Published in final edited form as:

Obstet Gynecol. 2010 June ; 115(6): 1217–1224. doi:10.1097/AOG.0b013e3181dd916f.

Adherence to Perinatal Group B Streptococcal Prevention Guidelines

William P. Goins, MD, MPH, Thomas R. Talbot, MD, MPH, William Schaffner, MD, Kathryn M. Edwards, MD, Allen S. Craig, MD, Stephanie J. Schrag, DPhil, Melissa K. Van Dyke, PhD, and Marie R. Griffin, MD, MPH

From the Division of Infectious Diseases, Department of Medicine, Baylor College of Medicine, Houston, Texas; the Department of Medicine, Divisions of Infectious Diseases and General Internal Medicine and Public Health, and the Departments of Preventive Medicine and Pediatrics, Vanderbilt Vaccine Research Program, Vanderbilt University School of Medicine, Nashville, Tennessee; the Tennessee Department of Health, Communicable and Environmental Disease Services, Nashville, Tennessee; and the Respiratory Diseases Branch, Division of Bacterial and Mycotic Disease, Centers for Disease Control and Prevention, Atlanta, Georgia

Abstract

OBJECTIVE—To estimate compliance with the 2002 revised perinatal group B streptococci (GBS) prevention guidelines in Tennessee, which recommend universal GBS screening of pregnant women at 35–37 weeks of gestation and, when indicated, administration of intrapartum chemoprophylaxis.

METHODS—Active Bacterial Core surveillance conducts active, population-based surveillance for invasive GBS disease in 11 Tennessee counties. A retrospective case-cohort study was conducted using a stratified random sample of all live births in surveillance hospitals during 2003–2004, including all early-onset GBS cases. Factors associated with GBS screening and lack of optimal GBS chemoprophylaxis were analyzed using logistic regression.

RESULTS—Screening was performed for 84.7% of pregnant women, but 26.3% of prenatal tests with documented test dates were performed before 35 weeks of gestation. Among women with an indication for GBS prophylaxis, 61.2% received optimal chemoprophylaxis, defined as initiation of a recommended antibiotic 4 hours or more before delivery. When the analysis was restricted to women who were admitted 4 hours or more before delivery, 70.9% received optimal chemoprophylaxis. Women not receiving optimal chemoprophylaxis were more likely to have penicillin allergy (11.7% compared with 2.5%, adjusted odds ratio [OR] 8.58, 95% confidence interval [CI] 1.57–47.04) or preterm delivery (45.5% compared with 13.2%, adjusted OR 5.52, 95% CI 2.29–13.30) and were less likely to have received the recommended prenatal serologic testing for other infectious diseases (77.9% compared with 91.1%, adjusted OR 0.30, 95% CI 0.09–0.98). Forty cases of early-onset GBS were identified (0.36 per 1,000 live births); 25% of these neonates were born to women who received screening at 35 weeks of gestation or later and, when indicated, optimal chemoprophylaxis.

© 2010 by The American College of Obstetricians and Gynecologists. Published by Lippincott Williams & Wilkins.

Corresponding author: William Goins, MD, MPH, 1709 Dryden Road, Suite 6.15, BCM 620, Houston, TX 77030; goins@bcm.edu. Dr. Craig's current affiliation is Malaria Branch, Division of Parasitic Diseases, National Center for Zoonotic, Vector-Borne and Enteric Disease, Centers for Disease Control and Prevention, Atlanta, Georgia.

Financial Disclosure

Dr. Talbot received money for a consultancy through Joint Commission Resources and received donated vaccine from Sanofi-Pasteur for a CDC-funded research study. The other authors did not disclose any potential conflicts of interest.

CONCLUSION—Universal prenatal GBS screening was implemented widely in Tennessee, although the timing of screening and administration of chemoprophylaxis often were not optimal. A substantial burden of early-onset GBS disease occurs despite optimal prenatal screening and chemoprophylaxis, suggesting that alternative strategies, such as vaccination, are needed.

LEVEL OF EVIDENCE—II

Group B streptococci (GBS) is the most common cause of neonatal sepsis, with both early and late presentations. Based on previous studies that showed that intrapartum antibiotic prophylaxis was effective in reducing early-onset disease (ie, first 6 days of life),¹ national consensus guidelines were issued in 1996 for prevention of perinatal GBS disease.² These initial guidelines recommended using either screening or a risk-based approach to identify women who should receive intrapartum chemoprophylaxis. After a subsequent study demonstrated that the screening approach reduced the risk of early-onset GBS disease by 54% when compared with the risk-based approach,³ revised guidelines were issued in 2002 that recommended screening all pregnant women for vaginal and rectal colonization with GBS between 35 and 37 weeks of gestation.⁴ The revised guidelines also recommended intrapartum chemoprophylaxis for women with a positive screening culture for GBS; women with unknown colonization status presenting with any of the following risk factors: delivery at less than 37 weeks of gestation, intrapartum temperature 38°C or higher, and rupture of membranes 18 hours or more before delivery; and women with a prior child with early-onset GBS disease or with GBS bacteruria during their current pregnancy. However, routine intrapartum chemoprophylaxis to prevent early-onset GBS disease was not recommended for women with intact amniotic membranes undergoing a planned cesarean delivery performed before onset of labor, regardless of the mother's colonization status, because of an extremely low risk for transmission of GBS to the newborn.

