Prenatal Versus Postnatal Tobacco Smoke Exposure and Intensive Care Use in Children Hospitalized With Bronchiolitis

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Abstract

Objective: Among children hospitalized with bronchiolitis, we examined the associations between in utero exposure to maternal cigarette smoking, postnatal tobacco smoke exposure, and risk of admission to the intensive care unit (ICU).

Methods: We performed a 16-center, prospective cohort study of hospitalized children aged <2 years with a physician admitting diagnosis of bronchiolitis. For 3 consecutive years, from November 1, 2007 until March 31, 2010, site teams collected data from participating families, including information about prenatal maternal smoking and postnatal tobacco exposure. Analyses used chi-square, Fisher's exact, and Kruskal-Wallis tests and multivariable logistic regression.

Results: Among 2207 enrolled children, 216 (10%) had isolated in utero exposure to maternal smoking, 168 (8%) had isolated postnatal tobacco exposure, and 115 (5%) experienced both. Adjusting for age, sex, race, birth weight, viral etiology, apnea, initial severity of retractions, initial oxygen saturation, oral intake, and postnatal tobacco exposure, children with in utero exposure to maternal smoking had greater odds of being admitted to the ICU (adjusted odds ratio [aOR] 1.51, 95% confidence interval [CI] 1.14–2.00). Among children with in utero exposure to maternal smoking, those with additional postnatal tobacco exposure had a greater likelihood of ICU admission (aOR 1.95, 95% CI 1.13–3.37) compared to children without postnatal tobacco smoke exposure (aOR 1.47, 95% CI 1.05–2.04).

Conclusions: Maternal cigarette smoking during pregnancy puts children hospitalized with bronchiolitis at significantly higher risk of intensive care use. Postnatal tobacco smoke exposure may exacerbate this risk. Health care providers should incorporate this information into counseling messages.

Keywords: bronchiolitis; cigarette smoking; intensive care unit; respiratory syncytial virus; tobacco

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What's New

Maternal cigarette smoking during pregnancy puts children hospitalized with bronchiolitis at significantly higher risk of requiring intensive care. Postnatal tobacco smoke exposure may exacerbate this risk. Health care providers should incorporate this information into counseling messages.

In the United States, bronchiolitis causes approximately 290,000 emergency department (ED) visits each year. Approximately 26% of these children are admitted to the hospital, with a median hospital length of stay of 2 to 3 days. Although the overall mortality rate is low, 3% to 5% of infants with bronchiolitis who visit the ED require mechanical ventilation and admission to the intensive care unit (ICU).[1]

Annually, 22,000 hospitalizations related to respiratory syncytial virus (RSV) bronchiolitis are attributable to parental cigarette smoking, a costly and preventable cause of morbidity and mortality.[2] In 2006, the United States Surgeon General summarized the evidence surrounding involuntary tobacco smoke exposure (TSE) and lower respiratory infections such as bronchiolitis in young children. Across studies from diverse settings, infants exposed to parental cigarette smoking after birth are at increased risk of lower respiratory infection,[3] possibly due to inhibition of the interferon β and γ–mediated response to viral infection in airway epithelium.[4,5] In addition, in utero TSE adversely affects developing lungs, causing structural changes and

limitations in air flow.[3,6–9] The surgeon general's report noted a paucity of data examining the effects of in utero and postnatal smoke exposure separately.[3]

To address this information gap, we investigated the association between prenatal smoke exposure and bronchiolitis, stratified by postnatal smoke exposure, in a large multicenter prospective cohort of hospitalized children with bronchiolitis. Recently, our group found that prenatal smoke exposure was an independent predictor of severe bronchiolitis, as defined by mechanical ventilation.[10] Given this important finding and the lack of data about the health effects of prenatal in relation to postnatal smoke exposure, in this analysis, we examined the relationship between smoke exposure and bronchiolitis severity in more detail by exploring both pre- and postnatal smoke exposure and by broadening the outcome to include all ICU admissions. We specifically focused on the risk of admission to an ICU among children with in utero exposure to maternal smoking, stratified by postnatal TSE.

