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Clinical Trial Paper

A quality improvement intervention to reduce emergency department radiography for bronchiolitis☆

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ABSTRACT

Introduction: Bronchiolitis is one of the most common infectious diseases in children and the most frequent cause of hospitalization in infants. Clinical practice guidelines recommend that a chest X-ray (CXR) should not be routinely obtained in the diagnosis of bronchiolitis, as studies have shown that they do not affect clinical outcomes, but rather lead to overuse of pharmacological agents and a longer length of hospital stay.
Objective: To determine whether active institution of bronchiolitis practice guidelines as part of a quality improvement project decreased the use of CXRs in the Pediatric Emergency Department (ED). Secondary outcomes included a decrease in the use of unnecessary medical interventions and a shorter mean hospital length of stay.
Methods: The study was conducted at two Hadassah Medical Center Pediatric EDs. Guidelines were reviewed with the ED staff during departmental seminars by a senior pediatric pulmonologist, and posted at the physician computer stations in the ED. Prospective, post-intervention, data obtained during the study period was compared to retrospective, pre-intervention, data from the year prior to implementation of the intervention.
Results: Post-intervention, 37% of patients vs. 58% in the retrospective cohort had a CXR via ED referral ($p < 0.001$). The use of hypertonic saline and bronchodilators decreased, while there was no significant change in antibiotic or corticosteroid use. There was a decrease in hospitalizations post-intervention (70% vs. 77%, $p = 0.05$).
Conclusion: This key intervention was successful in reinforcing the AAP guidelines, promoting greater cost-effectiveness, reducing radiation exposure, and saving valuable time and resources for the ED staff and the hospital.

1. Introduction

Bronchiolitis, an acute viral inflammation of the lower respiratory tract, is one of the most common infectious diseases in children [1] and the most frequent cause of hospitalization in infants [2]. The public health burden of bronchiolitis is significant. In Israel, respiratory syncytial virus (RSV) bronchiolitis was found to represent 7–9% of all pediatric admissions between the months of November and March. During the peak months, these admissions may even reach 20–40% of the pediatric ward bed occupancy [3]. The diagnosis of bronchiolitis is based on the patient's history and physical examination, typically presenting with signs and symptoms such as cough, shortness of breath, wheezing, retractions, tachypnea and crackles [4].

Since respiratory symptoms are the hallmark of the disease, many physicians tend to order chest X-rays (CXR), especially in the emergency department (ED), where radiography is easily available. However, the 2014 clinical practice guideline, published by the American Academy of Pediatrics (AAP), recommended that routine CXRs should not be obtained in the diagnosis of bronchiolitis [5] as studies had shown that they did not affect patient clinical outcomes, but rather led to overuse of antibiotics and a longer length of hospital stay [6–9]. The AAP further established that routine use of antibiotics, bronchodilators, epinephrine, corticosteroids, chest physiotherapy and laboratory studies was not recommended. However, implementation of

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these recommendations is not universal [10].

Previous studies have documented the value of quality improvement (QI) interventions in achieving the recommended management of acute bronchiolitis [1,2]. Pooled analysis of interventions that included the reduction of CXRs favored the intervention but reported variable results [11–15].

Since a prior survey (unpublished data) showed a high frequency of CXR use in infants presenting to the ED with bronchiolitis in our institution, we initiated an intervention aimed at reducing the overuse of CXR in order to improve the treatment of these infants.

Quality interventions may serve as a "gateway" promoting increased compliance with other guideline recommendations [16]; therefore, secondary objectives of the current study were to determine the effect of the CXR-focused intervention on the use of unnecessary blood tests and pharmacological interventions, as well as the effect on hospital length of stay. Finally, we wanted to determine which clinical and/or laboratory parameters nevertheless correlated directly with radiography use.

2. Methods

2.1. Study design

This was a prospective cohort study in two pediatric emergency departments (Hadassah Ein Kerem [EK] and Hadassah Mount Scopus [MS], Jerusalem, Israel). The intervention was performed in the ED during the peak season of bronchiolitis, between November 2015 and March 2016.

The post-intervention study population was compared with a pre-intervention control population from the parallel bronchiolitis season of the preceding year (2014–2015). Bronchiolitis was defined by the presence of a primary ICD-9 code. The sole exclusion criterion was age younger than one month.

