ORIGINAL ARTICLE

Evaluation of Universal Antenatal Screening for Group B Streptococcus

Melissa K. Van Dyke, Ph.D., Christina R. Phares, Ph.D., Ruth Lynfield, M.D., Ann R. Thomas, M.D., Kathryn E. Arnold, M.D., Allen S. Craig, M.D., Janet Mohle-Boetani, M.D., Ken Gershman, M.D., William Schaffner, M.D., Susan Petit, M.P.H., Shelley M. Zansky, Ph.D., Craig A. Morin, M.P.H., Nancy L. Spina, M.P.H., Kathryn Wymore, M.P.H., Lee H. Harrison, M.D., Kathleen A. Shutt, M.S., Joseph Bareta, M.P.H., Sandra N. Bulens, M.P.H., Elizabeth R. Zell, M.Stat., Anne Schuchat, M.D., and Stephanie J. Schrag, D.Phil.

ABSTRACT

BACKGROUND

Group B streptococcal disease is one of the most common infections in the first week after birth. In 2002, national guidelines recommended universal late antenatal screening of pregnant women for colonization with group B streptococcus to identify candidates for intrapartum chemoprophylaxis.

METHODS

We evaluated the implementation of the guidelines in a multistate, retrospective cohort selected from the Active Bacterial Core surveillance, a 10-state, population-based system that monitors invasive group B streptococcal disease. We abstracted data from the labor and delivery records of a stratified random sample of live births and of all cases in which the newborn had early-onset group B streptococcal disease (i.e., disease in infants <7 days of age) in 2003 and 2004. We compared our results with those from a study with a similar design that evaluated screening practices in 1998 and 1999.

RESULTS

We abstracted records of 254 births in which the infant had group B streptococcal disease and 7437 births in which the infant did not. The rate of screening for group B streptococcus before delivery increased from 48.1% in 1998–1999 to 85.0% in 2003–2004; the percentage of infants exposed to intrapartum antibiotics increased from 26.8% to 31.7%. Chemoprophylaxis was administered in 87.0% of the women who were positive for group B streptococcus and who delivered at term, but in only 63.4% of women with unknown colonization status who delivered preterm. The overall incidence of early-onset group B streptococcal disease was 0.32 cases per 1000 live births. Preterm infants had a higher incidence of early-onset group B streptococcal disease than did term infants (0.73 vs. 0.26 cases per 1000 live births); however, 74.4% of the cases of group B streptococcal disease (189 of 254) occurred in term infants. Missed screening among mothers who delivered at term accounted for 34 of the 254 cases of group B streptococcal disease (13.4%). A total of 61.4% of the term infants with group B streptococcal disease were born to women who had tested negative for group B streptococcus before delivery.

CONCLUSIONS

Recommendations for universal screening were rapidly adopted. Improved management of preterm deliveries and improved collection, processing, and reporting of culture results may prevent additional cases of early-onset group B streptococcal disease.

From the Epidemic Intelligence Service Program, Office of Workforce and Career Development, (M.K.V.D., C.R.P.), the Respiratory Diseases Branch, Division of Bacterial Diseases, National Center for Immunization and Respiratory Diseases (M.K.V.D., C.R.P., E.R.Z., S.J.S.), and the National Center for Immunization and Respiratory Diseases (A.S.) — all at the Centers for Disease Control and Prevention, Atlanta; the Minnesota Department of Health, St. Paul (R.L., C.A.M.); the Oregon Public Health Division, Portland (A.R.T.); the Georgia Department of Human Resources, Division of Public Health, Atlanta (K.E.A., S.N.B.); the Tennessee Department of Health, Nashville (A.S.C.); the California Emerging Infections Program, Oakland (J.M.-B., K.W.); the Colorado Department of Public Health and Environment, Denver (K.G.); Vanderbilt University School of Medicine, Nashville (W.S.); the Connecticut Department of Public Health, Hartford (S.P.); the Emerging Infections Program, New York State Department of Health, Albany (S.M.Z., N.L.S.); the University of Pittsburgh, Pittsburgh (L.H.H., K.A.S.); and the New Mexico Department of Health, Santa Fe (J.B.). Address reprint requests to Dr. Schrag at the Centers for Disease Control and Prevention, 1600 Clifton Rd. NE, MS C-23, Atlanta, GA 30333, or at zha6@cdc.gov.

