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# Evaluation of an Evidence-based Guideline for Bronchiolitis

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**ABSTRACT.** *Objective.* To describe the effect of implementing an evidence-based clinical practice guideline for the inpatient care of infants with bronchiolitis at the Children's Hospital Medical Center in Cincinnati, Ohio.

*Methodology.* A multidisciplinary team generated the guideline for infants  $\leq 1$  year old who were admitted to the hospital with a first-time episode of typical bronchiolitis. The guideline was implemented January 15, 1997, and data on all patients admitted with bronchiolitis from that date through March 27, 1997, were compared with data on similar patients admitted in the same periods in the years 1993 through 1996. Data were extracted from hospital charts and clinical and financial databases. They included LOS and use and costs of resources ancillary to bed occupancy.

*Results.* After implementation of the guideline, admissions decreased 29% and mean LOS decreased 17%. Nasopharyngeal washings for respiratory syncytial virus were obtained in 52% fewer patients. Twenty percent fewer chest radiographs were ordered. There were significant reductions in the use of all respiratory therapies, with a 30% decrease in the use of at least 1  $\beta$ -agonist inhalation therapy. In addition, 51% fewer repeated inhalations were administered. Mean costs for all resources ancillary to bed occupancy decreased 37%. Mean costs for respiratory care services decreased 77%.

*Conclusions.* An evidence-based clinical practice guideline for managing bronchiolitis was highly successful in modifying care during its first year of implementation. *Pediatrics* 1999;104:1334-1341; guideline, bronchiolitis, evidence-based medicine, pediatrics, outcome research.

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ABBREVIATIONS. RSV, respiratory syncytial virus; CHMC, Children's Hospital Medical Center; LOS, length of stay.

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With a peak incidence usually from late autumn to early spring, bronchiolitis in the United States is caused primarily by infection with the respiratory syncytial virus (RSV).<sup>1,2</sup> Significant morbidity as a consequence of bronchiolitis is infrequent and hospitalization is estimated to be required in only about 2% to 3% of cases. Nonethe-

less, bronchiolitis accounts for approximately 17% of all hospitalizations of infants.<sup>3-4</sup>

Case reviews of patients admitted with bronchiolitis to the Cincinnati Children's Hospital Medical Center (CHMC) in the years 1993 through 1996 suggested that hospitalization of these patients frequently was based on physician decisions to use  $\beta$ 2-agonist inhalation therapies. Thus, despite ample published evidence demonstrating the limited efficacy of  $\beta$ 2-agonist therapy for patients with bronchiolitis, these physicians were treating bronchiolitis patients as although they had asthma, or some other sort of reactive airway disease rather than a disease that is usually self-limiting, caused by a virus, and characterized primarily by edema rather than bronchospasm.<sup>2</sup>

It was additionally observed that hospital admissions were not only higher than expected, but, for unclear reasons, had also been increasing steadily over the 4-year period from 1993 through 1996. In response to these and other observations, a multidisciplinary team was assembled to critically explore the evaluation and management of this set of patients in Cincinnati. The result was an evidence-based clinical practice guideline. We now report on the effect implementation of the guideline had on the inpatient care of infants with bronchiolitis.

## METHODS

### Guideline Development

In 1996, a guideline development team was formed with 12 full-time members. These included community physicians, 1 of whom was chairman, hospital staff pediatricians, a chief resident, a pulmonologist, a respiratory therapist, nurses, and members of CHMC's Division of Health Policy and Clinical Effectiveness.

The charge to the committee was to produce an evidence-based clinical practice guideline reflecting scientifically defensible "best practices." They were asked to present the recommendations in a manner that would discourage indiscriminate variations in care attributable to the use of unproven or nonefficacious methods and therapies, without inhibiting variations required to meet the unique needs of particular patients. It was intended that use of the guideline would remain voluntary and totally at the discretion of the practitioner. To reinforce this, the committee was specifically asked to avoid including in the document words such as "should," "must," "always," or similar words that might suggest that the guideline recommendations were being published as mandates.

The committee charge did not include formatting the guideline recommendations into a clinical pathway. Unlike the evidence-based recommendations for best practice in guidelines, clinical pathways are frequently more focused on enhancing efficiencies and explicitly list daily expectations for care elements that may or may not be supportable using existing evidences. Because clinical pathways also frequently require "double charting" by the ward physicians and nurses, it was specifically asked that the final guideline include no elements that would require practitioners to

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document when guideline goals were met, when recommendations were not followed, or to record explanations as to why there were variances from intended practices as outlined in the guideline.

