

Variability in Inpatient Management of Children Hospitalized With Bronchiolitis



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ABSTRACT

OBJECTIVE: To determine the variability between hospitals in diagnostic testing and management interventions for children with bronchiolitis admitted to inpatient wards and identify its association with patient characteristics.

METHODS: A prospective, multicenter (16 hospitals), multi-year (2007–2010) observational study of children (age <2 years) hospitalized with bronchiolitis. Outcomes included variability in diagnostic testing (complete blood count, chest radiographs) and medications or interventions (bronchodilator, systemic corticosteroid, antibiotic, IV placement) by hospital. A modified Respiratory Distress Severity Score was utilized to assess severity of illness. For all outcomes, intraclass correlation coefficient (ICC) was calculated from a model to estimate the random effects of hospital without added covariates and compared to ICCs from a second model that adjusted for demographic and clinical patient characteristics. A second unadjusted and adjusted model was created for age ≥ 2 months.

RESULTS: Of 2207 subjects, 1715 were identified as admitted to inpatient wards. We observed wide variations in the propor-

tion of patients who received diagnostic testing (complete blood count 21–75%, chest radiograph 36–85%) and medications/interventions (bronchodilators 19–91%, systemic corticosteroids 8–44%, antibiotics 17–43%, IV placement 38–93%). Adjusting for demographic and clinical patient characteristics did not materially affect the proportion of variability attributable to hospitals (differences in ICCs with and without model adjustment <4%).

CONCLUSIONS: Wide variations in diagnostic test utilization and management interventions seen among children with bronchiolitis treated on the inpatient wards at 16 US hospitals were not attributable to demographic or clinical patient characteristics. These results further support efforts to standardize care for bronchiolitis through active quality improvement strategies.

KEYWORDS: bronchiolitis; intraclass correlation coefficient; hospitalization; quality of care; variation

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WHAT'S NEW

Variation in diagnostic testing and management has been described for multiple disease processes. This study demonstrates that such variation is not driven by demographic and clinical patient characteristics, including disease severity and fever, among children hospitalized with bronchiolitis.

GROWING DEMANDS FOR health care infrastructures to deliver better quality of care, and concurrently better outcomes, have dominated a national agenda, partly as a result of the cost of health care in the United States; in particular, national expenditures for hospital care exceeded \$760 billion in 2009 and continues to rise.¹ Wide variations in practice, including variations in diagnostic testing and therapy may contribute to high costs of care² without any increase in quality outcomes.³ Bronchiolitis, the leading

cause of hospitalization in infants, provides an example of how reducing variation in practice has demonstrated improved quality outcomes and reduced costs in pediatric inpatient settings.^{4,5}

An evidence base insufficient to conclusively define the utility of chest radiographs, complete blood cell (CBC) counts, antibiotics, or the optimal approach to delivery of β -agonist therapy has driven expert opinion and national consensus guideline development.^{6–8} Wide variations in emergency department (ED) practice have been demonstrated using clinical quality metrics or resource utilization indicators.^{9–11} Similarly, variability in admission, discharge decisions, and therapy have contributed to variability in the rate of admission and length of stay.¹² Isolated efforts at minimizing variation in these settings have demonstrated decreases in inpatient treatment variation and improved outcomes for bronchiolitis.¹³ The extent of variation between hospitals and its

relationship to patient specific characteristics, including clinical risk factors, remains uncertain.

We analyzed data from a prospective multicenter, multi-year study of more than 2000 children. We sought to determine the variability between hospitals in diagnostic testing and management interventions for children with bronchiolitis admitted to inpatient wards. We hypothesized that there would be wide variations in diagnostic testing and treatments at the 16 hospitals and that these differences would be unrelated to demographic or clinical patient characteristics, including severity of illness and fever.

