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Group B Streptococci Prophylaxis in Patients who Report a Penicillin Allergy: A Follow-up Study

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Abstract

Objectives—To compare adherence to the 2002 CDC guidelines for the prevention of perinatal group B streptococci (GBS) disease in penicillin-allergic patients between 2004–2006 and 2008.

Methods—Prior data from our institution revealed suboptimal adherence to the 2002 CDC guidelines for GBS prophylaxis among penicillin-allergic women. These data drove the hospital to implement a series of interventions. The original cohort (2004–2006) was compared to a cohort of women delivering between April 2008 and January 2009 (n=74) to determine whether or not the proportion who had antimicrobial sensitivity testing and received an appropriate antibiotic improved.

Results—In 2008, 76% (95% CI 66–84%) of GBS positive, penicillin-allergic women received an appropriate antibiotic (compared to 16.2% in 2004–2006, $p<0.001$). Antimicrobial sensitivity testing was performed in 79.4% of cases (95% CI 68–87%), compared to 11.4% in 2004–2006 ($p<0.001$).

Conclusion—With directed intervention, adherence to the 2002 CDC guidelines for GBS prophylaxis in penicillin-allergic women improved dramatically.

Keywords

Group B Streptococci prophylaxis; penicillin allergy; guideline adherence

INTRODUCTION

Group B Streptococci (GBS) is a leading cause of neonatal infection and intrapartum prophylactic antibiotics have reduced the incidence of early-onset neonatal GBS disease by 70%. (1,2) Penicillin (PCN) is the recommended antibiotic for GBS prophylaxis and, historically, patients reporting a PCN allergy received either clindamycin or erythromycin. Given the increasing prevalence of GBS resistance to both clindamycin and erythromycin, The Centers for Disease Control (CDC), in collaboration with the American College of Obstetricians and Gynecologists (ACOG) and the American Association for Pediatrics (AAP), provided new guidelines for the prevention of early-onset neonatal GBS disease in 2002 including specific guidelines for patients with a reported PCN allergy. (3–9)

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Data from this study were presented at the 36th Annual Scientific Meeting of the Infectious Disease Society of Obstetrics and Gynecology, Montreal, Quebec, Canada, Aug. 6–8, 2009.

In 2007, we published the results of our study evaluating adherence to the 2002 CDC GBS prophylaxis guidelines for GBS-positive, penicillin-allergic women who delivered at Women and Infants Hospital (WIH) between 2004 and 2006. (10) We found suboptimal adherence, with only 11% of GBS positive, PCN allergic patients undergoing sensitivity testing and 16% receiving an appropriate antibiotic based on the 2002 CDC recommendations. (10) In response to these findings, WIH instituted a series of interventions aimed to improve adherence to the guidelines. These interventions included educating providers by presenting lectures on the guidelines (a hospital research presentation, staff meetings, and Grand Rounds) and highlighting the 2002 CDC guidelines for GBS prophylaxis as “guideline of the month” (where details of the guidelines provided on posters throughout the hospital). In addition, a field for “PCN allergy” was added to laboratory ordering systems so that, if filled out properly, the laboratory could be reflexively prompted to perform GBS sensitivity testing.

The aim of the current study is to evaluate whether or not adherence to the 2002 CDC guidelines for GBS prophylaxis has improved since the 2004–2006 data collection period. We hypothesized that, among PCN-allergic, GBS positive patients delivering at WIH between April 2008 and January 2009 both the proportion who received antimicrobial sensitivity testing and the proportion who received an appropriate antibiotic increased from the prior 2004–2006 data collection period.

METHODS

We performed a retrospective cohort study of GBS positive obstetric patients who reported a PCN allergy and delivered at WIH between April 1, 2008 and January 1, 2009. April 1, 2008 was chosen because WIH implemented its interventions aimed to improve adherence to the guidelines (detailed in the Introduction) between May, 2007 and March, 2008. WIH Institutional Review Board approval for this project was obtained in December 2007. (IRB #07–0138)

To select the study sample, a list of all GBS positive patients who delivered between April 1, 2008 and January 1, 2009 was generated using ICD-9 codes 648.91 and v02.51. The electronic medical records of each GBS positive patient (n=1221) was reviewed by the research team to identify those patients who also reported a PCN or PCN derivative allergy (n = 104). (Figure 1)

Data were abstracted from medical records onto standardized data collection forms by the principal investigator and a trained research assistant. We recorded data on age, obstetric provider, insurance status, gestational age at delivery, type of delivery, recorded nature of the PCN allergy, means of identifying GBS positivity, antimicrobial sensitivity testing, and antibiotics received. Selection of the study sample was verified for accuracy first by having 10% of the GBS positive patient medical records reviewed by two members of the research team to confirm PCN allergy, and no discrepancies were identified. Additionally, we used a system of double data entry for all abstracted charts with discrepancies reconciled by re-reviewing the data collection sheets prior to data analysis. All data was maintained in a confidential computerized database.