METHODS

STUDY DESIGN

We performed a planned secondary analysis of data collected during a prospective, multicenter cohort study. The original study was conducted during the 2007 to 2010 winter seasons (November through March) at 16 large urban pediatric teaching hospitals as part of the Multicenter Airway Research Collaboration (MARC), a program of the Emergency Medicine Network (EMNet) (www.emnet-usa.org/). MARC members are listed in the Appendix. The enrollment period was limited to months in which the diagnosis of bronchiolitis is most common in order to best characterize its epidemiology. As previously described, site investigators used a standardized protocol to enroll a target number of consecutive children with bronchiolitis age <2 years from the inpatient ward and ICU, with purposeful oversampling of ICU patients.[11] All patients were treated at the discretion of the treating physician. Inclusion criteria were an attending physician's diagnosis of bronchiolitis, age <2 years, and the ability of the parent/guardian to provide informed consent. Patients were enrolled within 18 hours of admission. The exclusion criteria were previous enrollment or transfer to a participating hospital >48 hours after the original admission time. The consent and data collection forms were translated into Spanish. The institutional review boards at all participating hospitals approved the study.

DATA COLLECTION

During the prospective cohort study, investigators conducted a structured interview during the index hospitalization that assessed patients' demographic characteristics, medical and environmental history, duration of symptoms, and details of the acute illness. Interviews were conducted by site primary investigators, research nurses, and/or study coordinators using standardized case report forms. All study personnel had standardized training before local data collection. Medical records were reviewed to obtain clinical data from the preadmission evaluation (clinic or ED) and the child's inpatient course, including respiratory status, initial oxygen saturation at triage, medical management, and disposition. Data were submitted electronically to the EMNet Coordinating Center, where manual review for quality assurance was performed. On the basis of these checks, sites submitted any missing data and/or corrected discrepant data.

Prenatal TSE was determined using the following question: "Did the mother of [*child*] smoke cigarettes during the pregnancy?" Postnatal TSE was determined using the following question: "Does anyone who lives with [*child*], or who sees [*child*] on a regular basis, or who takes care of [*child*] in your house or somewhere else, *ever* smoke while in the same room as [*child*]?"

NASOPHARYNGEAL ASPIRATE COLLECTION AND VIROLOGY TESTING

Nasopharyngeal aspirates were performed within 24 hours of a child's arrival on the ward or medical ICU using a standardized protocol and shipped on dry ice to Baylor College of Medicine.[11] Polymerase chain reaction (PCR) assays were conducted as singleplex or duplex 2-step real-time PCR (rtPCR). Real-time reverse transcriptase PCR was used for the detection of RNA respiratory viruses, which included RSV types A and B, human rhinovirus (HRV), parainfluenza virus types 1, 2, and 3, influenza virus types A and B, 2009 novel H1N1, human metapneumovirus, coronaviruses NL-63, HKU1, OC43, and 229E, and enterovirus. rtPCR was used for the detection of DNA pathogens that included adenovirus, *Mycoplasma pneumoniae,* and *Bordetella pertussis*.[12–14]

STATISTICAL ANALYSES

All analyses were performed by Stata 12.0 (Stata Corp, College Station, Tex). Data are presented as proportions with 95% confidence intervals (CIs) and medians with interquartile ranges. We performed unadjusted analyses using chi-square, Fisher's exact, and Kruskal-Wallis tests, as appropriate. All P values are 2-tailed, with $P < .05$ considered statistically significant.

Multivariable logistic regression was conducted to evaluate independent predictors of a hospitalization requiring an ICU stay at any time during the admission, with prenatal and postnatal tobacco exposure the key exposures of interest. Other factors were tested for inclusion in the model if they were found to be associated with the outcome in unadjusted analyses ($P < .20$, eg, birth weight[15]) or were considered to be of potential clinical significance (eg, infant age). Variables were evaluated in the multivariable models in the same form as analyzed in the unadjusted analysis (ie, continuous vs categorical). The final multivariable model accounts for potential clustering by site, with results reported as odds ratios with 95% CIs.

RESULTS

Among 2207 enrolled children, 14 were missing data for one (n = 12) or both (n = 2) of the smoke exposure