all inpatient and outpatient claims paid by the HMO for its members between January 1, 1999, and December 31, 2001. After December 31, 2001, we used a 2-month claims run-out period, corresponding to the episode's clean period, to capture late claims for services provided within the study period. Episodes were analyzed by the month and year of their first service. An independent practice association (IPA)–HMO profiling team reviewed all identified problems regarding data accuracy, collection, and analysis so that the system could be improved continuously.

Developing an Acute Sinusitis Care Pathway

In early 2000, an IPA multidisciplinary task force was convened to create a local acute sinusitis care pathway. The acute sinusitis task force included pediatricians, family practitioners, internists, otolaryngologists, an allergist, and an infectious disease specialist. The task force was charged with identifying the most important evidence-based elements of quality care that could be measured using an administrative database. **Table 1** shows pathway elements generated by the task force. Lists of suggested firstline and secondline antibiotics, as well as nonrecommended less effective or inappropriate antibiotics, were published (**Table 2**). The task force based many of its recommendations on a 2000 report by the Sinus and Allergy Health Partnership,[7] modified by local experience and antibiotic resistance patterns.[8] For example, doxycycline was listed as an alternative firstline antibiotic for patients older than 8 years who were allergic to amoxicillin.

Creating a Pathway Scoring Measure

A second software program, the Referral Profiler Customization Utility (version 4.6, McKesson), was adapted to analyze the acute sinusitis care pathway. The presence or absence of services, and their correct sequence, defined the rate of pathway adherence. Complete and incomplete episodes of care were analyzed based on the type and sequence of initial services, rather than the length or total cost of the episode.

The referral profiler generated the number of deviations from the care pathway for each episode. Variations from the pathway were termed *exceptions* to recommended care. The total number of exceptions divided by the number of episodes gives the exceptions per episode, the metric used as the core physician profiling measure. **Table 3** summarizes the acute care services identified by the referral profiler customization.

Multifaceted Intervention

Education. One of us (JC) developed 2-hour interactive small group programs to educate panel practitioners about the sinusitis recommendations of the task force. The IPA conducted programs on the judicious use of antibiotics for adults and children with upper respiratory tract infections in the last 2 months of 1999. The recommendations were updated and the programs repeated in April 2001 based on the IPA guidelines. Program recommendations were supported by tool kits and patient materials conforming to the guideline recommendations. One of us (JK) produced a 1-page patient pathway that was distributed in a physician newsletter and could be downloaded from the RIPA Web site.[9]

Practitioner Profiling Reports. Physician profiling began in 1999. Beginning in April 2000, profiles for primary care physicians included an acute sinusitis care pathway report. Beginning in September 2000, the exceptions per episode measure was added. The pathway report also detailed the frequency of specific exceptions. In that way, a practitioner could determine, for example, that 75% of his or her pathway exceptions resulted from using ineffective antibiotics, while 25% were because of not seeing patients before prescribing antibiotics.

Starting in December 2000, physician profile cover letters reported the exceptions per episode score and the physician's performance in RIPA's newly initiated variable withhold program. By April 2001, the cover letter suggested how to improve the exception to pathway measure. Examples of physician-specific suggestions included "do more E&M visits before prescribing antibiotics" or "use fewer less effective antibiotics." Physicians received 5 profiles between April 2000 and December 2001.

Physician Financial Incentives. For primary care physicians, a scoring system was developed based 20% on patient satisfaction, 40% on efficiency, and 40% on quality measures. The exceptions per episode score for sinusitis counted for up to half of the quality component. The results for patient satisfaction, efficiency, and quality were combined to obtain a total score.

As a capitated IPA, RIPA kept a percentage of the capitation in reserve (the "withhold") to accommodate for increases in use. From 1999 through 2001, the percentage withheld by RIPA was 15% on each physician service. In 2000, the withhold was decreased to 10% for the top 5% of performers in the scoring system and increased to 20% for the bottom 5% of performers. Each primary care physician's sinusitis exceptions per episode score, total score, and corresponding specialty mean scores appeared on the physician's profile cover letters.