In a prior study, Eisenberg et al estimated the adherence to the initial 1996 guidelines in Tennessee women.⁵ Only 43% of these women underwent prenatal GBS screening in 1998–1999, and several cases of early-onset GBS disease occurred in neonates born to women with an indication for GBS chemoprophylaxis but who failed to receive optimal intrapartum chemoprophylaxis. The objective of the current study was to estimate adherence to the revised 2002 perinatal GBS prevention guidelines in Tennessee. The primary outcomes of interest were the proportion of women who underwent GBS screening and the proportion of women with an indication for GBS chemoprophylaxis who received optimal intrapartum chemoprophylaxis. Additionally, factors associated with GBS screening and lack of optimal chemoprophylaxis were estimated.

MATERIALS AND METHODS

Active Bacterial Core surveillance, sponsored by the Centers for Disease Control and Prevention (CDC), conducts active, population-based laboratory surveillance for invasive GBS disease⁶ in 11 Tennessee counties, which includes the state's four major cities (Memphis, Nashville, Knoxville, and Chattanooga) and the counties surrounding Nashville with a combined population of 2,818,711 (50% of the state's population).⁷ The study population consisted of all live births to surveillance-area residents during 2003 and 2004 who delivered at area hospitals with 10 births or more per year. The Tennessee data are part of a national retrospective case-cohort study conducted by the CDC to characterize adherence to perinatal GBS prevention guidelines.⁸ A random sample of all live births in study counties stratified by birth hospital and year was obtained from the Tennessee Office of Vital Records. Within each stratum, a weight was assigned to each birth according to the inverse of the probability of being selected. All births of neonates with early-onset GBS disease were included in the sample and assigned a weight of 1. Adjusting for the stratified sampling design by assuming a design effect of 1.5 based on a prior similar study,³ a sample

size of 600 births was required to calculate a 95% confidence interval (CI) no wider than 10 percentage points for a variable with a proportion equal to 50%. Additional details of the sampling method and data abstraction have been published previously.⁸ The institutional review boards of the Tennessee Department of Health, Vanderbilt University, and the CDC deemed the study exempt from review.

A case of early-onset GBS disease was defined by the isolation of GBS from a normally sterile site (eg, blood or cerebrospinal fluid) in a neonate younger than 7 days of age born to a woman living in the surveillance area. Preterm delivery was defined as delivery at less than 37 weeks of gestation. Intrapartum GBS risk factors were defined as preterm delivery, intrapartum temperature 38°C or higher, and rupture of membranes 18 hours or more before delivery. Adequacy of prenatal care was determined by the Kessner Index, which categorizes prenatal care as inadequate, intermediate, or adequate based on the timing of the initiation of prenatal care, the gestational age at delivery, and the number of prenatal visits.⁹ Women for whom the Kessner Index could not be determined because of missing data were categorized as having inadequate prenatal care. Screening for GBS was defined as any test for GBS colonization performed before admission for delivery or on admission 2 days or more before delivery. Collection techniques, including site of culture, could not be evaluated. Intrapartum was defined as the period between the onset of labor or rupture of membranes and delivery. For neonates delivered by cesarean, intrapartum was defined as the period between hospital admission for delivery and cord clamping.

Optimal GBS prophylaxis was defined as initiation of intrapartum penicillin or ampicillin 4 hours or more before delivery.⁴ For this analysis, we also considered cefazolin and vancomycin optimal in women who were allergic to penicillin if these agents were initiated 4 hours or more before delivery based on previous studies showing adequate umbilical cord plasma concentrations.^{10,11} Use of clindamycin or erythromycin for GBS prophylaxis was not considered optimal because susceptibility to these agents was not determined for the GBS isolate from prenatal screening.⁴