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Invasive group B streptococcal disease emerged in the 1970s as a leading infectious cause of illness and death in the first week of life.[1] Clinical trials in the 1980s showed that early-onset group B streptococcal disease (i.e., occurring in infants <7 days of age) may be prevented by administering antibiotic prophylaxis during labor and delivery to mothers who are colonized with group B streptococcus.[2] During the 1990s, candidates for intrapartum chemoprophylaxis were identified according to either a screening-based or a risk-based strategy[3-5]; this approach led to a 65% decrease in the incidence of early-onset group B streptococcal disease, from 1.7 cases per 1000 live births in 1993 to 0.6 cases per 1000 live births by 1998.[6] In 2002, national guidelines were updated, shifting from a recommendation of either of these alternative strategies to a recommendation of universal culture-based screening of pregnant women.[7,8]

Universal screening was expected to result in further declines in the incidence of early-onset group B streptococcal disease,[9] and active population-based surveillance showed a 27% decrease in incidence, from 0.47 cases per 1000 live births in 1999–2001 to 0.34 cases per 1000 live births after the guidelines were issued.[10] However, preventable cases may contribute substantially to the remaining burden of disease. The screening approach to prevention is challenging because it requires screening women at 35 to 37 weeks' gestation, having test results available at the time of labor, and making provisions for appropriate clinical management in the case of women whose group B streptococcal colonization status is unknown.[11] Since 2002, two limited studies have suggested that the rate of screening increased after the issuance of the updated national guidelines.[12,13]

We conducted a multistate evaluation of the implementation of screening and chemoprophylaxis in a retrospective cohort selected from a population of more than 800,000 live births. We had three primary objectives: assess the implementation of the 2002 screening and chemoprophylaxis guidelines, examine missed opportunities for the prevention of group B streptococcal disease, and characterize the remaining burden of early-onset group B streptococcal disease to identify areas that might benefit from additional public health prevention measures.

METHODS

STUDY POPULATION

The Active Bacterial Core surveillance system, a component of the Emerging Infections Program Network, conducts active, population-based surveillance for invasive group B streptococcal disease in selected counties in 10 U.S. states (see the Appendix).[14,15] The target study population was infants born alive to surveillance-area residents who delivered at area hospitals at which there were 10 births per year or more during 2003 and 2004; births at these hospitals accounted for nearly all resident births. We used data from a similar evaluation designed to assess births at Active Bacterial Core surveillance sites in 1998 and 1999 in order to compare practices before and after the issuance of the 2002 updated guidelines.[9] Colorado joined the Active Bacterial Core surveillance system in 2000, and New Mexico in 2004.

Cases of early-onset, invasive group B streptococcal disease, which was defined by the isolation of group B streptococcus from a normally sterile site in a live-born infant less than 7 days of age, were identified by routine population-based surveillance. All cases of group B streptococcal disease that occurred in the birth cohort were included, and each case was assigned a sample weight of 1; because New Mexico joined the Active Bacterial Core surveillance system in 2004, only cases of group B streptococcal disease among infants born in 2004 were captured for that state.

For the identification of births in which group B streptococcus was not present, a random sample of 7737 live births stratified according to surveillance area, year of birth, and birth hospital was selected from birth certificates in all 10 Active Bacterial Core surveillance sites. Within each stratum, births were selected by means of proportional allocation on the basis of the number of births per hospital per year. Births in which there was no group B streptococcal disease received an initial sample weight equal to the inverse probability of selection. This initial weight was adjusted to account for nonresponse (i.e., the absence of a chart available for abstraction). This adjustment for nonresponse assumed that within each birth year, hospital, and gestational age category (preterm vs. term), the abstracted charts were representative of all births without group B streptococcal disease.[16,17]

A Centers for Disease Control (CDC) institutional review board determined that this project protocol was considered to be a program evaluation, and therefore, informed consent was not required. The local institutional review board at each participating site also reviewed the protocol and waived the requirement for informed consent.

DATA COLLECTION

For each selected birth, trained abstractors collected standardized information from labor and delivery records on the mother's demographic characteristics, prenatal care, obstetrical characteristics, intrapartum antibiotic use, and screening for group B streptococcus. When labor and delivery records for mothers whose newborns had group B streptococcal disease were unavailable for abstraction, routinely collected Active Bacterial Core surveillance case-report data were used to replace missing values, if possible. Information from the birth certificate on race, ethnic group, and term status was used when this information could not be obtained from the medical records.

