

DECREASING OVERUSE OF THERAPIES IN THE TREATMENT OF BRONCHIOLITIS BY INCORPORATING EVIDENCE AT THE POINT OF CARE

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Objective To describe the effect of evidence-based point-of-care algorithms and rules, based on guideline recommendations, on the overuse of therapies for bronchiolitis.

Study design Pre-postintervention for infants < 1 year of age admitted with a first-time episode of bronchiolitis. Data collected for guideline-eligible patients discharged between January 15, 2002, and March 27, 2002, were compared with data collected for guideline-eligible patients discharged from the hospital with a diagnosis of bronchiolitis during the same time period in the first 5 years after the original guideline implementation (1997 to 2001). The primary outcome of interest was use of bronchodilator therapy. Secondary outcomes included use of guideline order sets, resource utilization, length of stay, and readmission.

Results A total of 256 patients from 2002 were compared with 1272 historic patients. In 2002, the odds of receiving any bronchodilator, more than 1, more than 2, and more than 4 bronchodilators were all significantly less than predicted by the 1997 to 2001 year-to-year trend. The odds of receiving a nasopharyngeal wash for respiratory syncytial virus and a chest radiography (OR = 0.680, CL = 0.476, 0.973) were also significantly lower than what was predicted from use trends of previous years.

Conclusions Evidence-based point-of-care instruments can have a significant effect on unwarranted treatment variation. (*J Pediatr* 2004;144:703-10)

Variation in the use of therapies unrelated to individual patient characteristics or illness severity was first described by Wennberg and Gittelsohn.¹ More recently, the Dartmouth Atlas project brought together researchers in diverse disciplines, including epidemiology, economics, and statistics, to focus on the accurate description of how medical resources are distributed and used in the United States.² Among the most notable findings was the documentation of remarkable differences in how Americans use health care resources and the influence of the local supply of resources on the rates of use of those resources.² Specific to pediatrics, Willson et al³ described wide variation in the care of infants with viral lower respiratory illness in 10 children's medical centers. Much of this variation appeared to represent institutional or individual physician practice preferences that bore little relation to illness severity and were generally not supported by evidence from clinical trials.

Evidence-based practice guidelines have been developed in part to reduce this unwarranted variation in clinical practice.⁴ Numerous studies have documented the salutary effect of guideline implementation on appropriate resource utilization.⁵⁻¹² At Cincinnati Children's Hospital Medical Center (CCHMC), we have reported the sustained benefits of a locally developed guideline for infants with bronchiolitis.^{13,14} Our model of acute care identifies four distinct decision points: the home, the primary care provider's office, the emergency department (ED), and the inpatient unit. On the basis of

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Table I. Guideline recommendations

1. Respiratory contact precautions in cohort room.
2. Laboratory and radiology tests ordered only as needed for diagnosis of comorbid condition.
3. Nasal suctioning important before feeding, before inhalation treatments, and PRN.
4. If trial inhalation treatment is ordered, suction before treatment and administer treatment only if postsuction respiratory score is >2 . Use the Respiratory Assessment/Care Record to document presuction and postsuction and posttreatment scores.
5. Continue inhalation treatments only in patients who show documented clinical improvement response. (Compare pretreatment [postsuction] with posttreatment respiratory score.)
6. Oximetry spot-checks if hypoxia is suspected from clinical assessment.
7. Supplemental oxygen if cyanotic or oximetry spot-checks are consistently $<91\%$ at rest on room air.
8. Encourage oral fluid intake for hydration, intravenous fluids only if necessary.
9. Minimizing intravenous use, oxygen therapy, and use of continuous monitoring devices will act to reduce length of stay.
10. Educate parents about nasal suctioning, the signs and symptoms of worsening hydration and respiratory conditions, and the normal prolonged symptoms of bronchiolitis.

these experiences, we hypothesized that the use of evidence-based point-of-care algorithms and rules, based on guideline recommendations, would be successful in decreasing variation, as demonstrated by decreased overuse of resources.