The team met for 1 hour weekly over a 4-month period. Members were provided data extracted from the hospital's clinical and financial computer systems. These data profiled the historical characteristics and care practices used in the management of bronchiolitis patients admitted to the hospital over the previous 4 years. Concurrently, the committee members began a review of the literature on the cause, pathophysiology, prognosis, evaluation, and care of bronchiolitis patients. Literature pertinent to the subjects was identified using electronic and other indexed sources, including Medline, information posted on medical subspecialty Web sites, and the reference files of local experts. Over 200 articles from refereed journals were identified and reviewed. Each article was first characterized using an internally developed grading scale (Table 1) and then critically assessed for scientific merit.

The committee decided to limit the scope of the guideline to the care of infants  $\leq 1$  year old admitted to the hospital with a first-time episode of typical bronchiolitis. Selecting only infants with first-time disease reduced the likelihood of including patients with asthma. Excluded from eligibility were infants with histories of immunodeficiencies, significant congenital heart diseases, bronchopulmonary dysplasia, congenital airway diseases or any other comorbid condition that might make the effect of the bronchiolitis more severe and, thereby, care more complicated. Patients requiring ventilator or other intensive therapies were also excluded.

As summarized in Table 2, the information was then reduced to bulleted and fully referenced recommendations for managing infants with a first-time episode of typical bronchiolitis. Criteria for discharging patients safely and expeditiously were also provided, as summarized in Table 3. None of the recommendations were stated as mandates and the guideline included a specific statement reinforcing this fact.

A preprinted admission order sheet was generated to reflect guideline intents for initial care. These orders referred to the use of a respiratory assessment document that was adapted from an assessment scoring tool used in a number of reviewed studies of the efficacy of  $\beta_2$ -agonist inhalations in bronchiolitis management.<sup>20</sup> The intent of introducing this assessment tool was to provide the practitioner with a method for objectively deciding on the efficacy of an initial  $\beta_2$ -agonist inhalation. This also served as a means for deciding the administration of subsequent inhalations.

### Guideline Review and Approval

Before implementing the resulting guideline, the admission order sheet, and the respiratory assessment scoring instrument, the documents were submitted for review and approval by hospital committees and individuals uninvolved in the formulation of the documents. These reviewing resources included the institutional review board. After reviewing the documents, the board concluded that the guideline was primarily a patient care instrument and, as long as patients were not randomized or identified in publications, consent would not be required to use the guideline recommendations. Approval was also obtained from the hospital's pharmacy and therapeutics committee, and the medical records committee. In addition, the documents were reviewed and approved by the institution's department of legal services, the hos-

pital's chief of staff, and the director of the clinical effectiveness program.

### Education

Dissemination of the guideline preceded implementation and was accompanied by educational presentations to the medical staff, including a medical grand rounds, a presentation at a monthly meeting held by community pediatricians, at housestaff training sessions, and in nursing training forums. The guideline was also mailed to all physicians on the CHMC medical staff. Formal education sessions were then augmented with videotaped preservation of presentations for use in educational reinforcement sessions, poster displays summarizing the guideline highlights, and summarization in hospital news publications.

### Implementation and Reinforcement Strategies

During the bronchiolitis season after implementation, daily rounds on all eligible admissions were made by the chief resident, a head nurse, and a study coordinator. During these rounds, guideline principles were reinforced with the ward physicians and nurses and any problems inhibiting implementation resolved.

## GUIDELINE EVALUATION

### Hypotheses

The assessment of guideline efficacy was structured to test a number of hypotheses. 1) If effective as a management tool, there would be a marked reduction in the use of all resources ancillary to bed occupancy, specifically those associated with inhalation respiratory therapies and laboratory studies. 2) If acceptable to the practitioners, a majority of infants admitted with bronchiolitis would be started on the guideline, as detected by the presence of a physician's signature on preprinted admission orders. 3) The numbers of admissions for bronchiolitis and lengths of stays (LOS) of those admitted would be reduced when practitioners received the information placing in doubt the efficacies of inhalations and some other interventions requiring hospitalization.

