The Effect of a Community Intervention Trial on Parental Knowledge and Awareness of Antibiotic Resistance and Appropriate Antibiotic Use in Children

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ABSTRACT. *Background.* **Overuse of antibiotics for children's upper respiratory infections is widespread and contributes to the emergence of antibiotic-resistant bacteria.**

Objective. **To assess changes in knowledge and awareness regarding antibiotic resistance and appropriate antibiotic use after community-wide educational interventions to reduce inappropriate antibiotic use.**

Design. **Baseline survey conducted during June through July 1997 and postintervention survey of baseline participants during June through August 1998.**

Setting. **Communities in northern Wisconsin.**

Participants. **Parents of 729 randomly selected children <4 years of age were called until 215 in each of the intervention and control areas were reached. Of the 430 baseline participants, 365 (85%) participated in the postintervention survey.**

Intervention. **Parent-oriented activities included distribution of materials and presentations. Physician-oriented activities included formal presentations and small group meetings.**

Outcome Measure. **Change in awareness about antibiotic resistance and knowledge about antibiotic indications.**

Results. **A higher proportion of parents in the intervention area (53%) were exposed to 2 or more local educational messages, compared with the control area (23%). From the baseline to the postintervention survey, the percentage of parents with a high degree of antibiotic resistance awareness increased more in the intervention area (58% to 73%) than in the control area (60% to 65%). In the intervention area, there was also a larger increase in knowledge regarding appropriate indications for antibiotic use, compared with the control area. The proportion of parents who expected an antibiotic for their child and did not receive one declined in the intervention area (14% to 9%), while it increased in the control area (7% to 10%). In addition, the percentage of parents in the intervention area who brought their child to another physician because they did not receive an antibiotic decreased (5% to 2%), while it increased in the control area (2% to 4%).**

Conclusion. **Parental knowledge and awareness about antibiotic indications and antibiotic resistance can be changed with educational interventions directed at parents and clinicians.** *Pediatrics* **2001;107(1). URL: http://www.pediatrics.org/cgi/content/full/107/1/e6;** ***antibiotics, antimicrobial use, antimicrobial resistance, parents, health education.***

ABBREVIATIONS. MESA, Marshfield Epidemiologic Study Area; CDC, Centers for Disease Control and Prevention; AAP, American Academy of Pediatrics; ARA, antibiotic resistance awareness; CI, confidence interval; OR, odds ratio.

Outpatient prescribing of antimicrobial drugs is widespread in the United States, and prescription rates are highest for children.[1] The overuse of antibiotics for treating upper respiratory infections among children is common regardless of geographic area, payment source, patient demographics, and physician specialty.[2] In 1992, antibiotics were prescribed for 44% of children <18 years of age diagnosed with a cold, 46% with a upper respiratory infection, and 75% with bronchitis,[2] conditions for which antibiotics are rarely indicated.[3,4]

As a result of widespread antibiotic use, infections caused by antibiotic-resistant pathogens are becoming more common. For example, the resistance of *Streptococcus pneumoniae* to penicillin and other antibiotics increased dramatically in the United States from the early 1980s to the 1990s.[5,6] Studies of risk factors for colonization[7–10] as well as invasive disease[11–17] caused by penicillin-resistant pneumococci have consistently found recent antibiotic use to be more prevalent among persons with penicillin-resistant pneumococci than among those with susceptible pneumococci. A reduction in antibiotic consumption is likely to reduce the selective pressure, slowing the emergence of resistant organisms.[18–20]

Physicians cite patient demand as an important motivation for antibiotic prescription,[21–23] and real or perceived parental expectations can influence antibiotic-prescribing behavior.[24–26] Results of a multi-

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clinic study suggest that parents believe that antibiotics are indicated for colds and cough.[27] Because real or perceived patient demand contributes to inappropriate antibiotic use, educational interventions must involve both physicians and parents.

During the fall of 1997, the Marshfield Medical Research Foundation conducted a community intervention trial in northern Wisconsin to promote appropriate antibiotic use in children. The impact of this educational intervention on antibiotic prescribing and penicillin-nonsusceptible *S pneumoniae* carriage has been reported separately.[28] The objectives of the current study were to assess changes in knowledge and awareness regarding antibiotic resistance and appropriate antibiotic use for acute respiratory illness among parents of young children living in the intervention and control areas.