METHODS

Bronchiolitis Guideline

The guideline for the care of infants 1 year of age or younger who were admitted to the hospital with a first-time episode of typical bronchiolitis was initially implemented at CCHMC in January 1997 and revised in November 2001 (Table I).^{13,14} The guideline emphasized the self-limited nature of bronchiolitis and the limited benefit of diagnostic tests and therapies.

Improvements in Care Delivery

As part of the Pursuing Perfection initiative, funded by the Robert Wood Johnson Foundation, CCHMC proposed to demonstrate significant improvements in patient care through an evidence-based approach to acute care conditions. Bronchiolitis was chosen as a model because of clear evidence of overuse of resources. A multidisciplinary team was created. The team developed point-of-care algorithms and rules specific to each of the four decision points: home, office, ED, inpatient. It was thought that the use of each of these tools at the point of care would operationalize the intent of the guideline statements, taking them from concept to action.

The emergency medicine physicians on the team led the development of an algorithm specific to bronchiolitis care in the ED. A draft of the algorithm was shared with an evidence review team consisting of ED leaders and experienced physicians. Recommended revisions were made and the algorithm was then tested by three physicians in the clinical setting. Emphasis was placed on the fact that it was the guideline being evaluated, not the physicians. To increase "ownership" of the algorithm by the ultimate users, space was provided on the back of the algorithm to obtain feedback from the ED physicians. Additional revisions were made to the algorithm in response to their comments and suggestions. The final version of the algorithm stated that a respiratory syncytial virus (RSV) test was not needed, a chest radiograph was optional, and it recommended bronchodilators only if respiratory assessment showed a positive response. The algorithm was shared at an ED divisional meeting and rolled out to the entire ED staff. Physicians on the development team, along with those already using the instrument, trained the rest of the staff. An ED nurse conducted similar educational sessions with nurses throughout the season. The algorithm was attached to the chart when a patient demonstrated symptoms of bronchiolitis. Feedback from the users continued to be collected to evaluate the usefulness of the algorithm in the ED.

The respiratory therapy department began a focused effort to encourage the use of respiratory function assessment to determine the need for and effect of bronchodilator treatment.¹⁵ A respiratory scoring sheet and treatment recommendations, specific to the care of the bronchiolitic patient, were developed under the leadership of a respiratory therapist. Throughout the season, this leader met biweekly with therapists to increase communication, receive their input on what they thought was or was not working, and to share the data regarding bronchodilator use. Respiratory therapists accompanied the physicians on morning rounds and were encouraged to make their recommendations verbally to the covering physician, based on the results of the respiratory assessment.

The community-based primary care physicians and hospitalists on the team developed standard clinical criteria for admission, discharge, and intensive care. Appropriate admission criteria included a respiratory rate >70 per minute, not taking oral feeds adequately to prevent dehydration, and requiring oxygen to maintain oxygen saturation $>91\%$. A patient was deemed ready for discharge when the respiratory rate was <70 per minute, he or she was taking oral feeds without difficulty and no longer required oxygen to maintain oxygen saturation $>91\%$, and the parent was able to care for the child at home. These criteria were disseminated to community physicians through the Internet and Intranet, grand rounds, newsletters, and direct mailings. Academic detailing, an educational strategy based on face-to-face contact with a credible messenger,¹⁶⁻²⁰ was conducted at 12 large pediatric practices, affecting approximately 50 physicians. The same criteria were disseminated to families through our residents' continuity clinic, community physicians, our Internet site, and

through day care centers in our regional area. The patient services department developed an inpatient clinical pathway and preprinted education and discharge documents that helped support the essence of the guideline in the daily operations of care. The standard order set, clinical pathway, discharge record, parent pathway, and education record were placed on each patient's chart at admission to be readily available to all care providers.

Process and outcome measures were communicated to the internal and external community on a weekly basis through an online reporting system. Weekly meetings with the improvement team were used to identify barriers and design solutions that were then tested by using Plan-Do-Study-Act cycles.²¹

Study Population

The improvement initiatives were first tested December 3, 2001. The population consisted of all infants younger than 12 completed months of age admitted to CCHMC with a first-time episode of uncomplicated bronchiolitis (International Classification of Diseases [ICD-9] codes 466.00-466.99). Excluded from guideline eligibility were infants with history of cystic fibrosis, 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 and patients with an ICU admission at any time during their stay were also excluded. Eligible patients were identified daily by review of ED and admission logs and confirmed by manual chart review and consultation with the physician caring for the infant if there was a question of eligibility.