### Study Population

The bronchiolitis guideline was implemented on January 15, 1997. Data collected from all guideline-eligible patients discharged from the hospital with a diagnosis of bronchiolitis from January 15 through March 27, 1997, were compared with data collected from records on historical control patients admitted before guideline implementation. The control group consisted of guideline-eligible patients discharged with bronchiolitis from January 15 through March 27 in each of the 4 years from 1993 through 1996.

### Sample Size

Data collected in the 4 years before guideline implementation revealed that 69% of admitted bronchiolitis patients were given  $\beta$ -agonist inhalations as part of their therapies and 57% of patients received  $>1$  dose. A sample size of 83 patients was deemed necessary to detect a 20% change in the administration of any  $\beta$ -agonist with an  $\alpha$  of .05 and 90% power. Four hundred patients were required to detect a 20% change in administration of multiple doses of  $\beta$ -agonist with 90% power at the  $P = .05$  level.

### Data Sources

Admission data were collected concurrently at the time of each encounter. Resource utilization ancillary to bed occupancy, length of hospitalization and all other information used as a basis for generating hospital charges were obtained retrospectively from the hospital financial and clinical computer systems. Chart reviews were used selectively to verify some retrospectively collected data, and also specifically to verify whether or not a guideline preprinted admission order was signed to initiate the guideline intents for managing eligible infants. The numbers of readmissions within 7 days of a patient's discharge were also tracked retrospectively, as well as the reasons for these readmissions. The actual cost of each resource used during hospitalization was extracted based on relative value units computed by the hospital financial system after adjustment of all costs to 1998 values for comparability. Because length of hospitalization is a well known surrogate for the basic costs of bed occupancy, these costs

TABLE 1. Categorization of Articles

Code	Evidence Basis
A	Randomized, controlled trial: large sample
B	Randomized, controlled trial: small sample
C	Prospective trial or large case series
D	Retrospective analysis
E	Expert opinion or consensus
F	Basic laboratory research
S	Review article
M	Meta-analysis
Q	Decision analysis
L	Legal requirement
O	Other evidence
X	No evidence

**TABLE 2.** Bronchiolitis Guideline Highlights

	Selected References [Evidence Grade]*
Overview	
It is recommended that bronchiolitis, in typical presentation, be viewed as a self-limited disease characterized by airway edema and not bronchospasm.	1 [S]
The basic management of bronchiolitis is anchored in the provision of therapies that assures that the patient is well oxygenated and well hydrated.	2 [S,E]; 5 [S]; 6 [S,E]; 7 [S,E]
Laboratory and radiologic studies	
Routine nasopharyngeal washing for RSV antigen is not recommended.	5 [S]; 8 [S]; 9 [S]
Chest radiographs are not recommended as a routine.	10 [D]; 11 [C]
Blood gases are recommended only as needed for individual patients.	[X]; [E]
Respiratory care therapies	
Chest physiotherapy is not recommended.	12 [E]
Cool mist therapy is not recommended.	13 [E]
Supervised cough and suction is not recommended.	12 [E]
Aerosol therapy with saline is not recommended.	14 [B]; 15 [A]; 16 [B]; 17 [A]
Steroid inhalations are not recommended.	18
Routine use of bronchodilator aerosol therapies is not recommended.	14 [B]; 15 [A]; 16 [B]; 17 [A]; 19 [D]; 20 [A]; 21 [B]; 22 [A]; 23 [S]; 24 [A]; 25 [A]; 26 [C]
Inhalations using epinephrine may be considered in selected patients.	1 [S]; 19 [D]; 27 [A]; 28 [A]
If, within 60 minutes of a trial inhalation therapy, there is not significant improvement, it is recommended that the therapy not be repeated.	14 [B]
Monitoring	
Discontinue electronic monitoring in timely manner to help transition to home.	[X]; [E]
Isolation	
Respiratory/contact isolation using 1-week cohorting.	[X]; [E]

**TABLE 3.** Discharge Criteria

Begin discharge planning on admission
Respiratory status
Respiratory rate usually <80/min.
Clearing of the infant's airway can be performed by parent using bulb suctioning.
Patient is either:
on room air, or
on stable oxygen therapy of <1/2 L/min by nasal cannulae for >1 day.
Nutritional status
The patient is on oral feedings at a level sufficient to prevent dehydration.
Treatment modalities
The patient is on oral medications or regularly administered parental agents.
Social
Home resources are adequate to support the use of any necessary home therapies.
Parent or guardian is proficient with therapies required.
Family has participated in the process leading to the discharge decision.
Follow-up
When indicated, home health care and durable medical supply agencies have been notified and arrangements for visits finalized.
Primary care provider(s) identified, notified, and agree(s) with discharge decision and follow-up appointments have been scheduled.

were not collected and, because cost figures are easier to define and more reliable, hospital charges also were not included.<sup>29</sup>

After guideline implementation, a random sample of parents was telephoned after discharge to determine the level of family satisfaction. For patients admitted before guideline implementation, family satisfaction was determined using data from a generic hospital-wide satisfaction survey.