DEFINITIONS OF VARIABLES

Preterm delivery was defined as delivery at less than 37 weeks' gestation. Intrapartum was defined as the period between the onset of labor or rupture of the membranes and delivery. In the case of cesarean deliveries, intrapartum was defined as the period between admission for labor or delivery and cord clamping. Antibiotics administered for prophylaxis associated with cesarean delivery were not classified as intrapartum when the timing of the administration was unknown. Screening for group B streptococcus before delivery was defined as any documented prenatal test or test at admission that was performed 2 days or more before delivery. The adequacy of prenatal care was determined by the Kessner index, which categorizes prenatal care as adequate, intermediate, or inadequate on the basis of the timing and number of prenatal care visits. For our analysis, we used two categories: inadequate (includes pregnancies with missing data) and adequate (includes intermediate).[18] We also used two categories for race: black and nonblack (which included white, Asian or Pacific Islander, American Indian, other, and unknown).

A history of group B streptococcus was defined as group B streptococcal bacteriuria in the mother during the current pregnancy or previous delivery of an infant with invasive group B streptococcal disease. Candidates for chemoprophylaxis included women who were positive for group B streptococcus at screening, had a history of group B streptococcus, or had unknown colonization status and a risk factor for group B streptococcus (preterm delivery, an interval between rupture of membranes and delivery of 18 hours or longer, or an intrapartum temperature of 38.0°C [100.4°F]) or higher at labor and delivery.[7]

STATISTICAL ANALYSIS

All analyses were conducted with the use of SUDAAN software, version 9.01 (Research Triangle Institute) to account for the stratified survey design. Data were weighted to account for an unequal probability of selection, and weighted values are reported. Pearson chi-square tests were used to compare distributions of categorical variables, and two-tailed P values of less than 0.05 were considered to indicate statistical significance. Factors associated with not being screened were evaluated with the use of univariate models, and all variables that were significant at a level of less than 0.15 in a univariate analysis were considered in multivariable logistic-regression models. The final multivariable model included main effects with a significance level of less than 0.05. Collinearity and all two-way interactions of main effects were evaluated; interaction P values of less than 0.05 were considered to indicate statistical significance.

RESULTS

STUDY SAMPLE

We analyzed data for 7691 live births from a cohort of 819,528 surveillance-area births in 2003 and 2004 (Table 1). We abstracted labor and delivery records for 7437 of 7737 live births (96.1%) in which the infant did not have group B streptococcal disease and 254 births in which the infant had early-onset group B streptococcal disease identified by active surveillance, representing an overall incidence of 0.32 cases of group B streptococcal disease per 1000 live births (range, 0.18 to 0.39). All 254 infants with group B streptococcal disease were included in this evaluation. A total of 89.0% of all the infants and 74.4% of the infants with group B streptococcal disease (189 of 254) were delivered at term.

Table 1. Characteristics of the Cohort from 10 Active Bacterial Core Surveillance Sites, 2003–2004.*

Variable	Cohort (N=7691)
Maternal demographic characteristics	
Race — % (95% CI)†	
White	67.0 (65.7–68.2)
Black	20.3 (19.2–21.4)
Other	12.1 (11.3–13.0)
Unknown	0.6 (0.5–0.8)
Ethnic group — % (95% CI)†	
Hispanic	18.0 (17.0–18.9)
Non-Hispanic	80.5 (79.5–81.5)
Unknown	1.6 (1.3–1.9)
Mother's age <20 yr — % (95% CI)	8.7 (7.9–9.5)
Medicaid payment of labor and delivery costs — % (95% CI)	25.7 (24.6–26.8)
Prenatal care and medical history	
Prenatal record in chart — % (95% CI)	98.1 (97.6–98.4)
Some prenatal care — % (95% CI)	98.6 (98.2–98.9)
Inadequate prenatal care — % (95% CI)‡	18.8 (17.8–19.9)
Documented history of illegal drug use — % (95% CI)	3.2 (2.8–3.7)
At least one previous live birth — % (95% CI)	58.5 (57.2–59.9)
Previous infant with invasive group B streptococcal disease — % (95% CI)	1.3 (1.0–1.7)
Group B streptococcal bacteriuria during current pregnancy — % (95% CI)	5.5 (4.9–6.2)
Allergy to penicillin — % (95% CI)	
With low risk of anaphylaxis	8.1 (7.4–8.9)
With high risk of anaphylaxis	1.0 (0.7–1.3)
Obstetrical characteristics	
Preterm delivery — % (95% CI)	11.0 (10.0–12.1)
Threatened preterm delivery — % (95% CI)	5.3 (4.7–6.0)
Rupture of membranes ≥18 hr before delivery — % (95% CI)	7.2 (6.5–8.0)
Intrapartum temperature ≥38.0°C — % (95% CI)	3.3 (2.8–3.8)
Suspected chorioamnionitis — % (95% CI)	3.1 (2.6–3.7)
Interval between admission and delivery <4 hr — % (95% CI)	25.0 (23.9–26.2)
Delivery by cesarean section — % (95% CI)	25.5 (24.3–26.7)
Screening for group B streptococcus	
Screened before delivery — % (95% CI)§	85.0 (83.9–86.0)
At ≥35 weeks' gestation	49.4 (48.1–50.7)
At <35 weeks' gestation	14.9 (13.9–15.9)
Positive test result for group B streptococcus	24.2 (23.0–25.5)
Screened at unknown date	35.7 (34.4–37.0)
Screened at admission only	2.8 (2.3–3.4)
Gestational age among women tested at <35 weeks' gestation — wk	
Median	33.6
Interquartile range	30.2–34.4