Data collected for patients discharged between January 15 through March 27, 2002, were compared with data collected for guideline-eligible patients discharged from the hospital with a diagnosis of bronchiolitis during the same time periods (January 15 to March 27) in the first 5 years after the original guideline implementation (1997 to 2001).

The institutional review board had previously concluded that the bronchiolitis guideline was primarily a patient care instrument and, as long as patients were not randomly assigned to the guideline or identified in publications, informed consent was not required to use the guideline recommendations.

Outcomes

Although clinicians were encouraged to adopt all of the guideline recommendations, emphasis was placed on reducing bronchodilator use. Thus, the primary outcome of interest was the use of bronchodilator therapy. Secondary outcomes included use of the guideline order set, resource utilization, inpatient length of stay, and rate of readmission. Use of the guideline order set 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 for guideline eligibility.

Data Sources

Patient data were collected concurrently at the time of each encounter. Resource utilization, length of hospitalization, and ED use and readmission within 7 days of discharge were obtained retrospectively from the hospital financial and clinical computer systems. Chart reviews were used to determine guideline use, site of care, and whether admission and discharge criteria were met for a sample of guideline-eligible patients. An independent pediatrician examined the charts of all guideline-eligible patients discharged with a diagnosis of bronchiolitis and readmitted within 7 days during the study periods of 2001 and 2002 to determine if they met discharge criteria when released and admission criteria at readmission.

Data Analysis

The analysis method was chosen to allow us to determine if the results for the 2002 season were significantly changed from the 1997 to 2001 trend since guideline implementation. Logistic regression models were used to assess categorical outcomes, including bronchodilator treatment, RSV wash, antibiotic administration, chest radiography, readmission, and revisit to the ED. Linear regression models were used to assess continuous variable outcomes such as length of stay and number of bronchodilator treatments. In all models, the individual patient was the unit of analysis. The independent variable consisted of a time variable measuring the number of years since 1997 and a dummy variable representing the year 2002. The value of the dummy variable parameter estimate indicated if the 2002 result was higher or lower than the established trend and the parameter test determined if the difference from the trend was statistically significant. A linear regression model was also used to examine the trend in the number of admissions per year, with the year being the unit of analysis. When expressed as means, results are followed by the standard deviations. Odds ratios (OR) and 95% confidence limits (CL) are reported. χ^2 tests were used to examine categorical variables and Student *t* tests were performed to examine normally distributed continuous variables for patients readmitted within 7 days of discharge. All statistical analyses were performed with the use of PC-SAS software (Release 8.1, SAS Institute Inc, Cary, NC).

RESULTS

Patient Characteristics

Data from 1528 patients were examined (Table II). A total of 1272 patients discharged with the diagnosis of bronchiolitis during the first 5 years of guideline availability were compared with the 256 guideline-eligible patients in 2002. There were no significant differences in age at admission, sex, or race between the first 5 years of guideline implementation and 2002. Significantly more of the patients admitted with bronchiolitis in 2002 had Medicaid coverage than in the previous 5 years (56% vs 41%, $P < .0001$).

Table II. Patient characteristics

Year	No. of patients admitted	Mean admission age in days (SD)	Boys, %	White race, %	Proportion of population on Medicaid, %
1997	316	109 (84)	58.2	Not available	50.0
1998	256	127 (91)	60.2	74.2	50.2
1999	218	104 (75)	49.1	76.2	33.5
2000	216	103 (84)	56.0	79.6	32.3
2001	266	107 (84)	58.7	75.9	33.0
2002	256	98 (77)	53.9	75.0	55.7
Totals	1528	108 (82)	56.3	76.1	43.4