Variables evaluated for association with adherence to screening included maternal age, race, and ethnicity; urban region of residence; previous live birth; illicit drug use; medical insurance status; prior child with GBS disease or presence of GBS bacteruria during the current pregnancy; adequacy of prenatal care; and prenatal screening for other recommended infectious diseases by serologic testing (human immunodeficiency virus, hepatitis B virus, syphilis, and rubella) and cervical swabbing (gonorrhea and *Chlamydia*). Three maternal-age strata (younger than 20 years, 20–34 years, and 35 years or older) were created to compare results with previous data.⁵ All women were included in the primary analysis of screening, but only those with an indication for GBS chemoprophylaxis were included in analyses of optimal chemoprophylaxis. Routine GBS chemoprophylaxis is not recommended for women undergoing a planned cesarean delivery in the absence of membrane rupture or labor. Therefore, women who delivered by cesarean were included in analyses of chemoprophylaxis if delivery occurred 4 hours or more after amniotic membrane rupture, when chemoprophylaxis clearly is warranted. When estimating adherence to recommendations for GBS chemoprophylaxis, penicillin allergy, preterm delivery, and delivery method were included in the model. Because we were interested in maternal and obstetric factors other than current indications for GBS chemoprophylaxis, the presence of a prior child with GBS or GBS bacteruria during the current pregnancy was removed from the model of GBS chemoprophylaxis.

Analyses were conducted using the sample weights. Data were analyzed with Stata (Intercooled 9, Stata Corporation, College Station, TX) to account for the stratified survey design. Weighted values are reported. Categorical variables were compared using Pearson ²

tests, and a two-tailed *P* value of less than .5 was considered statistically significant. Factors associated with GBS screening and lack of optimal GBS chemoprophylaxis, according to the 2002 CDC guidelines, were analyzed using logistic regression. All factors included in the univariable analyses also were included in the multivariable regression models. Reported odds ratios (ORs) are the results of the multivariable regression model.

RESULTS

The records for 877 live births were selected randomly from a cohort of 84,998 births in the surveillance areas during 2003 and 2004.^{12,13} Overall, 84.7% (95% CI 81.8–87.5) of women underwent GBS screening (Table 1), and GBS was detected in 26.6% (95% CI 22.9–30.4) of screening tests. The date of screening was documented in the labor and delivery record for only 63.6% (95% CI 59.6–67.5) of prenatal GBS screening tests. When documented, prenatal screening was performed before 35 weeks of gestation in 26.3% of women (33–34.9 weeks in 18.1%, 30–32.9 weeks in 2.6%, and less than 30 weeks in 5.6%) and 6 weeks or more before delivery in 9.5%. Among women with prenatal GBS screening performed at less than 35 weeks, 17.5% (95% CI 8.4–26.7) had threatened or actual preterm labor. Screening for GBS was associated significantly with receipt of recommended prenatal serologic testing for other infectious diseases (87.8% compared with 64.6%, OR 2.64, 95% CI 1.64–4.26), adequate prenatal care (92.2% compared with 71.0% for inadequate prenatal care, OR 3.69, 95% CI 1.92–7.07), intermediate prenatal care (84.2%, OR 2.17 compared with inadequate prenatal care, 95% CI 1.11–4.23), and maternal age of 20 through 34 years (85.6% compared with 76.6% for maternal age younger than 20 years, OR 2.39, 95% CI 1.15–4.96). No significant associations were noted with race, ethnicity, urban region of residence, previous live birth, illicit drug use, medical insurance status, presence of GBS bacteruria or previous child with GBS disease, or prenatal cervical swabbing for other infectious diseases.

Among all vaginal deliveries and cesarean deliveries occurring 4 hours or more after amniotic membrane rupture, 30.2% (95% CI 26.1–34.3) of women had indication for GBS chemoprophylaxis. Among women with indications for GBS chemoprophylaxis, optimal intrapartum chemoprophylaxis was started 4 hours or more before delivery in only 61.2% (95% CI 53.2–69.1) of births (Table 2). Intrapartum penicillin or ampicillin was initiated less than 4 hours before delivery in an additional 16.9% (95% CI 10.5–23.3) of births. Intrapartum cefazolin was administered to 11.6% (95% CI 5.6 to 28.8) of women without penicillin allergies who delivered by cesarean. An inappropriate antibiotic also was administered in 4.9% (95% CI 0.6–9.1) of vaginal births because none of the women who received clindamycin had a GBS isolate from prenatal screening with documented clindamycin susceptibility, as recommended. Restricting the analysis to those women who were admitted to the hospital 4 hours or more before delivery (86.2%) yielded improved delivery of optimal intrapartum chemoprophylaxis (70.9%, 95% CI 62.8–79.1). Women who delivered vaginally were more likely to receive no intrapartum prophylaxis compared with those who delivered by cesarean (17.8% compared with 0.1%, *P* < .001). However, the proportion of women who were admitted to the hospital 4 hours or more before delivery—and therefore had adequate time to receive an intrapartum antibiotic anytime before delivery—was similar among women who delivered vaginally and by cesarean (87.2% compared with 72.5%, respectively, *P* = .27).