* The Active Bacterial Core surveillance system conducts active, population-based surveillance for invasive group B streptococcal disease in selected counties in 10 U.S. states. Population size is unweighted. Reported values are weighted to account for the stratified survey design. CI denotes confidence interval.
† This characteristic was determined from labor and delivery records, case-report forms, or infants' birth certificates.
‡ Determination of inadequate care was based on the Kessner index, which categorizes care as adequate, intermediate, or inadequate on the basis of the timing and number of prenatal care visits. We used two categories: inadequate (included pregnancies with missing data) and adequate (included intermediate).
§ Screening before delivery refers to any prenatal test or test at admission that was performed 2 days or more before delivery.

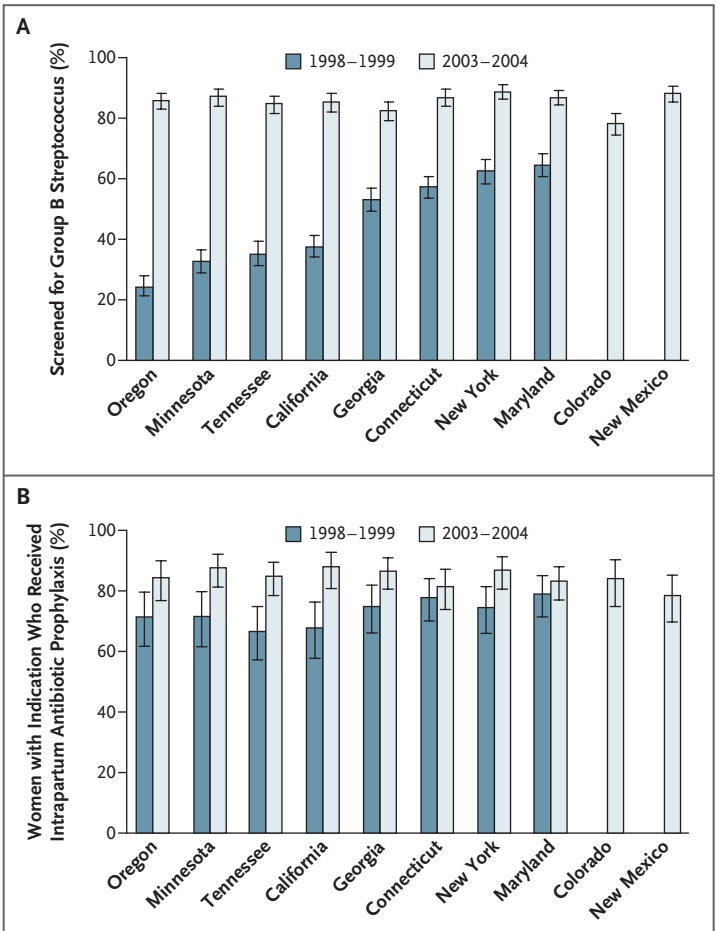

Figure 1. Screening and Treatment of Women before and after the Issuance of 2002 Revised Guidelines, According to Active Bacterial Core Surveillance Site.

The Active Bacterial Core surveillance system conducts active, population-based surveillance for invasive group B streptococcus in selected counties in 10 U.S. states. Colorado and New Mexico did not participate in the Active Bacterial Core surveillance system in 1998–1999. Reported values are weighted to account for the stratified survey design. Data for 1998–1999 are from Schrag et al.[9] The percentage of women screened for group B streptococcus before delivery, in 1998–1999 and in 2003–2004, is shown in Panel A. Screening before delivery includes any prenatal test or test at admission 2 days or more before delivery. The percentage of women who had an indication for intrapartum antibiotics and who received them is shown in Panel B. Intrapartum chemoprophylaxis was recommended for women who had a culture that was positive for group B streptococcus, who had previously delivered an infant with invasive group B streptococcal disease, who had group B streptococcal bacteriuria during their current pregnancy, or who had unknown colonization status and one of the following risk factors: preterm delivery (at <37 weeks' gestation), rupture of membranes 18 hours or more before delivery, or intrapartum fever. I bars in both panels indicate 95% confidence intervals.

