

Predictors of Critical Care and Mortality in Bronchiolitis after Emergency Department Discharge

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Objectives To identify the epidemiologic predictors and stratify the risk of critical care unit (CCU) admission or death in bronchiolitis following emergency department discharge. This information has not yet been explored.

Study design A population-based cohort study using Ontario-wide demographic and healthcare databases linked at the individual level. We assessed all infants with bronchiolitis discharged home from all emergency departments in Ontario, Canada, 2003-2014. Targeted information included plausible demographic and clinical predictors of CCU admission/death within 14 days of emergency department discharge. Using multivariable logistic regression analyses, we identified independent predictors of this outcome and stratified the outcome risk by the type of multivariable predictor.

Results Of 34 270 study infants, 102 (0.3%) were admitted to CCU or died after discharge. Predictors of CCU admission/death were: comorbidities (OR 5.33; 95% CI 2.82-10.10), younger age [months] (OR 1.47; 95%CI 1.33-1.61), low income (OR 1.53; 95% CI 1.01-2.34), younger gestational age [weeks] (OR 1.14; 95%CI 1.06-1.22), and emergent presentation (Canadian Triage and Acuity Scale 2) at the index visit (OR 1.55, 95% CI 1.03-2.33). The absolute event risk of CCU admission/death in infants with versus without comorbidities were 1.5% versus 0.26%, respectively ($P < .001$). The odds of these outcomes in infants with comorbidities plus ≥ 2 other predictors were 25 times higher than in infants without predictors (OR 25.1, 95% CI 11.4-55.3).

Conclusions Infants with comorbidities plus other predictors discharged from the emergency department with bronchiolitis are at considerable risk of subsequent CCU admission and death. These risk factors should augment current clinical and social considerations determining patient disposition. (*J Pediatr* 2018;■■■:■■■-■■■).

Bronchiolitis is the leading cause of infant hospitalizations and critical care unit (CCU) admission in the United States, with incurred annual costs in excess of \$500 million.¹⁻³ Annually, bronchiolitis accounts for 17 hospitalizations, 55 emergency department visits, and 132 office visits for every 1000 children in the general population.¹

Although most infants with bronchiolitis have a benign disease course, some experience a fulminant progression. In the United States, approximately 13% of infants with bronchiolitis discharged to home from an emergency department return to the hospital within the subsequent 2 weeks, and almost one-half of these patients are admitted to the hospital.⁴ Importantly, some returning patients require CCU admission or succumb to the disease.⁵ Although previous research focused on estimates of bronchiolitis mortality and patient disposition at the time of the index emergency department visit,⁵⁻¹⁶ no data are available on the proportion and epidemiologic characteristics of infants with bronchiolitis who are discharged from the emergency department and deteriorate shortly thereafter and either die at home or return to the hospital and require care in the CCU. This information is important to enhance clinical decisions regarding disposition of vulnerable infants with bronchiolitis who are at risk of severe outcomes shortly after emergency department discharge.

The primary objective of this study was to identify the risk and epidemiologic predictors of CCU admission or death within 14 days of emergency department discharge for bronchiolitis. Secondary objectives were to compare the proportion of infants with and without comorbidities who experience subsequent CCU admission or death from bronchiolitis and to stratify the risk of this outcome according to the type of predictors.

Methods

We conducted a population-based cohort study of infants residing in Ontario, Canada (approximate population 13.6 million in 2014). We assessed all infants

BORN Better Outcomes Registry & Network
CCU Critical care unit
CTAS Canadian Triage and Acuity Scale

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with bronchiolitis discharged to home from all emergency departments in Ontario between April 1, 2003, and March 31, 2014.

We used health administrative and demographic data housed at the Institute for Clinical Evaluative Sciences. The databases are linkable at the patient level using anonymous encoded identifiers. We used the Canadian Institute for Health Information National Ambulatory Care Reporting System and Discharge Abstract Database to obtain comprehensive data for all emergency department visits and hospitalizations, respectively. We used the Ontario Health Insurance Plan database to obtain physician claims data, the Better Outcomes Registry & Network (BORN) perinatal database (with data for infants born between April 1, 2006, and March 31, 2012 available for linkage) to capture maternal health-related behavior, and the Ontario Registrar General Death database to establish cause of death.¹⁷ The Registered Persons Database, a registry of all Ontario residents with publicly-funded health insurance, served to capture additional demographic information. This study was approved by the Research Ethics Boards of Sunnybrook Health Sciences Centre and The Hospital for Sick Children, both in Toronto, Ontario.