METHODS

Study Population

For the community intervention trial, the intervention area included the counties of Price, Rusk, and Lincoln and the adjacent cities of Wausau and Rhinelander in northern Wisconsin. The intervention area has a population of 107 884, including 7593 children < 4 years of age.[29] The control area was a 14-zip code region around Marshfield (see Marshfield Epidemiologic Study Area [MESA]-Central below).

For this telephone survey, the target group was household caregivers (usually parents) of children < 4 years of age. The sampling frame was obtained from MESA, a defined geographic region whose residents receive their care through the Marshfield Clinic regional network.[30] MESA is divided into 2 geographically distinct regions: MESA-Central and MESA-North. MESA-Central, the control area, comprises 14 zip codes surrounding Marshfield and has a population of 58 910 (as of January 1, 1998), including 2655 children <4 years of age. MESA-North, an 8-zip code subarea within the intervention area, has a population of 27 692, including 957 children <4 years of age.[29] Sampling of households within the intervention area was limited to MESA-North because a complete sampling frame was not available for the entire intervention area.

Baseline Survey

To achieve a final total sample of 430 households for the baseline survey, 2 random samples of 400 households (one each in the control and intervention areas) with a child <4 years of age were selected from the MESA database. No more than 1 child was selected per household. The lists of the eligible, randomly selected children in the intervention and control areas were randomly sorted, and the interviewers processed each list until they reached 215 parents in each of the 2 areas. At least 4 attempts were made to reach each household during June and July 1997. The survey questions assessed knowledge, beliefs, and practices regarding antibiotic use in young children and familiarity with the problem of antibiotic resistance.

Educational Interventions Regarding Appropriate Antibiotic Use

Parent-oriented educational activities were conducted in communities throughout the intervention area from September through December 1997. The parent and patient education materials included the pamphlet "Your Child and Antibiotics," produced by the Centers for Disease Control and Prevention (CDC) in collaboration with the American Academy of Pediatrics (AAP) and American Society for Microbiology. This pamphlet gives a simple explanation about antibiotics, bacterial and viral infections, and bacterial resistance and provides examples of when antibiotics are and are not needed for children (eg, rarely for bronchitis, not for colds). Approximately 30 000 copies of this pamphlet were distributed to clinics, pharmacies, child care facilities, and other agencies. Educational posters developed by the CDC were also distributed to clinics and community organizations.

Two nurse educators made presentations and distributed the educational materials to parents and staff at child care centers, local public health departments, schools, and community organization meetings and to staff at each primary care clinic. The information presented reinforced the key points of the pamphlet. The newspapers of several communities ran an article about antibiotic resistance in conjunction with the intervention.

The physician-oriented interventions included "grand rounds" presentations by one of the investigators (B.S.), small-group academic detailing to promote appropriate antibiotic use, and distribution of written materials. The latter included clinical practice guidelines for common respiratory illnesses consistent with CDC recommendations,[3,4,31–33] clinical fact sheets, and samples of patient education materials. Ninety-six of the 133 (72%) primary care clinicians in the intervention area participated in the small group meetings. A physician educator had a telephone discussion with 34 of the remaining 37 clinicians.

Postintervention Survey

The postintervention survey was identical to the baseline survey except for additional questions assessing exposure to specific educational interventions. The postintervention interviews were conducted from June through August of 1998.

Exposure and Outcome Measures and Statistical Analysis

Study interventions were defined as any local educational messages that parents received between the first and second surveys. These excluded any magazine articles or television programs about antibiotic resistance because these were not related to the study.

The summary measure antibiotic resistance awareness (ARA) was created. A high level of ARA was defined as agreement with the following 3 statements: "Some germs are becoming harder to treat with antibiotics"; "If antibiotics are overused, they will not work as well for treating infections"; and "If antibiotics are used frequently in your child, then your child may be infected with hard-to-treat bacteria." The ARA between the 2 surveys was compared using a difference of proportions[34] for the univariate analysis. A logistic regression was used for the multivariate analysis, with the ARA at the postintervention survey as the dependent variable and relevant covariates, including ARA at the baseline survey.