Overall, 38.8% (95% CI 30.9–46.8) of women with indications for GBS chemoprophylaxis did not receive optimal chemoprophylaxis (Table 2). Women not receiving optimal chemoprophylaxis were more likely to have penicillin allergies (11.7% compared with 2.5%, OR 8.58, 95% CI 1.57–47.04) and preterm delivery (45.5% compared with 13.2%, OR 5.52, 95% CI 2.29–13.30) and were less likely to have received the recommended

prenatal serologic testing for other infectious diseases (77.9% compared with 91.1%, OR 0.30, 95% CI 0.09–0.98). No significant associations were noted with age, race, ethnicity, urban region of residence, previous live birth, illicit drug use, medical insurance status, adequacy of prenatal care, delivery method, or prenatal cervical swabbing for other infectious diseases.

Active surveillance identified 40 cases of early-onset GBS disease in Tennessee during 2003 and 2004, for an overall incidence of 0.36 per 1,000 live births per year (Table 3). Twenty-one cases (52.5%) occurred in neonates who were born to women with negative screens for GBS. Fourteen of these 21 neonates were born to women with no risk factors. The timing of prenatal GBS screening was noted for 12 of the 21 women with negative screens for GBS, and screening occurred at 35 weeks of gestation or later in only five of these women. Because all 21 of these women had negative screens for GBS and lacked either a previous child with GBS disease or GBS bacteruria in the current pregnancy, GBS chemoprophylaxis was not indicated. Six neonates were born to women who did not have indication for GBS chemoprophylaxis because of unknown GBS status and lack of risk factors (Table 3). Thirteen neonates were born to women with indications for GBS chemoprophylaxis (ie, positive screen for GBS, unknown status with one or more intrapartum risk factor, or previous child with GBS disease), but only five of these women received optimal chemoprophylaxis (Tables 3 and 4). Among the eight women with indications for GBS prophylaxis but who did not receive optimal chemoprophylaxis, six delivered abruptly on admission with inadequate time to receive optimal chemoprophylaxis.

Twenty-six of the 40 neonates who developed early-onset GBS disease were born to women who delivered vaginally (0.33 per 1,000 live births). Among the 14 neonates born to women who delivered by cesarean, eight were born to women who had rupture of membranes 4 hours or more before delivery (0.83 per 1,000 live births) and six were born to women who had rupture of membranes less than 4 hours before delivery (0.27 per 1,000 live births).

DISCUSSION

Overall, GBS screening in Tennessee markedly improved from 43% of women in 1998–1999 to 85% in 2003–2004.⁵ This striking and encouraging increase in screening rates was coupled with the elimination of previously reported racial and regional differences in screening. Screening for GBS was associated significantly with the use of other recommended prenatal screening tests and greater prenatal care utilization. However, a substantial number of prenatal screens were performed before 35 weeks of gestation. The reasons for early screening were not documented. Although threatened or actual preterm labor occurred in 17.5% of women who had GBS screening performed at less than 35 weeks of gestation, this proportion was not different from that of the overall population (16.2%, 95% CI 12.9–19.5). Another possible reason for screening at less than 35 weeks of gestation is lack of provider familiarity with the screening recommendations, which could not be evaluated in this study. Lastly, the date of screening was not documented for 36.4% of prenatal GBS cultures, possibly overestimating the proportion of early prenatal cultures.

More than half of early-onset GBS disease in Tennessee occurred in neonates born to women with negative GBS screening tests, a finding that has been reported previously.¹⁴ One possible explanation is that 9.5% of prenatal cultures were performed 6 weeks or more before delivery. Because the sensitivity and negative predictive value of prenatal cultures collected 6 weeks or more before delivery are only 38% and 80%, respectively,¹⁵ some women who underwent screening early in pregnancy may not have been identified as being colonized with GBS, resulting in failure to receive optimal chemoprophylaxis. Other

possible reasons for a false-negative screening test are use of nonselective media and improper collection techniques, which could not be evaluated in this study.