2.2. Intervention design

A formal educational session, focused on reviewing the AAP and the Israel Society of Pediatric Pulmonology bronchiolitis guidelines, with emphasis on those sections on CXR, was held for all pediatric residents and pediatric senior physicians with clinical duties in the ED. The session was led by two pediatric pulmonology specialists (JR and MCC), and was held immediately preceding the bronchiolitis season, on November 1st, 2015. Additionally, radiography guideline cards were positioned alongside every computer screen and throughout the ED physician stations. These guideline cards stated that routine CXR is not indicated in non-severe bronchiolitis, as well as a list of conditions wherein a CXR should be considered. Such conditions included a toxic-looking or lethargic infant, a respiratory rate greater than 70 breaths per minute, respiratory distress, substantial use of accessory breathing muscles, a persistent blood oxygen saturation of less than 92%, or significant hypercapnia. The guideline cards concluded with a statement emphasizing that despite the aforementioned recommendations, the ED physicians should not hesitate to order a CXR if their clinical judgement called for it. Routine follow-up with the ED staff was conducted throughout the bronchiolitis season as well as during sign-out meetings and on pulmonary consultations. In addition, two pediatric pulmonologists, JR and MCC, were available at all times to answer questions, as stated on the guideline cards.

At the end of the intervention year, patient charts from both the ED and, when relevant, the subsequent hospitalization, were reviewed and comprehensive data on each patient was analyzed.

2.3. Data analysis

The Chi square and the Fisher's exact test were used to test the association between two categorical variables. The comparison of quantitative variables between two categories of a categorical variable was performed using the *t*-test. The Pearson correlation coefficient was calculated for assessing the strength of the linear association between two quantitative variables. The variables which were found to be significantly associated with the outcome variable were entered into a multivariate model of logistic regression for the dichotomous outcome variables, using the stepwise forward likelihood ratio method. All statistical tests were two-tailed and a p value of 0.05 or less was considered statistically significant. Statistical analysis was conducted using SPSS Statistics v.22 (IBM).

3. Results

A total of 544 diagnoses of bronchiolitis were made in the ED over the two bronchiolitis seasons, 224 in 2014–2015 and 320 in 2015–2016. Excluding infants that were less than one month old (10 cases and 18 cases respectively), as well as cases in which the primary complaint on ED admission was unrelated to bronchiolitis (7 cases and 4 cases respectively), a total of 505 cases were included in the final analysis, 207 pre-intervention and 298 post-intervention cases. The proportion of patients seen by each center was similar in the two time periods, with 127 (61.4%) pre-intervention patients and 181 (60.7%) post-intervention patients at Hadassah MS, and 80 (38.6%) pre-intervention patients and 117 (39.3%) post-intervention patients at Hadassah EK.

In terms of demographics and background, the pre- and post-intervention groups were similar in terms of gender, vaccination status, preterm birth, background disease, and family history of asthma (Table 1). The average age in our post-intervention group was significantly younger than in the pre-intervention group (5.7 ± 4.87 vs. 7.9 ± 5.39 months, $p < 0.0001$).

We compared the symptoms and physical examination findings between the two groups in order to confirm a similar patient clinical presentation in both groups, and found that both groups had similar findings on presentation, including duration of symptoms prior to presentation. The five most common presenting symptoms were (in

Table 1
Demographics and health characteristics of the study population.

	Total	Pre-intervention	Post-intervention	p Value
Hadassah Mount Scopus, n (%)	308 (61)	127 (61.4)	181 (60.7)	0.89
Hadassah Ein Kerem, n (%)	197 (39)	80 (38.6)	117 (39.3)	0.89
Age, months, (mean ± SD)	6.61 ± 5.21	7.9 ± 5.39	5.7 ± 4.87	**< 0.0001**
Female (%)	40.2	44	37.6	0.15
Children in family, number (mean ± SD)	3.02 ± 1.84	3.1 ± 2.05	2.9 ± 1.67	0.2
Vaccinated (%)	87.7	88.9	86.8	0.37
Preterm (%)	14.3	13.5	14.8	0.07
Family history of asthma (%)	16.9	18	16.2	0.66
Any background disease (%)	15.2	17.4	13.8	0.06

SD: standard deviation.