Control Group

The panel cohort served as its own historical control. The educational components began in fall 1999 and continued throughout the study. The major

Table 1. Rochester Individual Practice Association, Inc, Acute Sinusitis Care Pathway

- Most acute sinusitis patients have a viral infection, and all respond best to 7 to 10 days of aggressive symptomatic treatment, which includes measures to promote drainage (saline irrigation, warm mist inhalation, and pseudoephedrine hydrochloride) and measures to reduce inflammation (brompheniramine maleate and ibuprofen or naproxen sodium). The latter also help reduce cough and aches.
- Educate the patient about the importance of these measures for sinus drainage, the difference between viral and bacterial infections, and the expected course of his or her illness.
- Examine the patient before prescribing antibiotics. After nonantibiotic management, the firstline antibiotic is amoxicillin for 14 days. In penicillin-allergic patients older than 8 years, doxycycline can be used. Continue medical management as above. Imaging studies are not helpful early in the course of uncomplicated sinusitis.
- Reevaluate the patient if there is failure of 2 courses of complete medical management. Consider other diagnoses. Consider an ear, nose, and throat specialist or allergist referral, especially if there are 3 or more episodes a year. A plain x-ray film sinus series may be helpful to evaluate the maxillary or frontal sinuses. Computed tomography of the sinus is expensive compared with consultation.

integrated interventions (the report of the exceptions per episode score, the announcement of the variable withhold and its connection to the pathway score, and publication of the patient handout) occurred in September and October of 2000. Therefore, physician performance between January 1, 1999, and October 31, 2000 (the preintervention period), was used as a control for results for cases beginning between November 1, 2000, and December 31, 2001 (the postintervention period).

Statistical Analysis

Standard control chart methods were used to construct and analyze a statistical process control chart for exceptions per 1000 episodes by episode start month.[10] The *t* test was used to assess the statistical significance of differences between the preintervention and postintervention periods. Analysis was performed with the SPSS software package (release 11.01.1; SPSS Inc, Chicago, Ill).

RESULTS

Physician Intervention Group

There were approximately 900 credentialed primary care physicians as of December 1999, October 2000, and December 2001. These dates correspond to the beginning of the educational interventions, the

Table 2. Firstline, Secondline, and Less Effective Antibiotics per Rochester Individual Practice Association, Inc, Task Force

Firstline Antibiotics	Appropriate Secondline Antibiotics	Less Effective or Inappropriate Antibiotics
Amoxicillin	Amoxicillin-clavulanate potassium	Azithromycin
Doxycycline	Cefdinir	Clarithromycin
	Cefprozil	Cefaclor
	Cefuroxime axetil	Ciprofloxacin
	Levofloxacin	Erythromycin
	Gatifloxacin	Penicillin
	Moxifloxacin	Sulfamethoxazole-trimethoprim
		All other antibiotics not on firstline or secondline list

Table 3. Rochester Individual Practice Association, Inc, Acute Sinusitis Care Pathway Exceptions

Care Service Item	Action Required	Exception Generated
E&M visit	Must precede the first antibiotic prescription of the episode	Missing service (the E&M visit)
Firstline antibiotic	Must not be preceded by a secondline antibiotic	Out of sequence
	May only be used twice	Redundant service
Secondline antibiotic	Must be preceded by a firstline antibiotic for 2 days	Missing service (the firstline antibiotic)
	May only be used twice	Redundant service
Other antibiotics	Considered less effective or inappropriate	Inconsistent service (inconsistent with pathway)
Sinus plain x-ray films	Must be at least 7 days after first E&M visit	Early service
	May only be used once	Redundant service
Sinus computed tomographic scan	Always considered an exception to the pathway	Inconsistent service (inconsistent with pathway)
Other radiological studies	Always considered an exception to the pathway	Inconsistent service (inconsistent with pathway)

E&M indicates evaluation and management.

major integrated interventions, and the end of the postintervention analysis period, respectively. There were approximately 500 internists, 200 family practitioners, and 200 pediatricians at each of those points in time.

Episodes of Acute Sinusitis

There were 96 766 episodes of acute sinusitis during the 3-year study. Although there was an anticipated seasonal variation in the number of episodes per month, there was no change in the number of sinusitis episodes per month before and after October 2000 (2687 before and 2689 after, $P > .99$).

Results of Reporting and Incentivizing Pathway Adherence

Physician behavior changed significantly in the postintervention period (**Figure**, **Table 4**, and **Table 5**). The Figure shows a statistical process control chart of exceptions per 1000 episodes by episode start month. The centerline (mean) for all 36 months (36 data points) was 300 exceptions per episode. The exception rate was below that mean value from the third month after our intervention onward, a total of 12 consecutive data points. Because more than 8 successive points fell on the same side of the centerline, this represents special cause variation, ie, a change assignable to our intervention.[10] The mean overall exceptions per episode rate decreased 20%, from 326 per 1000 episodes before our major intervention to 261 after. By *t* test, the change was significant at $P < .005$ (Table 4).