Changes in practices between the 2 surveys and in the proportion of parents who thought that antibiotics were always or sometimes versus never indicated for each of the 5 respiratory diagnoses—bronchitis, cold, dry cough, flu, and nonstreptococcal sore throat—were compared using a difference of proportions.[34] Don't know responses were excluded.

A summary measure antibiotic indications score was created by the summation of the responses for the 5 diagnoses. Always, sometimes, or never were assigned the scores of 2, 1, or 0, respectively. Higher scores indicated less accurate knowledge regarding indications for antibiotic use. Don't know responses were excluded. To assess changes after the educational intervention, the baseline score was subtracted from the postintervention score to yield a net change for each respondent. This difference was compared between the intervention and control areas using a Student's *t* test for the univariate analysis and multiple linear regression for the multivariate analysis. Analyses were conducted using *SAS, Version 6.08* (SAS Institute, Cary, NC). The study was reviewed and approved by 2 institutional review boards, and verbal informed consent was obtained from all participants.

RESULTS

Baseline Survey Participants

Of the 729 eligible children, the caregivers of 34 (4.7%) refused, 110 (15.1%) had no phone number or a disconnected phone, and 155 (21.3%) were not reached before enrolling the target 215 parents in each area. There was no statistically significant difference between refusal rates in the intervention area (5.6%) and control area (3.7%; $P = .2$). Respondents were older ($P < .001$) and their children were less likely to ever have been enrolled in Medicaid ($P =$

.001), compared with nonrespondents. Respondents were similar to the residents of the surrounding community regarding race (97% white) and ethnicity (98% non-Hispanic).[29]

Postintervention Survey Participants

Of the 430 preintervention survey participants, 365 (84.9%) completed the postintervention survey, 18 (4.2%) refused, and 47 (10.9%) could not be reached. There was no statistically significant difference between the control and intervention areas in the proportion of caregivers participating in both surveys (Table 1). Parents who did not participate in the postintervention survey were younger (mean: 28.7 years of age vs 31.1 years of age for participants; $P = .003$) and less likely to have a college education ($P = .002$) or private insurance ($P < .001$), compared with those who completed both surveys. Subsequent analyses were restricted to parents who completed both surveys. The 4 nonparent caregivers were excluded.

Exposure to Educational Interventions

Parents were exposed to a median of 2 study interventions in the intervention area (range: 0–9) and 1 (range: 0–6) in the control area. In the intervention area 52.6% of parents were exposed to at least 2 study interventions, compared with 22.6% of parents in the control area ($P < .001$; Table 2). Among parents ($n = 245$) who brought their child to a clinician for respiratory symptoms or a well-child visit during the 6 months before the postintervention survey, those in the intervention area were more likely to report that a physician or clinic staff discussed antibiotic resistance during the visits (47.8% vs 27.7%; $P = .001$). Parents in the intervention area were also more likely to have read a magazine article ($P = .002$) but not to have watched a television show about antibiotic resistance ($P = .8$).

TABLE 1. Characteristics of Participants in Baseline (June through July 1997) and Postintervention (June Through August 1998) Surveys Compared With Participants of Only the Baseline Survey: MESA, Wisconsin

Characteristic	Both Surveys *n* (%) (*n* = 365)	Only First Survey, *n* (%) (*n* = 65)	*P* Value*
Study area			
Intervention	177 (82.3)	38 (17.7)	
Control	188 (87.4)	27 (12.6)	.1
Caregiver's education			
High school only	126 (77.8)	36 (22.2)	
Some college	239 (89.2)	29 (10.8)	.002
Type of caregiver			
Mother	323 (85.7)	54 (14.3)	
Father	38 (84.4)	7 (15.6)	
Other	4 (50.0)	4 (50.0)	.06
Child care attendance			
Yes	136 (87.7)	19 (12.3)	
No/don't know	229 (83.3)	46 (16.7)	.2
Child's insurance†			
Private	273 (88.9)	34 (11.1)	
Medical assistance	91 (74.6)	31 (25.4)	<.001
Child firstborn†			
Yes	125 (84.5)	23 (15.5)	
No	239 (85.1)	42 (15.0)	.9
Number of siblings			
0	83 (81.4)	19 (18.6)	
1–2	231 (86.8)	35 (13.2)	
3 or more	51 (82.3)	11 (17.7)	.4
Race of child			
White	356 (85.6)	60 (14.4)	
Nonwhite	9 (64.3)	5 (35.7)	.05‡
Ethnicity of child†			
Hispanic	6 (75.0)	2 (25.0)	
Non-Hispanic	358 (85.0)	63 (15.0)	.4‡