Guideline compliance was defined as a physician's signature on the bronchiolitis admission order sheet for patients who were designated as having bronchiolitis on admission and otherwise met the criteria set for guideline eligibility.

### Data Analyses

The data were stratified categorically based on whether or not they represented information about care delivered before or after introduction and implementation of the guideline. Data describing

care provided to all guideline-eligible infants, whether initiated by a guideline admission order sheet or not, were used compared with data from patients admitted before guideline implementation. For some comparisons, data were also stratified based on whether or not an admission order sheet was actually signed by a physician when an eligible patient was admitted with bronchiolitis after implementation of the guideline in 1997.  $\chi^2$  tests were used for analysis of categorical variables and Student's *t* tests were performed for normally distributed continuous variables. Wilcoxon rank sum tests were used for non-normally distributed data. All statistical analyses were performed using PC-SAS software (Release 6.12, SAS Institute Inc, Cary, NC). In this report, when expressed as means, results are followed by the standard deviations.

## RESULTS

### Patient Characteristics

Data from 1582 patients were examined. A total of 1300 records from the historical 4-year period before implementation of the guideline were available and compared with the data describing 282 patients discharged with the diagnosis of bronchiolitis after implementation in the winter of 1997. Of these 282 patients, 53 were not diagnosed as having bronchiolitis until after admission. Therefore, the guideline-eligible population was 229 infants. Neither gender, age, nor insurance coverage characteristics for admitted bronchiolitis patients were significantly different before and after implementation. There also were no differences in the gender, age, or insurance characteristics between patients stratified based on whether or not care was initiated by a physician signing a preprinted guideline-specific admission order sheet. The homogeneity of the population, as defined by the selection criteria, was reflected in the inclusion of over 90% of the population in the single All Patient Refined Diagnosis-Related Group (APR-DRG) classification of 096 that is common for patients with asthma or bronchiolitis.<sup>30</sup> The disease severity rating was mildly ill for all but 12% of the patients classified as moderately ill.

**TABLE 4.** Summary of Results

Outcome	Guideline Implementation		% Change	P
	Before	After		
Median eligible admissions	301 (range: 261–363)	229	–32%	<.001**
Mean LOS	2.9 ± 2.0	2.4 ± 2.0	–17%	<.001*
Median LOS	2 (range: 1–16)	2 (range: 1.9)	—	<.001**
Percentage who had any inhalation	69%	48%	–30%	<.001
Percentage who had >1 inhalation	57%	28%	–51%	<.001
Mean inhalations per patient ±SD	11.5 ± 10.2	5.1 ± 5.8	–56%	<.001
Percentage who had nasopharyngeal wash for RSV†	89%	43%	–52%	<.001
Percentage who had radiograph	70%	56%	–20%	<.001
Percentage who had blood gas	6%	8%	+14%	NS‡
Percentage who had antibiotics	56%	57%	+2%	NS
Percentage readmitted within 10 days	3%	3%	—	NS
Mean costs for all ancillary resources ±SD	\$ 971 ± \$633	\$609 ± \$562	–37%	<.001*
Mean costs for use of respiratory care services alone ±SD	\$ 273 ± \$252	\$ 63 ± \$79	–77%	<.001*

**Admission Rates**

During the January 15 through March 27 periods in the 4 years before guideline implementation, yearly admissions for bronchiolitis increased at an average rate of 15% per year for a total of 52% (Fig 1). In 1997, after the introduction of the guideline, admissions decreased 29%.

**Guideline Use (Compliance)**

Eligibility for the guideline was based on an admission diagnosis of bronchiolitis. In 1997, a guideline admission order was signed for 181 of the 229 eligible infants (79%).