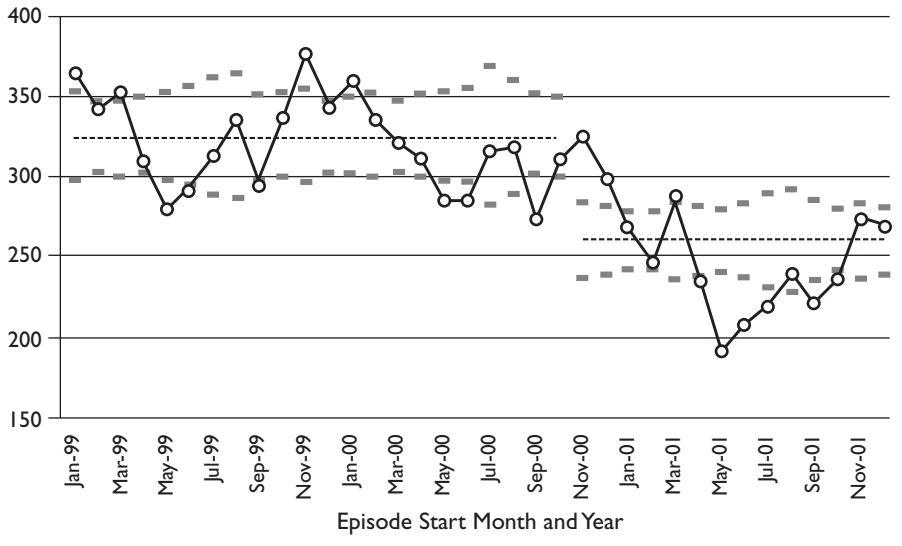
Approximately 95% of the change resulted from a lower rate of exceptions for use of less effective or inappropriate antibiotics. These decreased from 199 to 136 exceptions per 1000 episodes, a change of 32%. The remainder of the change was related to radiology exceptions. Radiology exceptions decreased by 20%, from 15 to 12 per 1000 episodes. These changes were significant at $P < .005$. There was no significant decrease in exceptions associated with prescribing of antibiotics before the patient had an office visit.

The mean number of antibiotic prescriptions decreased slightly, from 883 to 861 per 1000 episodes from before to after the study interventions, a 2.5% decrease ($P < .005$). Firstline antibiotic use increased 14%, from 451 to 514 prescriptions per 1000 episodes. Use of less effective or inappropriate antibiotics decreased 29%, from 311 to 222 prescriptions per 1000 episodes. These changes were significant at $P < .005$. The 2 most commonly used broad-spectrum antibiotics deemed less effective or inappropriate were azithromycin and clarithromycin. Both had a significant decrease after the study intervention (Table 5). Azithromycin use decreased 30%, from 97 to 68 prescriptions per 1000 episodes ($P < .005$). Clarithromycin prescriptions decreased 33%, from 30 to 20 per 1000 episodes ($P < .005$). There was no significant change in the use of appropriate secondline antibiotics (121 prescriptions per 1000 episodes before intervention to 125 after, $P = .15$).

Use of radiological services also changed significantly after the study interventions. The rate of plain x-ray film sinus series decreased from 16.9 to 12.2 per 1000 episodes, or 28% ($P < .005$) (Table 5). The rate of sinus computed tomographic scans fell by 39%, from 13.5 to 8.2 per 1000 cases in the postintervention period ($P < .005$).

Evaluation and management services rates changed little. There was no significant change in primary care physician E&M services. The otolaryngology consultation rate was unchanged after the study interventions, at 4.7 consultations per 1000 episodes of sinusitis (Table 5). Allergy consultations decreased, from 5.9 to 4.1 per 1000 episodes (31%, $P < .005$).

Figure. Overall Exceptions per 1000 Episodes*



*3-sigma control limits shown.

Table 4. Acute Sinusitis Care Pathway Exceptions per 1000 Episodes

Outcome	Before Intervention	After Intervention	% Change	*P*
Total exceptions per 1000 episodes	326	261	–20	<.005
Less effective or inappropriate antibiotics exceptions	199	136	–32	<.005
Radiology exceptions	15	12	–20	<.005
Missing office visit exceptions	26.6	26.5	0	.93

COMMENT

We have shown that a combination of a locally developed care guideline, physician profiles containing specific feedback, and a financial incentive influenced physicians' treatment patterns for targeted acute sinusitis measures. Most important, there was a significant increase in use of firstline antibiotics, associated with a large decrease in use of less effective or inappropriate antibiotics, including the 2 most common broad-spectrum antibiotics in that category. Secondary outcomes included a decrease in plain x-ray film sinus studies, sinus computed tomographic scans, and allergist consultation rates. The rate of otolaryngology consultations did not change. Taken together, these results suggest that our multiple intervention model was successful in changing physician behavior to improve adherence to a community-developed care guideline.