* *P* value was derived from the χ^2 test unless otherwise noted.
† Intervention group total is 364 because of missing value.
‡ *P* value was derived from the Fisher's exact test.

ARA

In the preintervention survey, the proportion of parents with high ARA was similar in the intervention (58.3%) and the control groups (60.2%). The only variable significantly associated with higher baseline ARA was having private insurance ($P = .05$). From the baseline to the postintervention survey, the percentage of parents with high ARA increased significantly in the intervention (change: 14.3%: 95% confidence interval [CI]: 6.6,22.0) but not in the control group (change: 4.3%; 95% CI: −4.1,12.7; Table 3). The difference between the changes was statistically significant ($P = .015$). Among parents who were exposed to no intervention, there was also an improvement in ARA in the intervention (change: 17.0%; 95% CI: 2.2,31.2) but not in the control group (change: 0%; 95% CI: −12.6,12.6), and the difference between the changes was statistically significant ($P = .013$).

Factors associated ($P < .1$) with a high ARA at the time of the postintervention survey in the univariate analysis included intervention area residence, high ARA in the preintervention survey, older parent age, older child age, exposure to at least 2 local interventions, watching a TV program about antibiotics, and reading a magazine article about antibiotics. These variables were entered into a stepwise logistic regression. In the final model, only baseline ARA (odds ratio [OR]: 4.0; 95% CI: 2.5,6.4) and exposure to 2 or more local interventions (OR: 1.9; 95% CI: 1.1,3.1) were associated with a higher ARA. There was no significant interaction between parental education and exposure to interventions.

Antibiotic Indications Score

Parents commonly thought that antibiotics were indicated for bronchitis, colds, dry cough, flu, and nonstreptococcal sore throat (Table 4). However, among parents in the intervention area, the proportion of respondents who correctly identified antibiotics as not being needed for colds, dry cough, flu, and nonstreptococcal sore throat increased significantly between the baseline and intervention periods ($P < .001$). In contrast, there was no significant change in the perception of the need for antibiotics for bronchitis. Antibiotic use knowledge also improved significantly among parents in the control area for colds, dry cough, and flu, but in each case, the magnitude of improvement was less than in the intervention area.

A low baseline antibiotic indications score (less likely to think that antibiotics are indicated) was associated in the univariate analysis with private health insurance ($P = .02$), college education ($P < .001$), and older parental age ($P = .004$). There was no

TABLE 2. Parental Exposure to Interventions by Study Area as Reported During Postintervention Survey: June Through August 1998, MESA, Wisconsin

Exposure	Intervention Area, *n* (%) (*n* = 175)	Control Area, *n* (%) (*n* = 186)	*P* Value*
Study interventions			
Number of study interventions exposed to			
0–1	83 (47.4)	144 (77.4)	
≥2	92 (52.6)	42 (22.6)	<.001
Physician or other staff person discussed antibiotic resistance with parent†			
Yes	55 (47.8)	36 (27.7)	
No/don't know	60 (52.2)	94 (72.3)	.001
Attended a group talk about antibiotic resistance			
Yes	17 (9.7)	4 (2.2)	
No	158 (90.3)	182 (97.9)	.004
Saw a poster about antibiotic resistance			
Yes	83 (47.4)	37 (19.9)	
No/don't know	92 (52.6)	149 (80.1)	<.001
Received a blue pamphlet entitled "Your child and antibiotics"			
Yes	69 (39.4)	18 (9.7)	
No/don't know	106 (60.6)	168 (90.3)	<.001
Read an article in the local newspaper about antibiotic resistance			
Yes	33 (18.9)	42 (22.6)	
No/don't know	142 (81.1)	144 (77.4)	.4
Exposures not part of intervention			
Saw a television show about antibiotic resistance			
Yes	59 (33.7)	65 (35.0)	
No/don't know	116 (66.3)	121 (65.1)	.8
Read a magazine article about antibiotic resistance			
Yes	104 (59.4)	81 (43.6)	
No/don't know	71 (40.6)	105 (56.5)	.002

* *P* value was derived from the χ^2 test.
† Analysis considers only 245 parents who took their child to a clinic for a well-child visit or visit for respiratory symptoms.