Study Subjects

We identified children aged <12 months who presented to the emergency department with acute bronchiolitis (International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Canada code J21 or J12.1) between April 1, 2003, and March 31, 2014. For infants diagnosed with bronchiolitis at multiple emergency department visits, only the first visit was selected, to minimize contamination with possible asthma episodes. We included only infants managed by a physician and discharged home from the emergency department and excluded patients who left without seeing a physician, left after seeing a physician without treatment, left against medical advice, or were admitted to the hospital.

All triaged emergency department patients are routinely assigned the validated Canadian Triage and Acuity Scale (CTAS) score,^{18,19} indicating the urgency with which the patient needs care, ranging from 1 to 5 points, with CTAS 5 corresponding to a nonurgent status and CTAS 1 corresponding to the need for resuscitation. Because the patients assigned CTAS 1 virtually always require hospitalization, only infants with a CTAS score of 2-5 (emergent assessment through a nonurgent status) were included.

Outcomes

The primary outcome was a composite outcome of either CCU admission or death within 14 days of discharge from the emergency department. Because hospitalizations represent a broad range of disease severity impacted by multiple factors, such as social circumstances and access to follow-up, we focused our study exclusively on infants with serious outcomes—those who received high-intensity care or died shortly after index emergency department discharge. For infants admitted to a CCU, additional characteristics were ascertained from the hospitalization record, including length of CCU stay and the use of

mechanical ventilation (intervention code 1.GZ.31 or Ontario Health Insurance Plan billing codes G557-G559 and G405-G407). We excluded CCU admissions and deaths attributed to external causes of injury, such as falls and traffic crashes (International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Canada codes V01-Y36), within 14 days of emergency department discharge. The outcome-free group comprised infants who had bronchiolitis but did not die and were not admitted to the CCU within 14 days of emergency department discharge.

Predictors of Subsequent CCU Admission or Death

We examined the following patient-level risk factors: age in months, sex, low income (in the lowest neighborhood income quintile), rural residence (as a proxy for access to care), gestational weeks at time of birth, small-for-gestational-age status,²⁰ and major comorbidities. The latter was defined as the presence of any of 31 complex chronic conditions, as described previously,²¹ diagnosed before the index emergency department visit. Infants were classified as having at least 1 comorbidity versus none. The CTAS score of the index emergency department visits was used to flag “emergent” (CTAS score of 2) visits, as a measure of baseline severity. We also stratified the risk of subsequent CCU admission or death in infants with no comorbidities versus those with comorbidities plus other significant predictors versus infants with no predictors.

We ascertained maternal-related risk factors including maternal age and parity at time of infant birth by linking infant hospital birth records to the corresponding maternal delivery records. By further linking maternal-infant record pairs to the BORN perinatal database, we obtained information about maternal smoking during pregnancy and initiation of breastfeeding, which were available exclusively for infants born between April 1, 2006, and March 31, 2012.

Statistical Analyses

Baseline characteristics were compared between those who did versus those who did not experience the outcome (CCU admission or death within 14 days of emergency department discharge) using the χ^2 and Kruskal-Wallis tests for categorical and continuous variables, respectively. We used univariate logistic regression to estimate crude associations between each risk factor and the odds of CCU admission or death. A multivariable logistic regression model using variables selected *a priori* based on their clinical and demographic relevance²² was used to estimate the adjusted associations between risk factors and the odds of CCU admission or death. Adjusted associations for maternal smoking and breastfeeding risk factors were estimated with a model fit to a subset of the data linked to the BORN perinatal database. Finally, we identified previously healthy patients, infants without comorbidities and those with comorbidities who also had ≤ 1 and ≥ 2 other multivariable predictors. We used logistic regression analysis to estimate the association between these patient categories and the odds of CCU admission or death. We also calculated the absolute risk and 95% CIs of the outcome for each subgroup.

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