Table III. Summary of results

Outcome	1997	1998	1999	2000	2001	2002
Order set use, %	67.0	74.3	68.9	76.0	66.7	90.0
Mean length of stay, d	2.5 ± 1.6	2.6 ± 1.6	2.4 ± 2.0	2.2 ± 1.7	2.4 ± 1.9	2.1 ± 1.8
Received bronchodilators (all patients), %	48.7	62.9	65.1	58.3	57.5	53.7
Received >1 bronchodilators (all patients), %	29.8	52.7	47.3	42.6	30.1	22.8
Received >2 bronchodilators (all patients), %	19.6	41.0	30.7	26.9	18.1	12.2
Received >4 bronchodilators (all patients), %	11.1	30.1	17.9	14.4	10.2	6.3
Mean inhalations (all patients)	2.0 ± 5.0	4.9 ± 8.1	3.6 ± 8.8	2.4 ± 4.3	1.8 ± 3.4	1.3 ± 2.5
Mean inhalations (patients who received at least 1)	4.1 ± 6.5	7.8 ± 9.1	5.5 ± 10.4	4.2 ± 4.9	3.2 ± 3.9	2.4 ± 3.0
Mean inhalations (patients who received >1)	6.1 ± 7.7	9.1 ± 9.4	7.2 ± 11.8	5.4 ± 5.3	5.2 ± 4.6	4.4 ± 3.8
Nasopharyngeal wash for RSV, %	46.2	44.1	48.2	59.7	40.2	22.7
Antibiotics, %	56.7	51.6	50.9	43.1	39.9	39.1
Chest radiograph, %	57.6	63.7	65.1	63.9	51.1	46.5
Readmitted within 7 d, %	1.9	2.0	3.7	1.9	4.1	4.3
Revisit to the ED within 7 d, %	1.3	2.3	1.8	0.9	1.9	2.0

Admissions

The total number of admissions in 2002 did not vary significantly from what was predicted by the year-to-year trend ($P = .51$). Eighty-five percent of patients admitted during the pilot project of 2002 met admission criteria. During the previous bronchiolitis season (the only year data were available), 83% of patients met these criteria ($P = .60$).

Order Set Use

The use of the order set (Table III) remained statistically unchanged from 1997 through 2001 (OR = 1.025, CL = 0.918, 1.144). However, order set use in 2002 was significantly higher than predicted by the trend (OR = 3.460, CL = 1.590, 7.531).

Length of Stay

The 1997 to 2001 year-to-year trend for length of stay demonstrated a significant decrease ($P = .04$). The length of stay in 2002 was not significantly different from the trend during 1997 to 2001 ($P = .71$).

Bronchodilator Use

In 2002, the odds of receiving any bronchodilator were significantly less than predicted by the year-to-year trend (OR = 0.690, CL = 0.482, 0.988). The 1997 to 2001 trend for the administration of more than 1 bronchodilator per patient (Fig 1) was flat (OR = 0.977, CL = 0.905, 1.054), whereas the odds of receiving more than 1 bronchodilator in 2002 were significantly less than predicted by the trend (OR = 0.482, CL = 0.326, 0.715). Similarly, in 2002, the odds of receiving more than 2 (OR = 0.472, CL = 0.292, 0.761) and more than 4 (OR = 0.473, CL = 0.254, 0.881) bronchodilators per patient were significantly less than predicted by the earlier trends.

Ancillary Resource Use

The odds of receiving (Fig 2) a nasopharyngeal wash for RSV (OR = 0.322, CL = 0.218, 0.475) and (Fig 3) a chest radiograph (OR = 0.680, CL = 0.476, 0.973) were significantly lower than what was predicted from the use trends of previous years. The use of antibiotics (OR = 1.138,