The decrease we observed in the use of broad-spectrum antibiotics judged less effective or inappropriate contrasts favorably with the results of a recent study by Steinman et al,[11] who reported that broad-spectrum antibiotic use in minor upper respiratory tract infections doubled nationwide in the 1990s, from 24% to 48% of all antibiotic prescriptions. In that study, azithromycin and clarithromycin were found to have increased from 1% or 2% of prescriptions to 13%, while among our primary care physicians their use significantly decreased.

This study reinforces the adage that "you get what you pay for." We tracked and scored sinus x-ray timing and sinus computed tomographic scans and observed reduced use. Although we recommended using antibiotics less often, we did not score or reward it. As a result, the total number of antibiotics prescribed did not decrease to a clinically meaningful degree, although the change was statistically significant. Measures that were reported and rewarded changed more dramatically. Future programs should target reductions in total antibiotic use.

Our findings support previous studies demonstrating that changing physician behavior is best accomplished by using multifaceted interventions. Reviews of this topic have shown that didactic interventions alone were ineffective,[1,4] while multiple interventions were the most effective.[4,12] A 2001 comprehensive review of guideline implementation reinforced this conclusion.[13] The authors, drawing on a Cochrane Effective Practice and Organization of Care systematic analysis, recommended a multifaceted intervention, including local modification of guidelines to achieve local buy-in, local consensus conferences, and feedback of performance compared with that of peers. Working independently, we fashioned a similar program, with the important addition of a financial incentive. In our community, local buy-in, interactive education, specific feedback, and a connection to the physician compensation mechanism resulted in significant improvements in our end points.

We believe that our physician profiles were effective because they contained specific action items, such as "use fewer less effective antibiotics," individualized for each primary care physician. The feedback was timely, in that profiles were distributed approximately 3 times a year. In these ways, we followed the recommendations of Phillips et al[14] for overcoming "clinical inertia."

Another unique element of our program was our metric, exceptions per episode. Any episode of acute illness involves a series of clinical decisions. The exceptions per episode score summarizes clinical decision making into a single measure. Allowing more than 1 exception per episode made our program more rigorous by making it more difficult to reach our target of 75% care pathway adherence. Using a continuous variable encouraged incremental improvement, because physicians received credit for each additional decision that adhered to our recommendations. Furthermore, the measure could be

Table 5. Services per 1000 Episodes of Acute Sinusitis

Outcome	Before Intervention	After Intervention	% Change	*P*
Antibiotic prescriptions	883	861	–2.5	<.005
Firstline antibiotics prescriptions	451	514	14	<.005
Appropriate secondline antibiotics prescriptions	121	125	3.3	.15
Less effective or inappropriate antibiotics prescriptions	311	222	–29	<.005
Azithromycin	97	68	–30	<.005
Clarithromycin	30	20	–33	<.005
Sinus plain x-ray films	16.9	12.2	–28	<.005
Sinus computed tomographic scans	13.5	8.2	–39	<.005
Otolaryngologist consultations	4.7	4.7	0	.99
Allergist consultations	5.9	4.1	–31	<.005
Total evaluation and management services	1320	1296	–1.5	<.005

applied to administrative data, obviating the need for medical chart review, which would have been impossible with 32 000 cases of sinusitis per year.

Smithson and Koster[15] wrote that financial incentives are the most powerful devices for changing physician behavior. Our variable withhold allowed 5% of practitioners to receive 5% lower, and 5% to receive 5% higher, withholds based on their profile scores. Historically, RIPA has returned between 50% and 100% of primary care specialty withholds. Therefore, a primary care physician's take-home income could have changed only about 1.25% to 2.5% either way (5% × 50%-100% withhold return × 50% overhead). Our physicians appeared to be sensitive to small financial incentives. Perhaps the need for a greater incentive was minimized by the quality of the clinical pathway and the feedback offered, supporting the value of a multiple intervention model. Our incentive plan is consistent with a broader movement to connect physician reimbursement to quality improvement.[16]

This study had several limitations. We created a variable withhold program but could not apply it selectively because RIPA was a community-wide physician panel. This made a concurrent nonintervention physician control group impossible. Rochester is unusual in that the penetrance of a single HMO was more than 70% of the commercial (non-Medicare and non-Medicaid) population during the study. The high community penetrance and the large number of sinusitis cases made profiling individual practitioners practical. Reproducing this model for an individual insurer or IPA with lower market penetration might necessitate pooling data from other payers. Recently, the National Committee for Quality Assurance and the Institute of Medicine have advocated such a plan to achieve patient populations large enough to profile individual physicians.[17]

Because we used a historical control, we could not account for the effect of national trends in antibiotic prescribing. However, the timing and the pattern of the changes in sinusitis care that we observed are not consistent with duplication of external trends. Two recent studies[11,18] have shown that overall antibiotic use decreased nationally through the 1990s. In contrast, among Blue Choice HMO patients in the Rochester area, immediately before our first educational intervention in 1999, antibiotic prescribing for sinusitis peaked, at almost 970 prescriptions per 1000 episodes in October of that year. After our intervention, antibiotic use for acute sinusitis declined in peak seasons at a rate similar to that of other communities. It seems unlikely that outside trends would happen to catch up with the Rochester physician community at the same time that we introduced our major intervention.