IMPLEMENTATION OF SCREENING AND CHEMOPROPHYLAXIS RECOMMENDATIONS

The percentage of women who were screened for group B streptococcus before delivery increased from 48.1% (95% confidence interval [CI], 46.7 to 49.5) in 1998–1999 to 85.0% (95% CI, 83.9 to 86.0) in 2003–2004. The percentage of women who were screened increased in all surveillance areas, and the range in 2003–2004 (78.2 to 88.8%) was smaller than the range in 1998–1999 (24.3 to 64.6%) (Fig. 1A). Only 49.4% of the women were known to have been screened at 35 weeks' gestation or later, including 2.8% who were tested solely at admission (Table 1); 14.9% were tested earlier than recommended, and 35.7% had an unknown date of testing. Among women who were screened before delivery, 98.4% had a documented result; 24.2% (ranging from 16.2 to 26.7% across surveillance areas) were documented to be positive for group B streptococcus. Among women who were tested before delivery and in whose medical records the type of test was recorded, 99.5% were tested with the use of cultures. In the case of the remaining 0.5%, a rapid polymerase chain reaction (PCR) test was used for 0.2%, a rapid antigen test was used for 0.1%, and another type of test (unspecified) was used for 0.2%; each of these categories represented fewer than 10 women.

The percentage of mothers who received intrapartum antibiotics increased from 26.8% (95% CI, 25.4 to 28.2) in 1998–1999 to 31.7% (95% CI, 30.4 to 33.0) in 2003–2004. Among women with an indication for intrapartum antibiotics, 73.8% (95% CI, 70.6 to 76.7) received chemoprophylaxis in 1998–1999, as compared with 85.1% (95% CI, 82.9 to 87.0) in 2003–2004 (Fig. 1B). Penicillin or ampicillin was the most common agent used for group B streptococcal prophylaxis (used in 76.7% of women with an indication for intrapartum antibiotics). Only 13.8% of the women who had an allergy to penicillin but who were at low risk for anaphylaxis (Table 1) received cefazolin, the second-line agent that was recommended in the 2002 guidelines. Clindamycin was the agent most commonly administered in women who were allergic to penicillin, regardless of whether they were at low or high risk for anaphylaxis; 69.9% of women at low risk and 83.5% of those at high risk received clindamycin. Use of vanco-

mycin was rare (administered in 0.3% of women who received prophylaxis). There were no verified episodes of anaphylaxis after chemoprophylaxis.

MISSED OPPORTUNITIES FOR PREVENTION

Screening

Mothers who delivered preterm were less likely to be screened than mothers who delivered at term (relative risk, 0.56; 95% CI, 0.51 to 0.62); therefore, we stratified the cohort further according to term status. Only 50.3% of the mothers who delivered preterm were screened before delivery, and 17.8% of the women who delivered preterm were screened at admission; among women for whom the interval between admission and delivery was 48 hours or more, 58.9% were screened at admission. In a univariate analysis, delivery at less than 34 weeks' gestation was the only significant factor associated with not being screened before delivery (relative risk, 1.5; 95% CI, 1.2 to 1.8).

Among women who delivered at term, the rate of screening before delivery was high (89.3%). In a univariate analysis, several subgroups of mothers (Table 2) had lower screening rates than the overall population of mothers who delivered at term, with the lowest rates of screening among women with inadequate prenatal care (76.9% of these women were screened) and women with a history of drug use (80.6% were screened). In the multivariable model, black race, Hispanic ethnic group, previous delivery of a live infant, history of drug use, and inadequate prenatal care remained significantly associated with not being screened (Table 2); there were no significant interactions between variables.