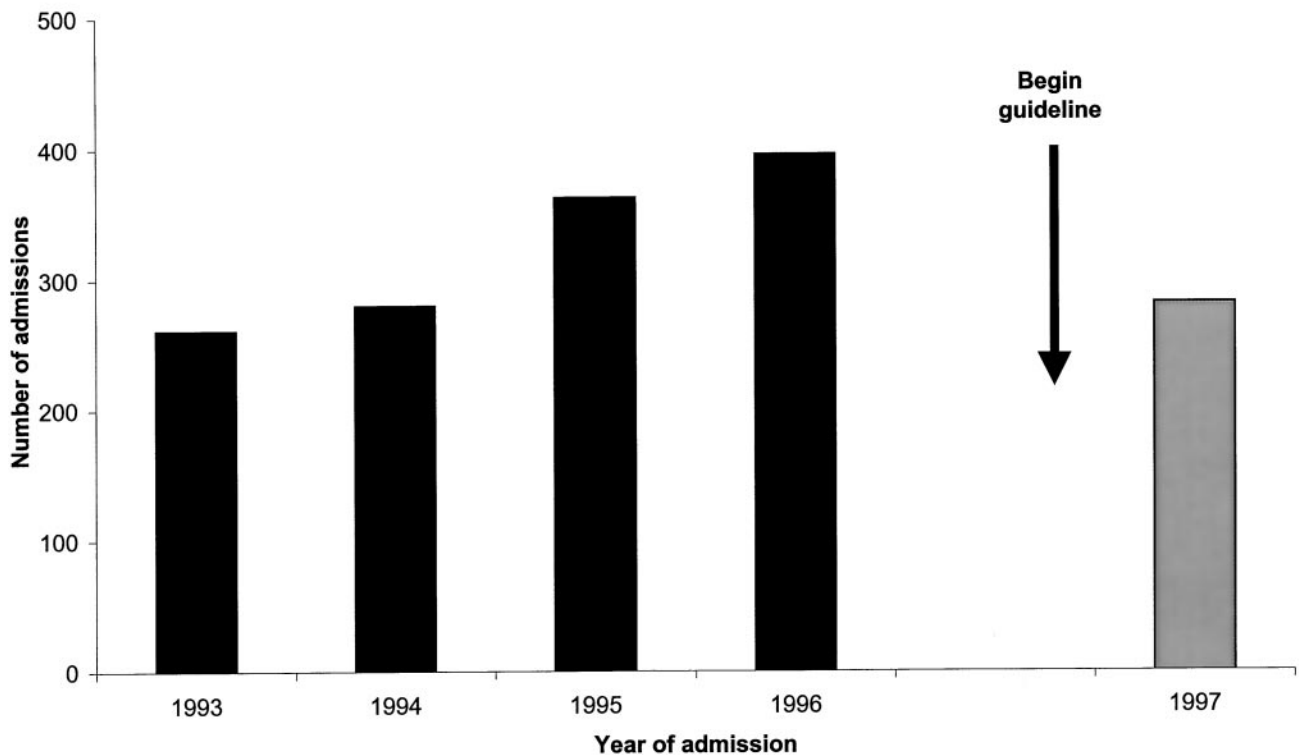
**LOS**

The mean LOS for patients admitted before guideline implementation was 2.9 ± 2.0 days (median: 2; range: 1–16). In 1997, the mean LOS was 2.4 ± 1.3 days (median: 2; range: 1–9 days). Both the absolute decrease in LOS and the decrease in variance in LOS, as reflected in the standard deviation, were statistically significant (*P* < .001).

**Use of β-Agonist Inhalation**

In the years before the guideline, 69% of the admitted infants were given β-agonist inhalations as part of their therapies. After implementation in 1997,

**Admissions for bronchiolitis (January 16 - March 31)**



**Fig 1.** Yearly numbers of infants ≤1 year old admitted with a diagnosis of first-time bronchiolitis before and after implementation of an evidence-based clinical practice guideline.

this was reduced significantly to 48% of the infants admitted ( $P < .001$ ).

Fifty-seven percent of all patients received multiple doses of  $\beta$ -agonist in the 4 years before guideline implementation. After implementation, only 28% of patients received multiple doses ( $P < .001$ ).

Before implementation, for infants receiving  $>1$  dose of  $\beta$ -agonist, the mean number of inhalations was  $11.5 \pm 10.2$  ( $n = 737$ ). After the guideline was introduced, this was reduced to  $5.1 \pm 5.8$  ( $P < .001$ ;  $n = 78$ ). This reduction was not different for eligible infants based on whether an official admission order was or was not signed by the physician.

