Reportable Bacterial Infections among New York City-Born Infants, 2001-2009

Beth M. Isaac, MPH[1,2], Abbey Masonbrink, MD, MPH[3], Joseph Kennedy, MPH[3], Sharon K. Greene, PhD, MPH[1], Robin R. Hennessy, MPH[1,4], Jennifer B. Rosen, MD[1], Lisa Trieu, MPH[1], Stephanie Ngai, MPH[1], Stephen S. Morse, PhD[2], and Don Weiss, MD, MPH[1]

Objective To determine rates of reportable bacterial infections among infants in New York City and identify populations at risk and preventable causes of morbidity.

Study design This retrospective cohort study matched live births in New York City from 2001-2009 to reported cases of bacterial infections among infants less than 1 year of age. Characteristics recorded on birth certificates were compared between infants with bacterial enteric infection, bacterial nonenteric infection, and no reportable bacterial infection. Multinomial logistic regression and multivariable logistic regression were used to identify risk factors for infection.

Results Bacterial infection was reported in 4.6 cases per 1000 live births. Of 4524 infants with a reportable infection, the majority (2880, 63%) had an enteric infection. Asian/Pacific Islanders in Brooklyn were the borough-level race/ethnic group with the highest enteric infection rate (8.5 per 1000 live births). Citywide, infants with enteric infections were disproportionately male, from higher poverty neighborhoods, born to foreign-born mothers, and enrolled in Special Supplemental Food Program for Women, Infants, and Children or Medicaid. In contrast, infants with nonenteric infections were more likely to have low birthweight and mothers characterized by US birth and black race or white Hispanic race/ethnicity.

Conclusions Distinct patterns of risk factors for enteric and nonenteric bacterial infections among infants were identified. The results suggest that infants born to Asian/Pacific Islander mothers residing in Brooklyn should be a focus of enteric disease prevention. More research is necessary to better understand what behaviors increase the risk of enteric disease in this population. *(J Pediatr 2016;174:218-25).*

The New York City (NYC) Department of Health and Mental Hygiene (DOHMH) collects surveillance data on over 80 reportable infections, over one-half of which are bacterial infections; however, the rates and risk factors for these infections among infants are largely unknown.[1] Infections remain an important source of infant mortality, and bacterial sepsis ranks among the top 10 causes of infant death in the US.[2-4] Of the nationally notifiable diseases reported to the Centers for Disease Control and Prevention in 2009, bacterial infections comprised the 5 most frequent infections among infants under 1 year of age, with the highest incidence reported for salmonellosis (128.6 per 100 000 infants).[5] In addition, group B *Streptococcus* (GBS) was noted in 2 nationwide studies as the most common pathogen responsible for sepsis in term infants within 7 days of birth.[6,7]

Disparities in the burden of bacterial infant infection exist by race, ethnicity, and socioeconomic status (SES). Non-Hispanic black infants have a greater risk of neonatal sepsis and sepsis-associated mortality.[7,8] Reported risk factors for salmonellosis among infants include lower household income, black race, and Hispanic ethnicity; risk factors for GBS include black race and young maternal age.[9-14]

Studies typically focus on identifying risk factors for individual diseases, but grouping diseases together for analysis might improve power to reveal additional risk factors or shared approaches for intervention. Analyzing information on reportable bacterial infections collected by DOHMH could identify preventable causes of morbidity and mortality and distinguish populations at risk to direct interventions, ultimately improving the health of NYC infants. This study estimated the incidence of reportable bacterial infections among NYC-born infants and identified potential risk factors for morbidity.

DOHMH	Department of Health and Mental Hygiene
GBS	Group B *Streptococcus*
NICU	Neonatal intensive care unit
NYC	New York City
SES	Socioeconomic status
WIC	Special Supplemental Food Program for Women, Infants, and Children

Methods

This retrospective cohort study included singleton live births from January 1, 2001 through December 31, 2009 to mothers living in NYC. All confirmed and probable cases of bacterial infections reported to DOHMH for infants in NYC diagnosed from January 1, 2001 through December 31, 2010 were de-duplicated, compiled, and matched with the NYC birth registry maintained by DOHMH. This project was approved by DOHMH (13-015) and Columbia University (AAAL 9273) institutional review boards.