TABLE 3. Comparison of ARA Before and After Interventions by Study Area: MESA, Wisconsin, June Through July 1997 and June Through August 1998

Belief	Intervention Area Before, *n* (%) (*n* = 175)	Intervention Area After, *n* (%) (*n* = 175)	Control Area Before, *n* (%) (*n* = 186)	Control Area After, *n* (%) (*n* = 186)
Some germs are becoming harder to treat with antibiotics				
Yes	152 (86.9)	166 (94.9)	167 (89.8)	165 (88.7)
No	14 (8.0)	5 (2.9)	10 (5.4)	15 (8.1)
Don't know	9 (5.1)	4 (2.3)	9 (4.8)	6 (3.2)
If antibiotics are overused, they will not work as well for treating infections				
Yes	156 (89.1)	171 (97.7)	162 (87.1)	170 (91.4)
No	11 (6.3)	4 (2.3)	13 (7.0)	10 (5.4)
Don't know	8 (4.6)	0	11 (5.9)	6 (3.2)
If antibiotics are used frequently in your child, your child may be infected with hard-to-treat bacteria				
Yes	113 (64.6)	132 (75.4)	121 (65.1)	127 (68.3)
No	37 (21.1)	27 (15.4)	37 (19.9)	41 (22.0)
Don't know	25 (14.3)	16 (9.1)	28 (15.1)	18 (9.7)
Agreed with all 3 statements*				
Yes	102 (58.3)	127 (72.6)	112 (60.2)	120 (64.5)
No	73 (41.7)	48 (27.4)	74 (39.8)	66 (35.5)

* Intervention group change: +14.3% (95% CI: +6.6,+22.0); $P < .001$. Control group change: +4.3% (95% CI: −4.1,+12.7); $P = .3$. Difference between 2 changes: +10.0% (95% CI: +1.9,+18.1), $P = .015$.

significant difference between the mean antibiotic indications scores of the intervention area (3.9) and the control area (4.3) in the preintervention survey ($P = .07$). In the postintervention survey, the mean score was significantly lower in the intervention area (2.7) than in the control area (3.5; $P < .001$). In the

TABLE 4. Parents' Understanding of Appropriate Antibiotic Use for Bronchitis, Colds, Dry Cough, Flu, and Sore Throats During Baseline (June Through July 1997) and Postintervention (June Through August 1998) Surveys: MESA, Wisconsin

Belief	Intervention Area Before, *n* (%) (*n* = 175)	Intervention Area After, *n* (%) (*n* = 175)	*P* Value*	Control Area Before, n (%) (*n* = 186)	Control Area After, *n* (%) (*n* = 186)	*P* Value*
Antibiotics needed for bronchitis						
Always	117 (66.9)	97 (55.4)		135 (72.6)	129 (69.4)	
Sometimes	37 (21.1)	50 (28.6)		41 (22.0)	41 (22.0)	
Never	6 (3.4)	6 (3.4)		2 (1.1)	4 (2.2)	
Don't know	15 (8.6)	22 (12.6)	1.0	8 (4.3)	12 (6.5)	.5
Antibiotics needed for colds						
Always	4 (2.3)	1 (.6)		8 (4.3)	2 (1.1)	
Sometimes	83 (47.4)	37 (21.1)		84 (45.2)	54 (29.0)	
Never	88 (50.3)	137 (78.3)		94 (50.5)	130 (69.9)	
Don't know	0	0	<.001	0	0	<.001
Antibiotics needed for dry cough						
Always	1 (.6)	1 (.6)		5 (2.7)	0	
Sometimes	67 (38.3)	35 (20.0)		78 (41.9)	63 (33.9)	
Never	103 (58.9)	136 (77.7)		99 (53.2)	120 (64.5)	
Don't know	4 (2.3)	3 (1.7)	<.001	4 (2.2)	3 (1.6)	.002
Antibiotics needed for flu						
Always	27 (15.5)†	11 (6.3)		34 (18.3)	12 (6.5)	
Sometimes	79 (45.4)	55 (31.4)		80 (43.0)	69 (37.1)	
Never	68 (39.1)	106 (60.6)		72 (38.7)	105 (56.5)	
Don't know	0	3 (1.7)	<.001	0	0	<.001
Antibiotics needed for nonstreptococcal sore throat						
Always	6 (3.4)	2 (1.1)		9 (4.8)	1 (.5)	
Sometimes	75 (42.9)	54 (30.9)		88 (47.3)	91 (48.9)	
Never	94 (53.7)	118 (67.4)		88 (47.3)	93 (50.0)	
Don't know	0	1 (.6)	<.001	1 (.5)	1 (.5)	.4