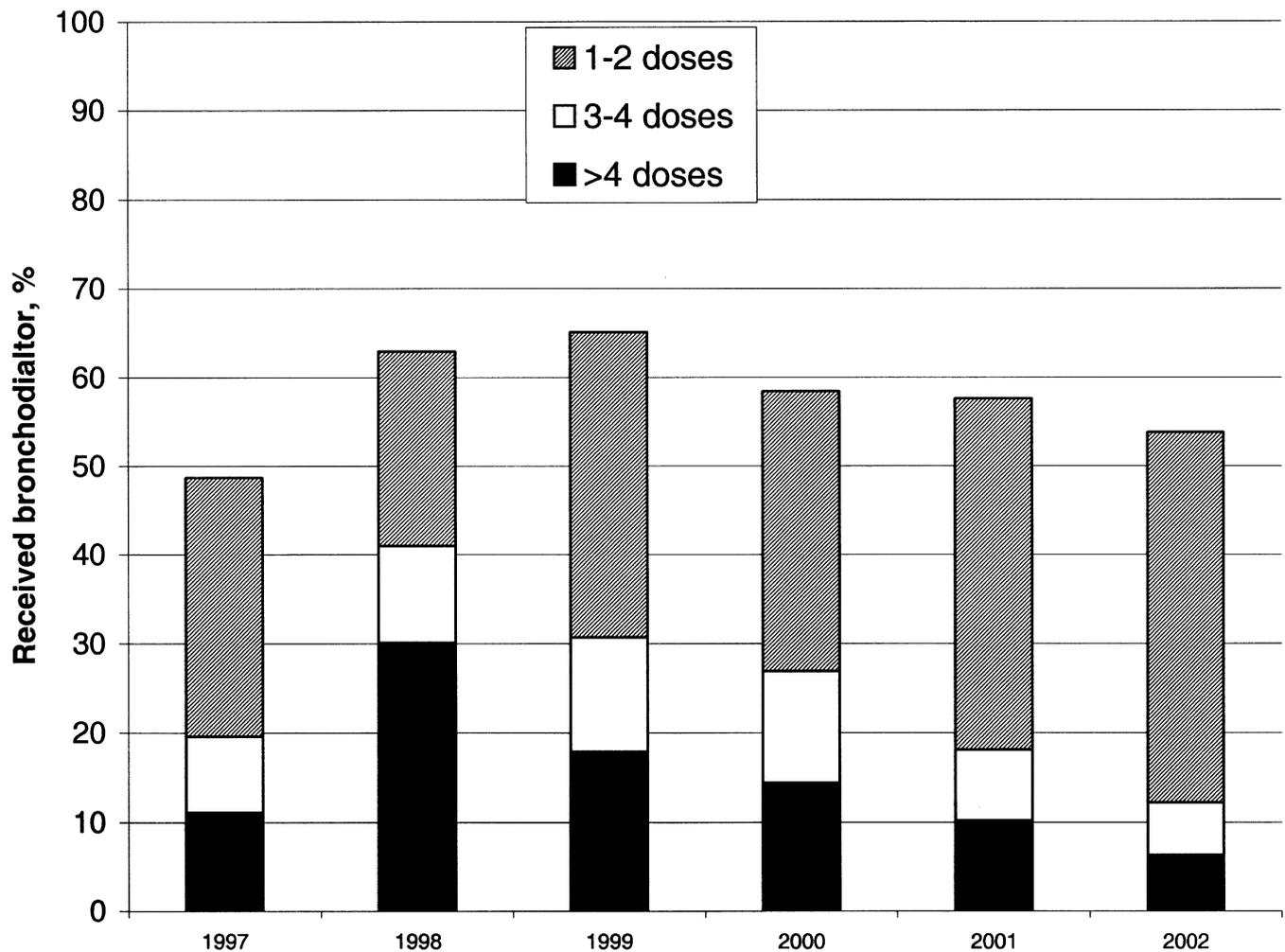


Fig 1. Intensity of bronchodilator treatment.

CL = 0.793, 1.633) in 2002 was not significantly different from what was predicted by the year-to-year trends.

The decrease in resource use was seen primarily in the ED. In 2001 (the only prior year for which ED-exclusive data were available), 27% of infants with bronchiolitis received a nasopharyngeal wash for RSV in the ED. This decreased to 13% of eligible patients in 2002 ($P = .01$). The proportion of infants receiving an RSV wash after admission to the inpatient unit did not change significantly. Similarly, the proportion of infants receiving a chest radiograph or antibiotics after admission did not change significantly between 2001 and 2002.