The respiratory assessment form, intended as a method for helping practitioners decide on the use of repeated doses of inhaled medications, was used for  $<10\%$  of the cases. This held true even when an admission order sheet prescribing the use of this instrument was signed by the physician.

#### Use of Clinical Resources Ancillary to Bed Utilization

Before implementation of the guideline, 89% of patients received nasopharyngeal washes to test for RSV antigen. This decreased to 43% after guideline implementation ( $P < .001$ ). A significantly greater number of RSV antigen studies were done in eligible infants not started on the guideline compared with those on the guideline ( $P < .01$ ), but those not on guideline still had significantly fewer RSV studies than those in the his-

torical control period ( $P < .002$ ). Chest radiographs were ordered in 70% of infants before implementation and 56% after the guideline was introduced ( $P < .001$ ). Chest radiographs were obtained with equal frequency for those on and off the guideline. There was no statistically significant change in the 6% to 8% of infants in whom blood gases were obtained or in the 56% to 57% of children who received antibiotics before and after implementation.

To test if antibiotic use was higher in younger infants, who are at greater risk for serious bacterial infections, the use of antibiotics was further analyzed by patient age. As summarized in Fig 2, the proportion of bronchiolitis patients receiving antibiotics was actually higher in older infants and the implementation of the guideline did not appear to influence the decision to begin antibiotics for any age category.

#### Readmission Rates

Readmissions to the hospital in the 7 days after discharge remained stable at 3% of discharge before and after guideline implementation. Independent chart reviews by a community-based practitioner uninvolved in the formulation of the guideline revealed no relationship between guideline recommendations and causes of readmissions.

### Bronchiolitis antibiotic use ages 0 through 365 days

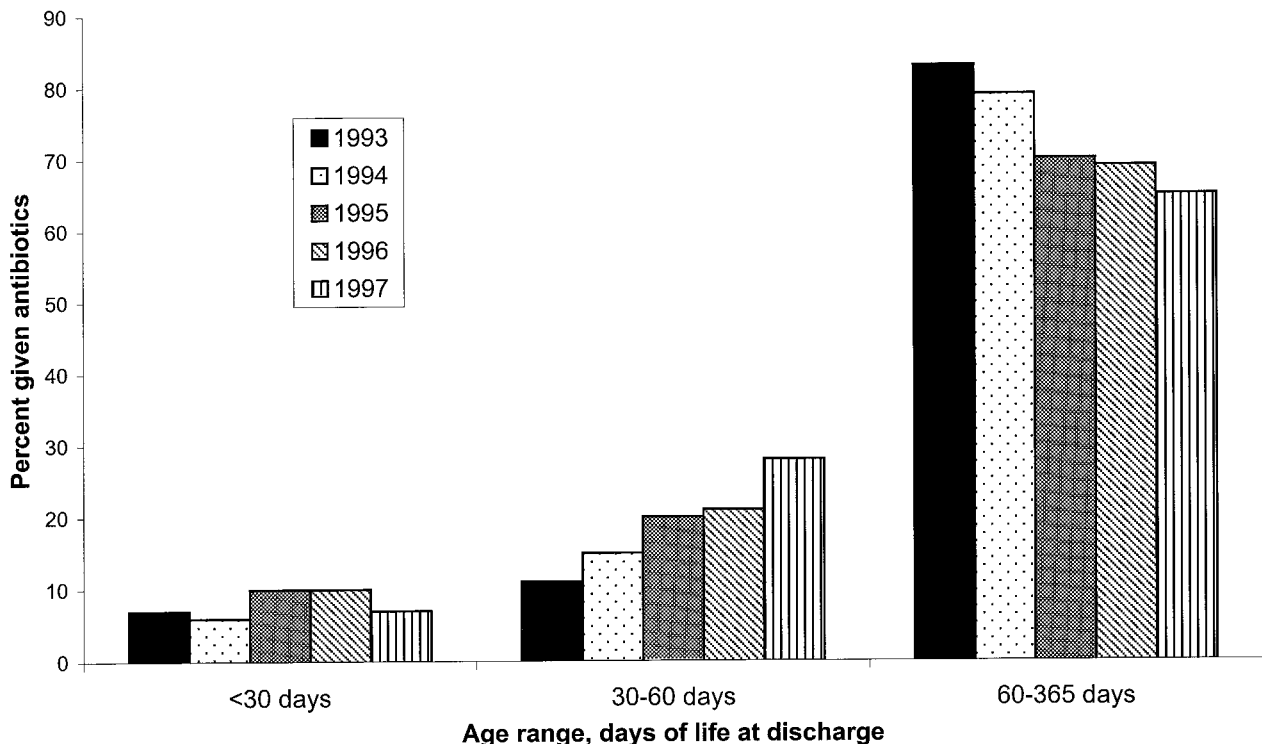


Fig 2. Percent of infants, in 3 age groups, given antibiotics during each year of the study.