Chemoprophylaxis Administration

Because chemoprophylaxis guidelines differ according to gestational age, we stratified the cohort again according to term or preterm delivery. Mothers who delivered preterm were less likely to receive chemoprophylaxis when indicated than mothers who delivered at term (relative risk, 0.81; 95% CI, 0.75 to 0.87). Among women who delivered preterm and were positive for group B streptococcus, 84.5% received chemoprophylaxis (Table 3). However, only 63.4% of women who delivered preterm and had unknown colonization status received intrapartum antibiotics. The median interval between admission and delivery for

Table 2. Factors Associated with Missed Screening for Group B Streptococcus before Delivery among Mothers Who Delivered at Term, 2003–2004.*

Variable	Not Screened (N=745)	Screened (N=5982)	Odds Ratio (95% CI)	
	%		Univariate Model	Multivariate Model
Black race†	24.8	18.6	1.44 (1.15–1.81)	1.29 (1.01–1.64)
Hispanic ethnic group†	24.4	17.8	1.50 (1.21–1.85)	1.39 (1.11–1.73)
Medicaid payment for labor and delivery	31.1	24.2	1.41 (1.16–1.71)	
Previous delivery of live infant	72.8	57.0	2.02 (1.65–2.48)	1.92 (1.56–2.35)
History of drug use	5.4	2.7	2.05 (1.35–3.12)	1.72 (1.13–2.62)
Inadequate prenatal care‡	38.0	15.2	3.41 (2.79–4.16)	3.07 (2.51–3.77)
Threatened preterm delivery	2.3	3.9	0.58 (0.34–1.00)	
Previous preterm delivery	8.2	5.0	1.71 (1.18–2.46)	
Group B streptococcal bacteriuria during current pregnancy	3.5	5.9	0.57 (0.34–0.96)	
Previous infant with invasive group B streptococcal disease	2.1	1.2	1.72 (0.93–3.17)	

* Screening before delivery refers to any prenatal test or test at admission that was performed 2 days or more before delivery. The multivariate model included only effects with a significance level of less than 0.05. Population size is unweighted. Reported percentages are weighted to account for the stratified survey design.

† This variable was determined from labor and delivery records, case-report forms, or infants' birth certificates.

‡ Determination of inadequate care was based on the Kessner index, which categorizes care as adequate, intermediate, or inadequate on the basis of the timing and number of prenatal care visits. We used two categories: inadequate (included pregnancies with missing data) and adequate (included intermediate).

preterm births was 10.4 hours (interquartile range, 3.8 to 28.8). Women were less likely to receive chemoprophylaxis when the interval between admission and delivery was less than 4 hours than when the interval was 4 hours or more (Table 3). In a univariate analysis, no other factors were associated with missed chemoprophylaxis among the women who delivered preterm.

The rate of administration of chemoprophylaxis was high among women who delivered at term: 87.0% of women who were positive for group B streptococcus and 78.5% of women with a risk factor and unknown colonization status received intrapartum antibiotics (Table 3). The length of time between admission and delivery was the only factor associated with missed chemoprophylaxis in a univariate analysis. The median interval between admission and delivery for term births was 7.8 hours (interquartile range, 3.8 to 13.1). Women who were positive for group B streptococcus or had a history of group B streptococcus were less likely to receive chemoprophylaxis when the interval between admission and delivery was less than 4 hours than when the interval was 4 hours or more.

LIMITATIONS OF SCREENING AS A PUBLIC HEALTH STRATEGY

Although preterm infants have a higher incidence of early-onset group B streptococcal disease than term infants (0.73 vs. 0.26 cases per 1000 live births), in our study population, 74.4% of the cases of group B streptococcal disease (189 of 254) occurred in term infants. Among term deliveries, lack of screening contributed to only a small portion of the early-onset disease burden;

Table 3. Implementation of 2002 Recommendations Regarding Intrapartum Chemoprophylaxis, According to Term Status, 2003–2004.*

Group B Streptococcus Status	Preterm Delivery† (N=962)	Term Delivery (N=6727)
	% (95% CI)	
Positive prenatal screening test before delivery‡		
Total	29.7 (23.9–36.3)	23.9 (22.6–25.2)
Received intrapartum antibiotics		
Overall	84.5 (72.9–91.7)	87.0 (84.9–88.9)
<4 hr between admission and delivery	79.6 (54.8–92.6)	62.7 (56.2–68.8)
≥4 hr between admission and delivery	85.8 (71.7–93.5)	94.0 (92.2–95.5)
Unknown colonization status§		
Total	54.2 (49.3–59.0)	0.7 (0.5–1.0)
Received intrapartum antibiotics		
Overall	63.4 (57.0–69.4)	78.5 (63.7–88.4)
<4 hr between admission and delivery	34.0 (24.3–45.3)	38.9 (8.4–81.5)
≥4 hr between admission and delivery	74.1 (66.7–80.4)	84.3 (69.3–92.7)
History of group B streptococcus bacteriuria or previous infant with group B streptococcus disease		
Total	6.2 (4.3–8.7)	6.7 (6.1–7.5)
Received intrapartum antibiotics		
Overall	73.5 (53.9–86.8)	80.7 (76.0–84.7)
<4 hr between admission and delivery	59.9 (28.7–84.7)	55.6 (44.5–66.1)
≥4 hr between admission and delivery	74.9 (51.6–89.3)	89.7 (85.0–93.1)