Overall, 38.8% of women with indications for GBS chemoprophylaxis did not receive optimal chemoprophylaxis, including receipt of clindamycin without documented susceptibility. Others also have reported high rates of clindamycin use in penicillin-allergic women without documented susceptibility of the colonizing GBS strain.¹⁶ Because GBS resistance has increased in recent years, the use of clindamycin for chemoprophylaxis without documented susceptibility is not recommended.⁴ However, only 3.4% of all women with indications for chemoprophylaxis received clindamycin, so a reduction in clindamycin use is unlikely to affect the rate of early-onset GBS disease. Although administration of prophylactic antibiotics 4 hours or more before delivery results in decreased transmission of GBS to the neonate^{17,18} and decreased neonatal GBS disease,¹⁹ only 61.2% of women with indications for GBS chemoprophylaxis received optimal chemoprophylaxis 4 hours or more before delivery as recommended. Although providers are unable to adhere to this recommendation in women who deliver precipitately, only 70.9% of women who were admitted 4 hours or more before delivery and who could have received optimal chemoprophylaxis actually received it.

Women who delivered vaginally were more likely to receive no intrapartum prophylaxis compared with those who delivered by cesarean. Because the proportion of women admitted to the hospital 4 hours or more before delivery was similar among those who delivered vaginally and those who delivered by cesarean, lack of adequate time does not appear to be the reason for the failure to administer an intrapartum antibiotic to women who delivered vaginally. The difference in receipt of an intrapartum antibiotic by delivery method may be due in part to our exclusion of cesarean deliveries occurring less than 4 hours after rupture of membranes. Among women with indications for GBS prophylaxis who delivered by cesarean, 82.0% were excluded from the analysis of chemoprophylaxis because of rupture of membranes less than 4 hours before delivery. Among these women, 39.7% did not receive an intrapartum antibiotic. However, many of these women probably underwent a planned cesarean before the onset of labor or rupture of membranes, and GBS prophylaxis is not routinely recommended in this setting.

There are several limitations to this study. Data were obtained by review of medical records and Active Bacterial Core surveillance case reports, and documentation may have been incomplete. Births were studied primarily in urban counties, and practices in rural areas may be different. However, the study population was similar to that reported previously, allowing comparisons over time.^{3,5}

Further research is needed to address whether optimal intrapartum chemoprophylaxis is administered to women with indications for GBS prophylaxis who deliver by cesarean because confusion may exist between the use of chemoprophylaxis for prevention of early-onset GBS disease and prevention of surgical-site infections. Antibiotics were given at the time of delivery or immediately afterward in only 8.4% (data not shown) of all cesarean deliveries among women with indications for GBS chemoprophylaxis despite the ineffectiveness of this approach to prevent early-onset GBS disease. Because postpartum antibiotics were not abstracted routinely, this proportion is likely an underestimate. In previous years, surgical chemoprophylaxis for cesarean deliveries was delayed until the time of umbilical cord clamping because of concern of neonatal exposure to the antibiotic and the potential to mask neonatal sepsis. Recent studies have shown that administration of antibiotics before incision leads to no increase in neonatal sepsis, admission to the neonatal intensive care unit, or sepsis workup.^{20,21} Future guidelines should emphasize the appropriate selection and timing of prophylactic antibiotics for the prevention of both

surgical-site infections and early-onset GBS disease because antibiotics administered too long before incision are suboptimal for prevention of the former and too near incision are suboptimal for prevention of the latter.

Disturbingly, 10 of the 40 neonates (25%) with early-onset GBS disease were born to women who received the recommended prenatal screening at 35 weeks of gestation or later and, when indicated, optimal intrapartum chemoprophylaxis. The highest incidence of early-onset GBS disease occurred in neonates born to the 9.1% of women with negative screening tests but who had at least one risk factor. Indeed, early-onset GBS disease incidence in this group was similar to that reported for this same subgroup before recommendations for GBS chemoprophylaxis.²² Further consideration of additional prevention strategies for similar women is warranted if these findings are confirmed in other populations.

Encouragingly the incidence of early-onset GBS disease in Tennessee fell from 0.63 cases per 1,000 live births in 1998–1999 to 0.36 in 2003–2004 after the release of the revised guidelines for universal prenatal screening.⁵ In addition to revision of current recommendations and strategies to improve adherence to recommendations, further decreases in early-onset GBS disease may require additional preventive approaches such as vaccines. Group B streptococcal conjugate vaccines have been shown to be immunogenic and provide functional levels of capsular-specific immunoglobulin G in the neonates born to women vaccinated in the third trimester.²³ Immunization also potentially would affect late-onset neonatal disease and disease in adults. Adherence to established guidelines and rates of early-onset GBS disease should be reassessed periodically.

Acknowledgments

Supported by the Agency for Healthcare Research and Quality T32 HS 013833, the Vanderbilt-Sanofi Pasteur Healthcare Vaccinology and Epidemiology Training Program, Centers for Disease Control and Prevention Emerging Infections Program cooperative agreement U50/CCU416123-9, and the Max it Out Foundation.