## Family Satisfaction

Forty randomly selected parents of infants admitted in 1997 were called and interviewed over the phone. Seventy-seven percent of the families whose infants were not treated using the guideline parameters felt they received adequate information while in the hospital. For those families with infants treated on the guideline, the same question returned a higher satisfaction level of 93%. For all patients, overall satisfaction with the hospital's performance was 96%. Satisfaction with preparation for discharge was 98%. Ninety-eight percent of the parents reported that by 8 days after discharge their families were back to their normal routines. Parental return to work occurred on average by 3.5 days after discharge. These satisfaction scores were not significantly different from those generated using the generic satisfaction survey methodologies during the years before guideline implementation.

## Changes in Hospital Costs

Mean costs for use of all resources ancillary to bed occupancy decreased 37% from a mean of \$971  $\pm$  \$633 for the 4 years before guideline implementation to \$609  $\pm$  \$562 in 1997. Both the differences in means and in the standard deviations were significant at  $P < .001$ . Mean hospitalization respiratory care costs decreased 77% from \$273  $\pm$  \$252 per patient in the years 1993 through 1996 to \$63  $\pm$  \$79 in 1997. All of the differences in mean costs and reductions in their variances were significant at the  $P < .001$  level.

## DISCUSSION

The current report adds another pediatric demonstration that quality medical care can be cost-effective. The apparent success of this bronchiolitis guideline in reducing resource utilization for care without increasing readmission rates or decreasing family satisfaction is rewarding and reassuring, but not surprising. The recommendations in the guideline are based on firm scientific evidences, bolstering its credibility among community health providers. It is also consistent, supportive, and, with data derived from a larger population, extends a similar independent experience recently published by Adcock et al.<sup>31</sup>

Major components of this guideline are arguments against the routine use of  $\beta$ -2-agonist inhalations for therapy for patients with typical and uncomplicated bronchiolitis. Numerous randomized clinical trials and meta-analyses of these trials have raised serious doubt about the therapeutic efficacy of  $\beta$ -agonists in bronchiolitis patients. Some of these studies have even indicated that treating bronchiolitis with inhalations can cause hypoxia in some infants.<sup>5,14,32-33</sup> Despite published evidence, these relatively aggressive therapies have remained prevalent.<sup>5,7,15-17,19,25-26,32,34-36</sup>

The persistent use of therapies of questionable efficacies has been justified because 15% to 25% of bronchiolitis patients are reported to subsequently progress to develop asthma<sup>37-39</sup> and, in the first presentation with wheezing, might be demonstrating this fact. In addition, retrospective histories indicate that 9% to 44% of older asthmatic children had their

first episode of wheezing in their first year of life.<sup>40-41</sup> But, despite these general prevalence figures, the relationship between bronchiolitis and subsequent asthma has been established primarily using populations of patients that include those in whom bronchiolitis occurred repeatedly. The true proportion of infants  $\leq 1$  year old with a first-time episode of bronchiolitis who will later develop asthma is still uncertain and likely lower.

Because of these uncertainties about true prevalence, the guideline does allow that practitioners might appropriately give at least 1 trial dose of a  $\beta$ -2-agonist inhalation to selected patients. But because efficacy of an inhalation should be clear within 1 hour of its delivery, the guideline also recommends strongly that repeat doses of inhaled medications be reserved only for those rare patients with a major and sustained clinical improvement in respiratory function after the initial trial. It is interesting that the practitioners apparently rejected the use of the respiratory assessment tool provided to help them make these decisions. It is additionally instructive to note that even when the use of this tool was prescribed by a physician's order, the nurses and respiratory therapists actually administering the therapies did not include the respiratory score in their documentation of the events. The reasons for this rejection are still unclear.