* *P* value for the difference in proportion of always or sometimes versus never. Don't know is excluded.
† Totals add up to 174 because of 1 missing value.

intervention area, there was a larger decrease in the antibiotic score (−1.1), compared with the control area (−.8), but the difference was not statistically significant ($P = .07$). The difference in scores was not associated with any variable in the univariate analysis at a *P* value <.1.

Antibiotic Use Practices

In the intervention area, the percentage of parents who expected an antibiotic for their child and did not receive one during the 6 months before the survey decreased from 13.7% (preintervention) to 8.6% (postintervention). In the control area, this proportion increased from 7.0% to 10.2%. The difference between the 2 area changes was −8.4% (95% CI: −13.9,−2.8; $P = .003$). The percentage of parents who brought their child to another physician because they did not receive an antibiotic decreased from 4.6% to 1.7% in the intervention area and increased in the control area from 2.2% to 3.8%. The difference between the 2 area changes was −4.5% (95% CI: −8.0,−.9; $P = .02$).

Few parents reported that the physician had prescribed an antibiotic over the phone in the baseline (intervention area, 3.4% and control area, 1.6%) and postintervention surveys (intervention area, 4.6% and control area, 1.6%). Parents rarely reported using an antibiotic for a later infection in the same child in the baseline (intervention area, .6% and control area, 1.6%) and postintervention surveys (intervention area, 0% and control area, 1.1%). Few parents reported saving and using an antibiotic on another child for whom it was not prescribed (intervention area, .6% and control area, 1.1%) at baseline, and none reported doing this in the postintervention survey.

DISCUSSION

This is the first published population-based study of parental knowledge and awareness about antibiotics and resistance and appropriate antibiotic use in children. Community participation was good with refusal rates <5% during each of the 2 surveys. Follow-up was quite complete with 85% of the baseline parents participating during the second survey.

There was a high penetration of the educational messages in the intervention area. Over one half of the parents reported being exposed to 2 or more local interventions, and nearly one half received information on antibiotic resistance from their health care provider. Improved provider communication with parents represents a significant impact of this project because of the association between communication and satisfaction with care for a respiratory infection visit.[24,26] Moreover, some have questioned whether it is feasible for physicians to spend additional time talking to patients, and these results suggest that physicians were willing to do so as part of this multifaceted intervention. The control area participants (23%) who reported being exposed to 2 or more interventions may have experienced the effects of the intervention area activities spilling over into the control area of similar activities or materials being available in the control area independent of the study. The parent education pamphlets had been distributed by the AAP to all their members and could be ordered

from the AAP or CDC. The finding that parents in the intervention area were more likely to report having read a magazine article (magazine articles were not part of the intervention) about antibiotic resistance than those in the control area suggests that the interventions may have heightened awareness or interest in the subject among parents.