The authors thank Paige Lewis, MSPH, Christina R. Phares, PhD, and Emily Weston, MPH, Centers for Disease Control and Prevention, Atlanta, Georgia, and Brenda Barnes, RN, CCRP, Jane Connors, RN, Amanda Faulk, RN, and Melinda Eady, Department of Preventive Medicine, Vanderbilt University School of Medicine, Nashville, Tennessee, for their assistance with abstraction and data management.

References

1. Boyer KM, Gotoff SP. Prevention of early-onset neonatal group B streptococcal disease with selective intrapartum chemoprophylaxis. *N Engl J Med*. 1986; 314:1665–9. [PubMed: 3520319]
2. Prevention of perinatal group B streptococcal disease: a public health perspective [published erratum appears in *MMWR Morb Mortal Wkly Rep* 1996;45:679]. *MMWR Recomm Rep*. 1996; 45:1–24.
3. Schrag SJ, Zell ER, Lynfield R, Roome A, Arnold KE, Craig AS, et al. A population-based comparison of strategies to prevent early-onset group B streptococcal disease in neonates. *N Engl J Med*. 2002; 347:233–9. [PubMed: 12140298]
4. Schrag S, Gorwitz R, Fultz-Butts K, Schuchat A. Prevention of perinatal group B streptococcal disease. Revised guidelines from CDC. *MMWR Recomm Rep*. 2002; 51:1–22. [PubMed: 12211284]
5. Eisenberg E, Craig AS, Gautam S, Khalil MM, Shaktour B, Schaffner W, et al. Beyond screening: identifying new barriers to early onset group B streptococcal disease prevention. *Pediatr Infect Dis J*. 2005; 24:520–4. [PubMed: 15933562]
6. Schuchat A, Hilger T, Zell E, Farley MM, Reingold A, Harrison L, et al. Active bacterial core surveillance of the emerging infections program network. *Emerg Infect Dis*. 2001; 7:92–9. [PubMed: 11266299]

7. U.S. Census Bureau. Census 2000 data for the state of Tennessee. Available at: <http://www.census.gov/census2000/states/tn.html>. Retrieved March 11, 2008
8. Van Dyke MK, Phares CR, Lynfield R, Thomas AR, Arnold KE, Craig AS, et al. Evaluation of universal antenatal screening for group B streptococcus. *N Engl J Med*. 2009; 360:2626–36. [PubMed: 19535801]
9. Kotelchuck M. An evaluation of the Kessner Adequacy of Prenatal Care Index and a proposed Adequacy of Prenatal Care Utilization Index. *Am J Public Health*. 1994; 84:1414–20. [PubMed: 8092364]
10. Fiore Mitchell T, Pearlman MD, Chapman RL, Bhatt-Mehta V, Faix RG. Maternal and transplacental pharmacokinetics of cefazolin. *Obstet Gynecol*. 2001; 98:1075–9. [PubMed: 11755556]
11. Laiprasert J, Klein K, Mueller BA, Pearlman MD. Transplacental passage of vancomycin in noninfected term pregnant women. *Obstet Gynecol*. 2007; 109:1105–10. [PubMed: 17470590]
12. Tennessee Department of Health. Number of live births with rates per 1,000 population, by race of mother, for counties of Tennessee, resident data. 2003. Available at: <http://health.state.tn.us/statistics/vital.htm>. Retrieved May 5, 2008
13. Tennessee Department of Health. Number of live births with rates per 1,000 population, by race of mother, for counties of Tennessee, resident data. 2004. Available at: <http://health.state.tn.us/statistics/vital.htm>. Retrieved May 5, 2008
14. Puopolo KM, Madoff LC, Eichenwald EC. Early-onset group B streptococcal disease in the era of maternal screening. *Pediatrics*. 2005; 115:1240–6. [PubMed: 15867030]
15. Yancey MK, Schuchat A, Brown LK, Ventura VL, Markenson GR. The accuracy of late antenatal screening cultures in predicting genital group B streptococcal colonization at delivery. *Obstet Gynecol*. 1996; 88:811–5. [PubMed: 8885919]
16. Matteson KA, Lievense SP, Catanzaro B, Phipps MG. Intrapartum group B streptococci prophylaxis in patients reporting a penicillin allergy. *Obstet Gynecol*. 2008; 111:356–64. [PubMed: 18238973]
17. de Cueto M, Sanchez MJ, Sampedro A, Miranda JA, Herruzo AJ, Rosa-Fraile M. Timing of intrapartum ampicillin and prevention of vertical transmission of group B streptococcus. *Obstet Gynecol*. 1998; 91:112–4. [PubMed: 9464732]
18. Wakimoto H, Yano H, Baba S, Okuzumi K, Okamoto N, Wakimoto Y, et al. Prevention of vertical transmission of group B streptococcus [Japanese]. *Kansenshogaku Zasshi*. 2005; 79:549–55. [PubMed: 16167786]
19. Lin FY, Brenner RA, Johnson YR, Azimi PH, Philips JB 3rd, Regan JA, et al. The effectiveness of risk-based intrapartum chemoprophylaxis for the prevention of early-onset neonatal group B streptococcal disease. *Am J Obstet Gynecol*. 2001; 184:1204–10. [PubMed: 11349189]
20. Sullivan SA, Smith T, Chang E, Hulsey T, Vandorsten JP, Soper D. Administration of cefazolin prior to skin incision is superior to cefazolin at cord clamping in preventing postcesarean infectious morbidity: a randomized, controlled trial. *Am J Obstet Gynecol*. 2007; 196:455.e1–5. [PubMed: 17466699]
21. Thigpen BD, Hood WA, Chauhan S, Bufkin L, Bofill J, Magann E, et al. Timing of prophylactic antibiotic administration in the uninfected laboring gravida: a randomized clinical trial. *Am J Obstet Gynecol*. 2005; 192:1864–8. [PubMed: 15970833]
22. Boyer KM, Gotoff SP. Strategies for chemoprophylaxis of GBS early-onset infections. *Antibiot Chemother*. 1985; 35:267–80. [PubMed: 3931544]
23. Baker CJ, Rench MA, McInnes P. Immunization of pregnant women with group B streptococcal type III capsular polysaccharide-tetanus toxoid conjugate vaccine. *Vaccine*. 2003; 21:3468–72. [PubMed: 12850362]