Generating a guideline prescribing best-care practices is simple compared with getting practitioners to accept the guideline facts to a degree sufficient to even be willing to try a change in what are often long-standing and habituated practices. One of the remarkable observations during this experience is that we were able to implement this guideline without generating physician-specific report cards that imply threatened sanctions for noncompliance, thus avoiding the rancor that sometimes leads to resistance.

From anecdotal comments, we know that many practitioners appreciate our explicit acknowledgment in the published recommendations that their use of the guideline was voluntary and that we expect the recommendations to be applied only when they judged them to be in the best interest of the patient. Although supported again only by anecdotal exchanges with the users, we also interpret the success of this guideline as evidence that the guideline contents are compelling and convincing because the recommendations of each are supported by referenced evidence that can be reviewed and independently assessed by any practitioner with access to a library. Although debates continue over the relative strengths of content and implementation methods as influences in guideline success, it is clear, at least to the authors of this article, that content is not a neutral.

Finally, it is necessary to acknowledge certain limitations that this study shares with others that report salutary effects of an intervention when the conclusions are based on comparisons of populations that are not concurrent in time. It is simply not possible to control for all potential confounders when comparison populations are not concurrent. As a corollary, it

is also impossible to prove beyond all reasonable doubt that an intervention alone is the sole cause of any effect measured as an outcome variable. However, to strengthen the link between the bronchiolitis guideline implementation as a likely influence on causing the changes observed and reported in this paper, some potential and specific possible confounders in this study are worth brief discussion.

For example, it is possible that our study population, by happenstance, coincided with a milder than usual RSV season. If this is so, it is possible that some of our favorable outcomes were attributable simply to coincidence. We believe this likelihood is slim for a number of reasons. Our results mirror those reported by Adcock et al<sup>31</sup> who also used historical controls but drawn from a bronchiolitis population admitted during a single RSV season when viral invasiveness would likely be relatively constant. Although a mild RSV season might contribute to the reduction in admissions recorded, the significant reduction in LOS and the mean number of inhalation therapies given to patients after publication of the guideline cannot be explained based only on disease prevalence. Our acknowledgment of this limitation is, therefore, tempered with a fair degree of confidence in our conclusions.

We also need to certify that practitioners in 1997, after the guideline was implemented, did not try to avoid the guideline recommendations by admitting patients with bronchiolitis under a different diagnostic rubric, such as asthma. This is a very unlikely possibility in our institution where admitting diagnoses are almost invariably assigned by the emergency department physician and not by the referring practitioner. In addition, there were 1000 admissions for asthma in 1996 and 926 admissions in 1997. Thus, there is no evidence to suggest shifting of diagnoses as an explanation for the fewer bronchiolitis admissions in 1997. Alternatively, we also know from multiple, albeit anecdotal, attestations from community practitioners that by placing the efficacy of  $\beta$ -2 agonist inhalation therapies in doubt, the guideline simply eliminated one of the major indications practitioners used previously as a criterion for admission.

We do not believe that fewer patients were encountered at our hospital simply because their physicians sent them to other community hospitals for care. To test this, we examined the data for children who live in a single Cincinnati zip code, 98% of whom are traditionally and currently referred only to CHMC for care when emergency or inpatient services are needed. Before guideline implementation, the admission rate for bronchiolitis at the Children's Hospital was 13 per 1000 population in this group. After guideline implementation, the rate decreased to 9 bronchiolitis admissions per 1000 population.

Our methods for implementation included frequent visits by a chief resident, a nurse, and a clinical coordinator. These 3 individuals were extremely committed to the task of observing and ensuring that barriers to implementation were removed. They also served as daily physical reminders of the guideline as a management tool. Their effectiveness and importance cannot be overstated, but, unfortunately,

also cannot be quantitated nor isolated as uncontrolled independent variables.

We urge caution when interpreting the data on family satisfaction. Our surveys were conducted on a randomly selected, but small, sample of patients treated in 1997 and the instrument used to determine satisfaction after implementation has not yet been verified as reliable using larger samples. Satisfaction of families encountered before guideline implementation was determined using a different survey. The before and after comparisons of satisfaction cannot, therefore, be characterized as rigorous. We have included the results of these surveys only to provide some meager level of reassurance that family satisfaction was not grossly compromised by guideline introduction.

## CONCLUSION

In summary, we believe that our results are sufficiently strong to recommend pursuing the guideline we describe by testing to see if the described results are sustained through subsequent years in our own institution and testing if similar efficacies can be demonstrated by testing this or similar guidelines in other settings.

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