The primary outcome was the diagnosis of a reportable bacterial infection during the first year of life (under 365 days). Age of infant at time of infection was based upon birth certificate date of birth and reported date of diagnosis (with the exception of pertussis, for which date of onset was used). Reportable infections were classified according to Council of State and Territorial Epidemiologists case definitions; DOHMH case definitions were used for diseases with no Council of State and Territorial Epidemiologists case definition.[1,15]

Bacterial infections were categorized as either enteric diseases given a common oral portal of entry (botulism, campylobacteriosis, hemolytic uremic syndrome, listeriosis, salmonellosis, Shiga toxin-producing *Escherichia coli*, shigellosis, typhoid fever, and yersiniosis) or nonenteric diseases as a comparison for the enteric diseases (chlamydia, congenital syphilis, gonorrhea, invasive group A streptococcal infection, invasive GBS infection, invasive *Haemophilus influenzae* (all serotypes) infection, latent tuberculosis infection, active tuberculosis disease, Lyme disease, meningococcal disease, bacterial meningitis [other than meningococcal], and pertussis). Diseases not reportable throughout the entire study period (eg, methicillin-resistant *Staphylococcus aureus* and invasive *Streptococcus pneumoniae*) were excluded from this study. Infants with both enteric and nonenteric infections were analyzed in the enteric group. Of the diseases included in this study, vaccination for pertussis and *Haemophilus Influenzae* type b is recommended by the US Advisory Committee for Immunization Practices within the first year of life.[16]

Birth registry matching was conducted based on the infant name, parental names, address of residence, phone numbers, and sex, and was manually reviewed (**Appendix 1**; available at www.jpeds.com). Reports of infant infections that did not match to birth records because of birth outside of NYC or insufficient information were excluded from the study. To ensure all infants in the study could be considered viable and, therefore, susceptible to infection, infants who died on the same day as birth and were either born weighing below 500 g or before a gestational age of 24 weeks were excluded.[17]

Potential risk factors investigated were drawn from birth records and included both infant and maternal factors: sex, birthweight, gestational age, chorioamnionitis, placenta previa, fever during labor or delivery, prepregnancy hypertension, gestational hypertension, prenatal care, delivery method, prolonged rupture of membranes, prepregnancy diabetes, gestational diabetes, and infant admission to the neonatal intensive care unit (NICU) on the day of birth. Maternal demographics such as race/ethnicity, Special Supplemental Food Program for Women, Infants, and Children (WIC) or Medicaid enrollment, borough of residence, location of birth, neighborhood (census tract-level) poverty, and education level were also included. Data coded as unknown were considered missing. Variables are defined in **Appendix 2** (available at www.jpeds.com).

Statistical Analyses

Incidence over the study period was calculated as all cases of reportable bacterial infections per 1000 live births from 2001-2009. Annual incidence was calculated as the number of reportable bacterial infections per 1000 live births by year of birth. Multinomial logistic regression was used to determine the association between each factor and the 3-level outcome of bacterial enteric infection, bacterial nonenteric infection, and no reportable bacterial infection (reference level). To adjust for covariates specific to each outcome, statistically significant risk factors in bivariate analyses were used to fit 2 separate multivariable logistic models, one for the outcome of reported enteric bacterial infection and the other for reported nonenteric bacterial infection. To assess whether race/ethnicity effects were driven by distinct subpopulations, interaction terms between race/ethnicity and WIC/Medicaid enrollment, foreign birth, neighborhood poverty, and borough of maternal residence were tested in each model. Because the relative timing of NICU admission and diagnosis of infection on the day of birth could not be determined, the association between infection and NICU admission was assessed both including and excluding infants with infection diagnosed on the day of birth. Final models were chosen by comparing the Akaike information criterion and significance of the likelihood ratio test after the addition of each variable. Variables were added in decreasing order of magnitude of association and increasing P value. No evidence of multicollinearity between covariates was found using tolerance and variance inflation factor cut points of 10% and 10, respectively. Hosmer and Lemeshow goodness of fit tests were conducted for both final models. For all analyses, the level of statistical significance was P value of <.05. Analyses were conducted using SAS v 9.2 (SAS Institute Inc, Cary, North Carolina).

Results

Of infants reported to DOHMH with a reportable bacterial infection during 2001-2009, 82.5% matched with birth records. Infants were excluded from analysis if they were born to mothers with unknown or non-NYC residence (n = 86 767), had a reported diagnosis date prior to date of