* Reported values are weighted to account for the stratified survey design. The 2002 recommendations can be found in Schrag et al.[7]
† A preterm delivery was defined as delivery at less than 37 weeks' gestation.
‡ Screening before delivery refers to any prenatal test or test at admission that was performed 2 days or more before delivery.
§ In the term cohort, unknown colonization status refers to women with unknown status in whom the rupture of membranes occurred 18 hours or more before delivery or who had an intrapartum temperature of 38.0°C or higher.

only a small percentage of term infants with group B streptococcal disease were born to mothers from key subgroups of unscreened women, such as women with inadequate prenatal care or women with a history of drug use (Table 4). Overall, 18.0% of the cases of early-onset group B streptococcal disease in term infants occurred among infants of unscreened women.

The largest portion of cases of group B streptococcal disease in term infants (61.4%) occurred in the infants of women who had been screened and who had tested negative for group B streptococcus (Table 4). Among the women in this subgroup for whom information on screening-test dates was available (76.7%), the median gestational age at screening was similar to that for all term births (35.6 and 35.9 weeks, respectively). To determine whether the observed number of cases of group B streptococcal disease in infants born to mothers with negative cultures (i.e., false negative cases) was higher than the number anticipated, we estimated the number of false negative cases that would be expected, using assumptions from our cohort and findings from previous studies. We assumed that antenatal culture-based screening was 96% specific for colonization status at delivery,[19] that the percentage of newborns who would be colonized with group B streptococcus when chemoprophylaxis was not administered was 50%,[2] and that the incidence of disease among colonized newborns ranged from 5.1 cases per 1000 live births among newborns with no risk factors to 10 cases per 1000 live births among newborns with risk factors.[20] On the basis of these assumptions, we expected that there would be 44 to 86 cases of group B streptococcal disease among term infants who were born to women with negative results of prenatal screening for group B streptococcus — 30 to 72 fewer cases than the 116 cases we observed.

DISCUSSION

The recommendation of universal antenatal screening for group B streptococcus was an important policy shift that posed challenges for its implementation.[12,21] However, all the sites in our multistate surveillance rapidly adopted universal screening after the guidelines were issued. Moreover, 98.4% of screened women had a documented result, and 87.0% of the women who tested positive for group B streptococcus and who delivered at term received intrapartum chemoprophylaxis. This successful adoption of screening recommendations is likely to have contributed to the documented 27% decline in the incidence of early-onset group B streptococcal disease from 1999–2001 to 2003–2005.[10] The incidence of 0.32 cases per 1000 live births that we observed in our cohort matched a conservative estimate of what universal screening was expected to achieve.[9]

The feasibility of decreasing the incidence of early-onset group B streptococcal disease further depends in part on the ability to reduce the number of missed opportunities for prevention. We identified potential areas for improvement among women who deliver preterm with unknown colonization status, women who are allergic to penicillin, and women with false negative screening results. The 2002 guidelines recommended screening and chemoprophylaxis at admission and delivery for women with unknown colonization status and a risk of preterm delivery. Nevertheless, almost half of these women were not screened, and more than a third (36.6%) did not receive chemoprophylaxis. Our study design excluded women with a risk of preterm delivery whose labor was successfully arrested; this group would have the most opportunity to benefit from conventional culture-based screening, which requires approximately 48 hours for results to be ob-

Table 4. Characteristics of Mothers Who Delivered at Term and Whose Infants Had Group B Streptococcal Disease, 2003–2004.

Characteristic	Mothers Who Delivered at Term and Whose Infants Had Group B Streptococcal Disease (N=189)
	no. (%)
Screened	155 (82.0)
Positive for group B streptococcus	37 (19.6)
Negative for group B streptococcus	116 (61.4)
Unknown colonization status	2 (1.1)
Not screened*	34 (18.0)
Black race	10 (5.3)
Hispanic ethnic group	7 (3.7)
Previous delivery of live infant	11 (5.8)
History of drug use	3 (1.6)
Inadequate prenatal care	15 (7.9)

* Characteristics associated with not being screened are not mutually exclusive; the characteristics listed here were those that remained significant in a multivariable analysis of factors associated with not being screened.

tained. It has been reported that commercially available real-time PCR tests can yield results in 45 minutes.[22,23] However, the real-world feasibility of using these tests must still be assessed.[7,24] Studies are needed to investigate whether the use of rapid-test screening, as compared with late antenatal culturing, results in a similar proportion of women with positive results who receive adequate and appropriate intrapartum chemoprophylaxis. Our finding that screening was less likely to be performed when the interval between admission and delivery was shorter than 4 hours suggests a possible role for rapid testing.