Despite a high initial ARA, the community interventions were associated with an increase in awareness about antibiotic resistance in the intervention but not in the control area. In the multivariate analysis, previous knowledge and having been exposed to 2 or more local educational interventions were independently associated with high awareness at follow-up; however, study area was not. Therefore, actual exposure to an intervention was more important than residing in the intervention area. There was no evidence that these improvements were limited to persons of higher socioeconomic status (as measured by the surrogate markers having private insurance or more education). There was also improvement in antibiotic resistance knowledge among persons reporting no exposure to interventions in the intervention area but not in the control area. Some persons may not have recalled specific messages, and there may have been a diffusion of education to those not directly affected by a message.

Many parents were concerned about overuse of antibiotics at baseline during the preintervention survey. Despite this concern, parental misconceptions about appropriate indications for antibiotics were common. This finding is similar to that of a clinic-based study in which 32% of parents thought that antibiotics were always or sometimes needed for colds.[27]

Knowledge regarding appropriate indications for antibiotics improved in both areas, but the improvement tended to be greater in the intervention area. The improvement in the control area may have been caused by information unrelated to the project that affected knowledge, spillover of the intervention, or the baseline survey, causing participants to pay more attention to the issue. Although the pamphlet did provide some information about antibiotic indications, the interventions were not designed to teach parents about specific antibiotic indications. Parental education and having private insurance were associated with better baseline knowledge about antibiotic indications, but these factors were not associated with improvement in knowledge.

Although antibiotics are rarely indicated for acute bronchitis in children,[4] children diagnosed with bronchitis are commonly treated with antibiotics.[2,35] Most parents in the study thought that antibiotics were always needed for bronchitis, and this did not improve with the second survey. One reason for the lack of improvement may be that this diagnosis is more ingrained as a cause for therapy than others such as colds. Patients with previous experience receiving antibiotics for bronchitis are more likely to think that antibiotics are indicated for bronchitis.[36] It has also been reported that some clinicians use the term bronchitis to justify prescribing antibiotics,[25] reinforcing the commonly held belief that antibiotics are needed to treat bronchitis. Another reason for the lack of improvement may be that the materials did not effectively communicate that antibiotics are rarely indicated for bronchitis in children, or physicians did not believe this and, therefore, did not communicate this message to parents. If physicians want to avoid administering antibiotics for a cough, the term chest cold or cough illness may be preferable to the term bronchitis.

Contrary to the perceptions of many physicians, few parents reported at baseline that their expectations for antibiotics were not met and even fewer sought treatment from another physician if antibiotics were not prescribed. The decline in the number of parents reporting unmet expectations for antibiotics in the intervention area was probably not caused by physicians prescribing more antibiotics because a separate evaluation showed a decline in liquid antibiotic sales in the intervention but not in the control area.[28] The decline in unmet expectations was more likely caused by parents having a better underlying understanding about judicious use of antibiotics and/or physicians better communicating reasons why antibiotics were not needed. Studies indicate that most parents primarily seek physician consultation to determine whether antibiotics are needed,[22,37,38] and patients' satisfaction is not correlated with receipt of antibiotics but with time spent by the clinician[24] and parents' subsequent understanding of treatment.[24,26]

There are several limitations with this study. It was not possible to validate the ARA or antibiotic indications measures. Information was self-reported from parents who may have been reluctant to report practices that could be considered inappropriate. In addition, what parents report that they believe may not translate to how they will act when their children are actually sick. Participation was limited to those who had telephones, and parents who participated in both surveys were of a higher socioeconomic status as measured by having private insurance and education than were those who participated in only the baseline survey. However, education and insurance status were not associated with changes among participants. The population was also relatively homogeneous regarding race and ethnicity. It may not be possible to generalize the results of these specific interventions to urban or more diverse populations regarding race and ethnicity. Finally, no information was gathered about the child's clinician, so the specialty of the clinician is unknown and it is not possible to evaluate the effectiveness of clinician-oriented interventions.

This study indicates that it is possible to improve parental awareness about antibiotic resistance with education and parental understanding of specific antibiotic indications. Even if parents do not understand the specific indications, it may be possible to decrease antibiotic use if parents are aware of the problems of antibiotic overuse and resistance and if clinicians clearly explain their decisions for using or not using antibiotics. If clinicians decrease the inappropriate prescription of antibiotics for upper respiratory infections and effectively communicate their

reasons for not using antibiotics, children will be spared the adverse effects of antibiotics and the development of antibiotic resistance may be slowed.

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