Revisit and Readmission Rates

The odds of making a return ED visit (OR= 1.162, CL = 0.306, 4.415) or being readmitted within 7 days (OR= 0.976, CL = 0.381, 2.505) of discharge were not significantly different from what was predicted by the trend of the previous years.

Twenty-one of the guideline-eligible patients discharged with a diagnosis of bronchiolitis during the study periods of 2001 and 2002 were readmitted within 7 days of discharge.

These patients were significantly younger (69 vs 104 days, $P = .002$) than patients who were not readmitted. All 21 patients met discharge criteria when discharged the first time, and 90% met admission criteria at the time of readmission.

DISCUSSION

Our hypothesis was that development and use of evidence-based, point-of-care instruments, specific to the site of care, would result in a decrease in unwarranted variation. In bronchiolitis care, less variation would be demonstrated by a decrease in resource utilization. The team believed that real improvement would require tools specific to each of the four decision points and that these tools should be developed by those who would use them. In addition, they believed that use of the evidence-based instruments should be as simple and easy as possible. The significant reductions in bronchodilator use, RSV tests, and chest radiographs we observed support this approach.

The most significant change was found in care delivered in the ED. The staff ordered half the number of RSV wash tests compared with the prior year, and the use of chest

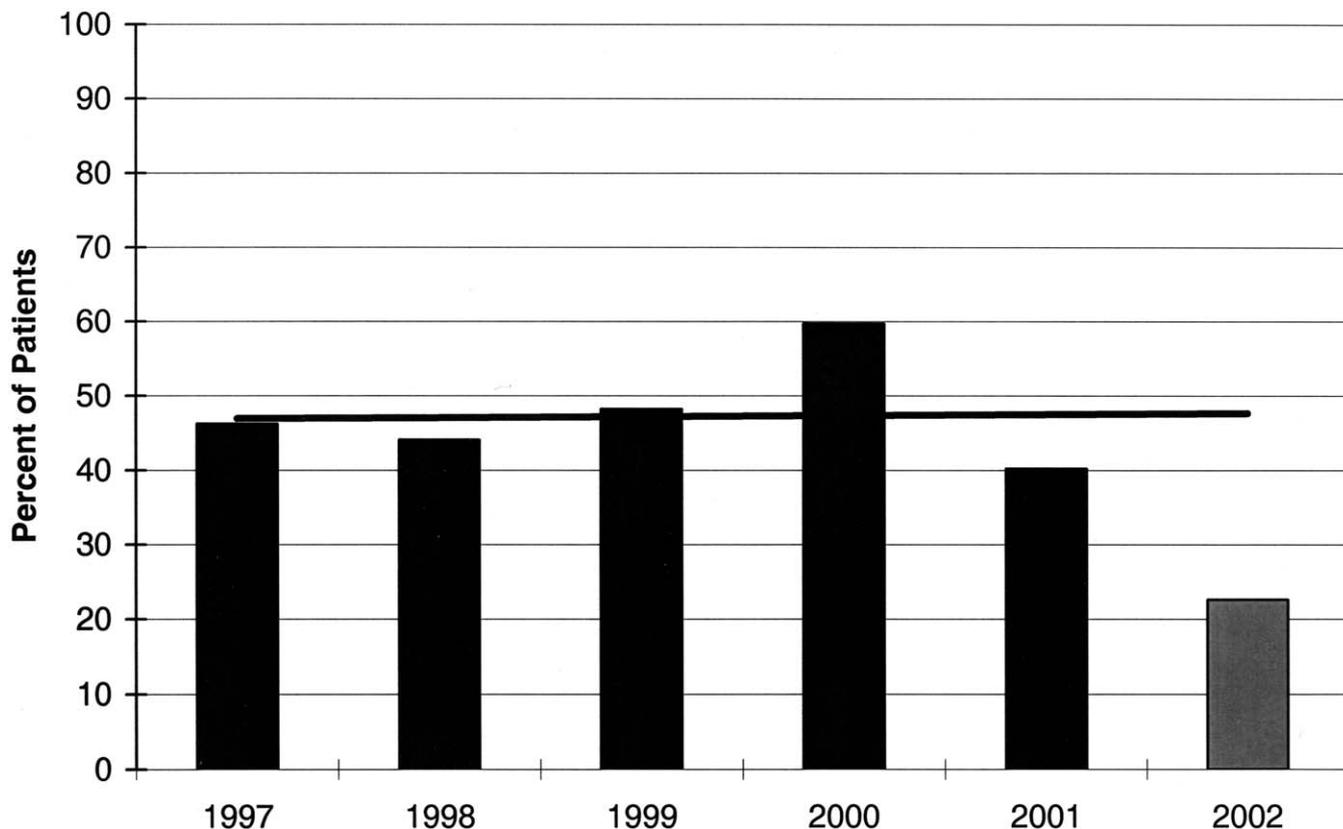


Fig 2. Proportion of patients receiving nasopharyngeal wash for RSV. *Line* represents trend over time.

radiography was also significantly decreased. At our institution, most infants with bronchiolitis are admitted through the ED, and most tests and therapies are initiated there. The algorithm for care was developed by ED physicians and therefore “owned” by the group. Chest radiographs and RSV washes were not seen as standard options because they were not included on the care algorithm. In addition, the algorithm was placed with the chart; therefore, it was visible at the point of care. The provider did not need to find the algorithm for each new patient; in a busy facility, the team thought this was crucial to “make the right thing the easy thing.”²²