Statistical control chart analysis confirmed that there was a shift in the process of sinusitis treatment after our intervention. Nonetheless, the process was not completely "in control" before or after the intervention: several months in both periods had fewer or more exceptions than would be expected. This analysis suggests that there may be other secondary causes for variation in the process. For example, sinusitis may be milder in May and June than in other months and therefore attributed to allergic or viral causes. If those episodes were treated less often with antibiotics, there

would be fewer opportunities for exceptions. Further studies beyond the scope of this article would be needed to elucidate those secondary effects.

However, excluding the months not in control as not being statistically comparable yields an exception rate of 327 per 1000 episodes before the intervention and 263 after the intervention, identical to the results obtained when including those episodes. Therefore, those secondary causes did not bias our results, and they do not detract from the dramatic process shift that occurred after our intervention.

Our pattern of antibiotic use changed differently from national trends as well. Neither Steinman et al[11] nor McCaig et al[18] showed a decrease in antibiotic prescribing specifically for sinusitis. We saw a decrease in the use of targeted broad-spectrum antibiotics, in contrast to national trends.[11] Moreover, our intervention affected behaviors outside of antibiotic use.

Our analysis included pediatric and adult patients. There could be concern that a difference in sinusitis treatment between pediatricians and other primary care physicians would affect our results. We believe that that was not the case.

The acute sinusitis task force was careful to make sure that our recommendations were relevant to both the adult and pediatric age groups. These basic points apply to children and to adults. All the appropriate firstline or secondline antibiotics (except doxycycline in young children) can be used in pediatric and adult cases. The antibiotic designations *less effective* or *inappropriate* for sinusitis apply to children and adults.

Our main results, a decrease in use of less appropriate antibiotics, an increase in use of firstline antibiotics, and a decrease in inappropriate sinus imaging, therefore should be independent of the age group examined. Our profiling data showed that exceptions per episode decreased for all 3 primary care specialties. Nonetheless, differential guideline adherence among specialties remains an important issue beyond the scope of this article.

Administrative data are susceptible to inaccuracies. For example, we were not able to track antibiotics given out as samples or purchased outside of HMO insurance coverage. However, throughout the study, approximately 90% of patients had prescription drug coverage (J. Owerbach, PhD, director of Excellus BlueCross BlueShield pharmacy benefits, written communication, March 13, 2003).

Physician coding practices could be a source of inaccuracy. For example, a physician might code those cases for which he or she decided to prescribe antibiotics as acute sinusitis and code the rest as viral illness. Some physicians might have used codes for chronic or allergic sinusitis, which were not included in our study episodes. To guard against this, we used multiple interventions throughout the study to promote accurate coding. Arguing against a change in coding practice is the before and after consistency of the number of sinusitis episodes according to billing data. Furthermore, our yearly incidence of sinusitis was approximately 7.6% (32 000 episodes among 420 000 patients). McCaig et al[18] found an approximate 9% annual visit rate for sinusitis, suggesting that our physician sinusitis coding rate was similar to national patterns.

This model likely can be generalized to other acute conditions. We created a similar pathway for otitis media. We are in the process of analyzing the results of that pathway.

We believe that a similar system, modeling the recommendations of Bodenheimer, Wagner, and Grumbach[5,6] and Casalino et al,[19] can improve the care of chronic diseases as well. Toward that end, Excellus BlueCross BlueShield of the Rochester Region, RIPA, and the Rochester Health Commission have received a grant from the Rewarding Results program to apply this system to improving the care of patients with diabetes mellitus, asthma, coronary artery disease, and depression.

In 2000, Avorn and Solomon[3] wrote:

> Given the availability of information systems that track every detail of a physician's prescribing behavior and can increasingly be linked to clinical data, more can be done to improve prescribing. In the coming decade, it will become possible to assess physician prescribing in terms not merely of dollars spent but of clinical intelligence.

We have demonstrated that currently available information systems, coupled with physician education, feedback, and a modest financial incentive, can assess and affect physician prescribing.

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