METHODS

STUDY DESIGN

We conducted a prospective cohort study during the 2007 to 2010 winter seasons as part of the Multicenter Airway Research Collaboration (MARC), a program of the Emergency Medicine Network (EMNet) (<http://www.emnet-usa.org>). The study design and methods have been described previously.¹⁴ Briefly, 13 to 16 hospitals in 12 US states enrolled children hospitalized with bronchiolitis over 3 years utilizing a standardized protocol of identifying consecutive hospitalized patients. All institutions were large urban hospitals with academic affiliations that provided a variety of specialty services/expertise for pediatric patients but had varied census sizes and work flow infrastructures. We included all children age <2 years with an attending physician diagnosis of bronchiolitis.

The institutional review board at all participating hospitals approved the study. The consent and data collection forms were available in English and Spanish.

DATA COLLECTION

Investigators conducted structured interviews and chart reviews to gather data from the preadmission evaluation (defined as occurring in the ED, clinic or primary care visit preceding the admission) and the clinical course on the inpatient wards. These data were manually reviewed at the EMNet Coordinating Center, and hospital investigators were queried about missing data and discrepancies.

To examine the variability in inpatient care among children hospitalized for bronchiolitis, we identified all non-intensive care unit patients who were admitted to the observation unit, inpatient ward, or stepdown unit and did not receive an intensive care unit intervention (ie, continuous positive airway pressure or intubation); they are referred to here as inpatients. Of 3910 eligible children from 16 hospitals, 2207 subjects (56%) were enrolled in the parent study, of whom 1715 (78%) were identified as in-

patients. A median number of 120 patients (interquartile range 87–130) were enrolled at each of the hospitals; no statistical difference in hospital enrollment totals was noted.

To evaluate bronchiolitis severity among participants, a modified Respiratory Distress Severity Scores (RDSS) was calculated with a maximum possible summed score of 8. In contrast to the RDSS described in a previous study,¹⁵ the modified RDSS retained the categorization of retractions and respiratory rate by age, but dichotomized wheezing and simplified the assessment of aeration (Table 1). The initial preadmission RDSS (rather than RDSS at other times in the management) was utilized to account for the influence of initial decision making by providers on the subsequent preadmission and inpatient diagnosis and treatment.

Nasopharyngeal aspirates were collected using a standardized protocol described elsewhere.¹⁴

STATISTICAL ANALYSES

All analyses were performed by Stata 13.0 (StataCorp, College Station, Tex). Data are presented as proportions with 95% confidence intervals (CI), medians with ranges or interquartile ranges, or means with 95% CIs. To assess the variability in inpatient care, unadjusted association between study hospital and other factors were examined by chi-square test, Fisher's exact test, ANOVA, and Kruskal-Wallis tests, as appropriate.

All *P* values were 2-tailed, with *P* < .05 considered statistically significant. Imputed values, calculated with the Stata impute command, were used to calculate the RDSS when 1 of the components was missing (*n* = 192); patients missing data for more than 1 component (*n* = 100) were not assigned an RDSS value. When comparing results of the imputed RDSS variable to the nonimputed RDSS variable (calculated from children who had complete data), there was no material difference observed (data not shown). Thus, all presented RDSS results were obtained using the imputed version of the variable.

Multilevel mixed effects logistic regression models that specify hospital-specific random effects were generated to assess between-hospital variability with and without adjustment for demographic and clinical patient characteristics. For each diagnostic test or management intervention, we first created a reduced model to estimate the random effects of the hospital, evaluating the between-hospital differences alone. A second, full model was created for all outcomes to estimate hospital effects while additionally adjusting for patient characteristics (demographic characteristics included were age, sex, race, insurance, and estimated median household income by zip code

Table 1. Modified Respiratory Distress Severity Score (RDSS)*

Score	Respiratory Rate, bpm		Wheezing	Air Entry	Retractions
	Age 0–11.9 mo	Age 12–23.9 mo			
0	≤40	≤30	No	None	None
1	41–55	31–45	...	Mild	Mild
2	>55	>45	Yes	Moderate or severe	Moderate or severe

*Total score: 0–4 mild; >4 moderate to severe.

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