Similarly, the respiratory therapists developed a respiratory assessment form and recommendations specific to bronchiolitis that stressed measuring the efficacy of the initial bronchodilator dose before administering more. Subsequently, the percentage of patients receiving multiple bronchodilators dropped. The therapists developed strong “buy-in” to the changes, working throughout the bronchiolitis season to refine their approach and reinforce acceptance of their recommendations. This resulted in the sharing of a consistent and concrete way of demonstrating the effectiveness of bronchodilator therapy, taking concept to action.

The standard order set for inpatient care was developed to establish care based on guideline recommendations. Use of the order set was seen as convenient and timesaving for the admitting house officer. By the time the admitting officer evaluated the patient, the order set was on the chart, ready for review, clarification, and signature.

To help community physicians determine which children with bronchiolitis needed hospitalization, standard admission criteria were developed and disseminated. However, the overall number of admissions did not decrease, and the percentage of admissions that met admission criteria did not increase. This lack of effect may in part be due to an admission rate that was already low. In 2002, the bronchiolitis admission rate for the 8-county metropolitan area surrounding our institution was 19.7 in 100,000 infants. This compares to a national rate of 25 in 100,000.²³ Our team expects that community office instruments will have more effect with conditions for which there is a higher percentage of admissions that do not meet admission criteria.

For evidence-based guidelines and point-of-care tools to work, patients or parents must understand and accept treatment recommendations. Parents are considered an integral part of improving care and were included on the guideline revision team and as members of our Pursuing Perfection team, closely involved in planning and monitoring. In addition to the tools for providers, we also developed an evidence-based parent pathway and information sheets. We did not directly measure the effect of these instruments on parent expectation or behavior; however, we do expect that parent knowledge of evidence-based recommendations will affect provider behavior.

One of the limitations of our study is that we did not use a randomized approach. In trying to affect provider behavior and the culture of care, we thought it would be nearly