Table 1

Screening for Group B Streptococci in 11 Urban Counties in Tennessee, 2003–2004

Maternal Characteristic	No. of Women	Estimated No. of Women *	Screened [% (95% CI)]
All	877	110,089	84.7 (81.8–87.5)
Age (y)			
Younger than 20	110	11,573	76.6 (66.5–86.6)
20–34	662	83,754	85.6 (82.4–88.7)
35 or older	105	14,762	5.9 (76.9–94.8)
Race			
White	582	73,827	85.9 (82.3–89.4)
African American	262	31,678	81.6 (76.1–87.1)
Other/multiple	33	4,584	86.1 (73.8–98.4)
Ethnicity			
Non-Hispanic	774	97,425	86.5 (83.5–89.5)
Hispanic	103	12,664	70.3 (60.1–80.5)
Region of state			
A	401	44,203	84.0 (79.9–88.1)
B	282	34,324	82.6 (77.5–87.6)
C	125	18,159	92.9 (87.0–98.9)
D	69	13,403	81.1 (69.4–92.7)
Previous live birth			
None	336	43,174	88.5 (84.1–92.9)
1 or more	541	66,915	82.2 (78.4–86.0)
Illicit drug use			
No	855	107,737	85.0 (82.1–87.9)
Yes	22	2,352	68.8 (44.6–93.0)
Medical insurance			
Medicaid	325	38,564	82.7 (77.7–87.8)
Self-pay	33	3,856	56.3 (36.4–87.8)
Other	519	67,670	87.4 (83.8–90.9)
Antepartum risk factor			
GBS bacteruria or prior child with GBS	88	12,105	94.2 (88.8–99.6)
Neither	789	97,984	83.5 (80.3–86.6)
Adequacy of prenatal care †			
Inadequate/missing	253	29,647	71.0 (64.2–77.8)
Intermediate	198	24,941	84.2 (77.8–90.6)
Adequate	426	55,500	92.2 (88.9–95.4)
Serologic prenatal testing ‡			
Performed	733	95,117	87.8 (84.9–90.8)
Not performed	144	14,972	64.6 (55.1–74.2)
Cervical prenatal testing §			
Performed	618	83,675	87.5 (84.3–90.8)

Maternal Characteristic	No. of Women	Estimated No. of Women [*]	Screened [% (95% CI)]
Not performed	259	26,414	75.5 (69.2–81.8)

CI, confidence interval; GBS, group B streptococci.

^{*}Numbers are estimates made from weighted values of the sample. Individual counts may not sum to total number of women owing to rounding.

[†]Data are based on the Kessner Index, which categorizes prenatal care into inadequate, intermediate, and adequate on the basis of the timing of initiation of prenatal care, gestational age at delivery, and number of prenatal visits.

[‡]Prenatal testing for human immunodeficiency virus, hepatitis B virus, syphilis, and rubella.

[§]Prenatal testing for both gonorrhea and chlamydia.