Although previous guidelines recommended the use of clindamycin in the case of women who are allergic to penicillin, the 2002 guidelines recommended the use of cefazolin in those who are allergic to penicillin but at low risk for anaphylaxis. Our observation that 69.9% of such women received clindamycin and that less than 1% of colonized women who were allergic to penicillin had a test result that documented susceptibility of group B streptococcus to macrolides suggests a need to educate providers and laboratory personnel about the recommended agents and to identify barriers to the implementation of the drug guidelines.[25] Cefazolin is the preferred agent for women at low risk for anaphylaxis because its activity is similar to that of the first-line agents, penicillin and ampicillin, and resistance to group B streptococcus has not been documented.

We found that 61.4% of the term infants with group B streptococcal disease were born to women who had had negative cultures for group B streptococcus, a finding that was similar to the results of a single-hospital chart review of early-onset cases of group B streptococcal disease.[26] In the case of any highly implemented prevention strategy, remaining cases of disease will often be the result of prevention failures; given the performance of the antenatal screening test for group B streptococcus as a predictor of intrapartum colonization status, some false negative results are expected to occur. Our population-based approach allowed us to determine that the number of false negative test results among mothers whose full-term infants had group B streptococcal disease was somewhat greater than would be expected on the basis of the literature, highlighting the importance of identifying factors that contribute to false negative results. Because colonization can be transient,[27] screening more than 5 weeks before delivery could be one contributor.[19] Improved documentation of screening dates would help clinicians assess whether screening results were obtained within the recommended time period. Screening outside this window, however, is probably only one of several management steps that may account for false negative results; others may include the collection of specimens,[28] the processing of cultures,[29] and the recording and reporting of screening results. Rapid, PCR-based testing at admission for delivery may improve the accuracy of screening by identifying colonization status at the time of labor and delivery.

With increased screening, the overall percentage of infants exposed to intrapartum antibiotics increased by 5%, which was close to the increase that was predicted when the guidelines were issued.[9] Although case reports of anaphylaxis after intrapartum chemoprophylaxis have been published,[30,31] we found no verified instances in our cohort. No increased risk of sepsis unrelated to group B streptococcus as a result of intrapartum prophylaxis has been documented, and infants who were exposed to intrapartum antibiotics were not at increased risk for invasive *Escherichia coli* infection, the second most common early-onset pathogen.[32] However, continued monitoring of neonatal sepsis is needed.[33]

The problem of a higher incidence of early-onset group B streptococcal disease among black infants than among nonblack infants remains unresolved. Since 2004, the incidence of early-onset group B streptococcal disease has increased to 0.37 cases per 1000 live births, owing in part to an increasing incidence among black infants.[34] As of 2004, we had not identified differences in screening or intrapartum chemoprophylaxis administration between black and nonblack mothers that could explain the disparities in the incidence. However, our evaluation of preventive practices for group B streptococcus was restricted to the information documented in labor and delivery records. We had limited prenatal information and were unable to assess clinical and laboratory procedures. There may also be differences in policies and practices among providers, institutions, and laboratories.[13,35]

The broad implementation of universal screening after the 2002 guidelines were issued shows that public health policy can be translated into

action. Recommendations were rapidly adopted and coincided with a decline in the incidence of early-onset disease. Universal screening and intrapartum chemoprophylaxis were not expected to prevent all cases of early-onset group B streptococcal disease,[11] and our results also highlight the challenges and limitations of this approach to prevention. New strategies, such as the development of vaccines against group B streptococcus,[36] continue to hold the most promise for further prevention of early-onset group B streptococcal disease.

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APPENDIX

The Active Bacterial Core surveillance study sites included California (3-county San Francisco Bay area), Colorado (5-county Denver area), Connecticut, Georgia (20-county Atlanta area), Maryland, Minnesota (7-county Minneapolis–St. Paul area), New Mexico (6 counties), New York (7-county Rochester area and 8-county Albany area), Oregon (3-county Portland area), and Tennessee (11 urban counties).

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