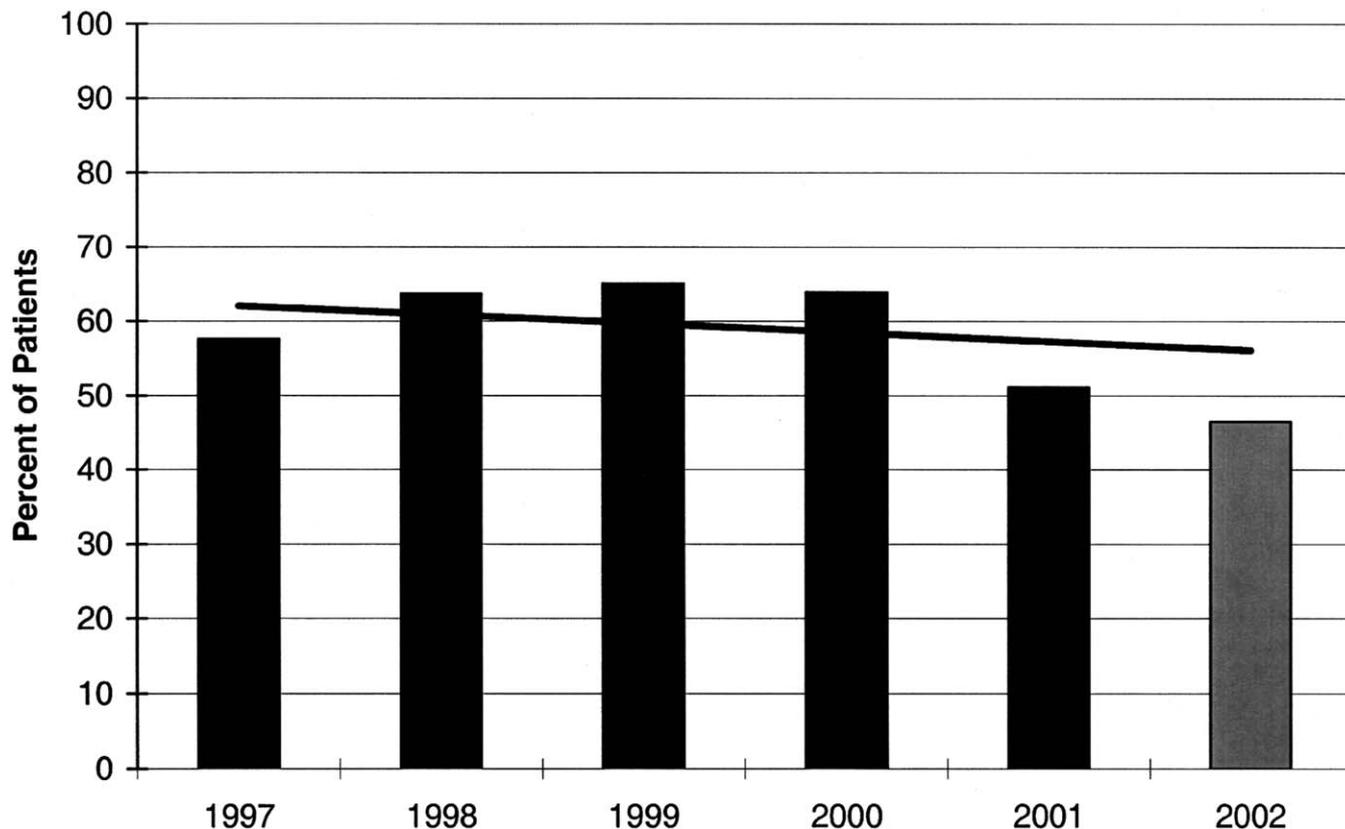


Fig 3. Proportion of patients receiving chest radiography. Line represents trend over time.

impossible to have a separate study population. Additionally, we had a 5-year trend showing results prior to these new initiatives. In addition, our findings represent just a single bronchiolitis season and cannot address the sustainability of these instruments over time. We continue to collect data on guideline use.

There have been several other accounts of bronchiolitis guideline implementation.²⁴⁻²⁸ All report at least some initial decrease in resource utilization, especially the use of bronchodilator treatment, with no perceived or measured decrease in quality of care. However, most concluded that substantial numbers of bronchodilator treatments are still being ordered. Implementation in these reports ranged from simple mailing, publication, and posting of the guideline to various staff in-services and educational sessions. Although we have used several of these methods in the past, the results of this study suggest that with a high level of organizational commitment and clinician leadership, organizations can significantly increase guideline adherence by helping front-line clinicians develop their own point-of-care tools based on available evidence, providing timely feedback on important outcome measures, soliciting, and heeding user input and being available to help identify barriers and design rapid solutions. The use of evidence must be made easy for the users, and we believe the users know best how to improve their systems of care delivery.

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