Table 2
Group B Streptococcal Prophylaxis Among Women With Indications for Prophylaxis^{*,†}

Intrapartum Prophylaxis	Total (N=219)	Admitted 4 h or More Before Delivery (n=180)	Vaginal Delivery (n=202)	Cesarean Delivery [‡] (n=17)	Early-Onset GBS Disease (n=11)
Optimal [‡]	61.2 (53.2–69.1)	70.9 (62.8–79.1)	60.6 (52.4–68.9)	69.0 (36.2–101.9)	5 (0.31)
Suboptimal	38.8 (30.9–46.8)	29.1 (20.9–37.2)	39.4 (31.1–47.6)	31.0 (–1.9 to 63.8)	6 (0.58)
Intrapartum penicillin or ampicillin less than 4 h before delivery	16.9 (10.5–23.3)	9.8 (4.2–15.4)	16.7 (10.3–23.2)	19.2 (–12.9 to 51.3)	1 (0.22)
Inappropriate choice of intrapartum antibiotic ^{§//}	5.3 (1.2–9.4)	5.5 (0.9–10.1)	4.9 (0.6–9.1) [§]	11.6 (–5.6 to 28.8) ^{//}	0 (0.00)
None	16.7 (10.8–22.5)	13.8 (7.9–19.7)	17.8 (11.6–24.0)	0.1 (–0.1 to 0.3)	5 (1.13)

GBS, group B streptococci.

Data are % (95% confidence interval) or n (incidence per 1,000 live births).

Percentages are weighted to account for the sampling method and may not total 100% due to rounding.

* Group B streptococcal prophylaxis was indicated in 30.2% of women.

[†] Only those cesarean deliveries with membrane rupture occurring 4 hours or more before delivery were included.

[‡] Optimal prophylaxis is defined as initiation of intrapartum penicillin or ampicillin during the intrapartum period 4 hours or more before delivery. Cefazolin and vancomycin also were considered optimal in women who were allergic to penicillin if these agents were initiated 4 hours or more before delivery.

[§] Twelve penicillin-allergic women received either clindamycin without susceptibility testing (11) or levofloxacin (1) during the intrapartum period.

^{//} Two women without penicillin allergies received cefazolin during the intrapartum period.

Table 3

Early-Onset Group B Streptococcal Disease in 11 Urban Counties in Tennessee, 2003–2004

Maternal GBS Colonization	Risk Factors [*]		Total
	None	1 or More	
Negative [†]	14 (0.24)	7 (0.70)	21 (0.31)
Unknown	6 (0.63)	4 (0.51)	10 (0.58)
Positive	6 (0.49)	3 (0.24)	9 (0.36)
Total	26 (0.33)	14 (0.46)	40 (0.36)

GBS, group B streptococci.

Data are n (incidence per 1,000 live births).

^{*} Delivery at less than 37 weeks of gestation, intrapartum temperature 38°C or higher, rupture of membranes 18 hours or more before delivery, previous child with GBS disease, or GBS bacteruria during current pregnancy.

[†] Neonates who developed GBS were born to women screened at 35 weeks of gestation or later (5) and at less than 35 weeks of gestation (7) and to those missing the date of screening (9).

Table 4

Details of Obstetric Care For Neonates With Early-Onset Group B Streptococcal Disease Born to Women With Indications for GBS Prophylaxis

Indication for GBS Prophylaxis	Risk Factor(s) *	Timing of Event Before Delivery			Optimal GBS Prophylaxis
		Intrapartum Antibiotic	Admission (h)	Antibiotic Initiation (h)	
Positive screening test					
1	None	Ampicillin	18.0	17.5	Yes
2	None	Ampicillin	7.2	6.7	Yes
3	Intrapartum fever, prolonged rupture of membranes	Ampicillin	39.8	17.1	Yes
4	Preterm delivery (23.6 wk)	Penicillin	18.8	18.8	Yes
5	Preterm delivery (35.4 wk), prior child with GBS disease	Ampicillin	5.8	4.3	Yes
6	None	Ampicillin	3.4	2.1	No
7	None	Ampicillin	2.9	1.7	No
8	None	Penicillin	2.5	2.5	No
9	None	None	0.2	—	No
Unknown colonization status with a risk factor					
10	Preterm delivery (35.3 wk), prolonged rupture of membranes	None	25.7	—	No
11	Prior child with GBS disease	None	16.3	—	No
12	Preterm delivery (28.7 wk)	None	0.0	—	No
13	Preterm delivery (35.6 wk), prior child with GBS disease	None	0.0	—	No

GBS, group B streptococci.

* Risk factors include preterm delivery (ie, less than 37 weeks of gestation), intrapartum fever (38°C or higher), prolonged rupture of membranes (ie, 18 hours or more before delivery), previous child with GBS disease, or GBS bacteriuria during current pregnancy.