We described the age, gravidity, parity, race-ethnicity, provider type, type of insurance, gestational age at delivery, mode of delivery, means in which GBS positivity was determined, whether or not the nature of the PCN allergy was documented, and antibiotic administered for our population of GBS positive PCN-allergic patients (n=104). We then compared, in this population of GBS positive, PCN-allergic patients, (1) patients who received antimicrobial sensitivity testing with those who did not, and (2) patients who

received an appropriate antibiotic with those who did not. For both of these analyses, we excluded women who had a gestational age less than 37 weeks (n=10) and women who had a cesarean delivery without labor who were gestational age greater than 37 weeks (n=9). We excluded women who delivered before 37 weeks because women are not universally screened for GBS prior to 37 weeks. Women with a cesarean delivery without labor were excluded because these patients do not universally require GBS prophylaxis.

Antimicrobial sensitivity testing was defined as “performed” if it was documented in the antenatal records, in the laboratory data sheets, in the intrapartum chart, in the postpartum chart, or in the electronic laboratory data files. Women who received a cephalosporin who were determined to be at low risk for anaphylaxis (n=17) were excluded for the analyses of antimicrobial sensitivity testing, as antimicrobial sensitivity testing is not uniformly necessary for patients at low risk for anaphylaxis. The final sample size for these analyses was 68 women.

“Appropriate antibiotic” was defined as cephalosporin for patients at low risk for anaphylaxis, clindamycin or erythromycin if GBS was susceptible to both of these antibiotics, and vancomycin if antimicrobial sensitivity was unknown or if GBS was resistant to either clindamycin or erythromycin. One patient had missing data on the outcome (antibiotic administered) and was excluded from the analyses of appropriate antibiotic administration. The final sample size for these analyses was 84 women.

We performed a sample size calculation for both of our primary outcomes (proportion of patients who received antimicrobial sensitivity testing and proportion who received an appropriate antibiotic). From our previous study, we knew that 11% of GBS positive, PCN allergic women received antimicrobial sensitivity testing and 16% of GBS positive, PCN allergic women received an appropriate antibiotic. In order to see at least a 20% increase in both of these outcomes and setting $\alpha=0.05$ and $\beta=0.20$, we needed 53 women for analyses of antimicrobial sensitivity testing and 68 for analyses of “appropriate antibiotic”. Data were analyzed using STATA 9.0 (STATA Corp, College Station, TX). Categorical variables were compared using Fisher’s exact test, medians were compared using Wilcoxon’s rank sum test, and 95% Confidence Intervals (CIs) were calculated for binomial proportions using Agresti-Coull method.

RESULTS

Between April 1, 2008 and December 31, 2008, there were 6982 deliveries at WIH. Of those, 1221 GBS positive patients were identified, giving a 17.5% prevalence of GBS positivity. Approximately 9% (n=104) of these women reported a PCN allergy and these charts were reviewed.

In this population, 75% of women had documentation of the nature of their penicillin allergy and 76% of women delivered vaginally. (Table 1) Overall, 94% of women received antibiotic prophylaxis, and 47% of these women were given clindamycin. After applying the detailed exclusion and inclusion criteria to the sample, 85 patients remained and the charts were eligible for analyses. (Figure 1)

Next, we compared women who did and did not have antimicrobial sensitivity testing. (Table 2) Seventy nine percent (95% CI 68.2–87.4%) of the 68 women in the sample received antimicrobial sensitivity testing. We found a lower rate of sensitivity testing for GBS isolates identified in urine compared to rectovaginal screening culture. Although 86% (n=43/50) of patients with GBS identified by rectovaginal culture had sensitivity testing, only 55% (n=6/11) of patients with GBS bacteriuria had sensitivity testing (p=0.05). We found that women without antimicrobial sensitivity testing were more likely to have higher

gravidity and be multiparous than women with antimicrobial sensitivity testing, however there was no difference between groups in terms of age, race/ethnicity, and whether or not they received antibiotics.

Table 3 shows the comparisons between women who did and did not receive an appropriate antibiotic. Of the 84 patients included in these analyses, 76.2% (95% CI 66%–84.1%) received an appropriate antibiotic. Of those patients receiving an inappropriate antibiotic, 80% (95% CI 57.8–92.5) received clindamycin. Again, there was no difference between groups in terms of age, race/ethnicity, provider type (not shown), gravidity, and whether or not they received any antibiotics. The women who did not receive an appropriate antibiotic were more likely to be multiparous compared to women who received an appropriate antibiotic.

Our final analyses compared antimicrobial sensitivity testing, appropriate antibiotic prophylaxis, and antimicrobial received between 2004–2006 and 2008. (Table 4) Antimicrobial sensitivity testing increased from 11.4% in 2004–2006 to 79.4% in 2008 (95% CI 7.5–16.8% and 68.2–87.4%, respectively, $p < .001$). Appropriate antibiotic prophylaxis increased from 16.2% in 2004–2006 to 76.2% in 2008 (95% CI 11.7–22.1% and 66–84.1%, respectively, $p < 0.001$). Overall, between both time periods both cephalosporin use and vancomycin use increased significantly (from 8.1% to 20.2% and from 6.6% to 28.6%, respectively) and clindamycin use decreased significantly (from 83.3% to 48.8%).

COMMENT

Most cases of early onset neonatal GBS disease can be prevented by administering appropriate intrapartum antimicrobial prophylaxis to women who are at risk for transmitting GBS to their newborn. National guidelines for the prevention of GBS disease were first published in 1996 and were revised in 2002. (9,11) In our study published in 2007, we found that two important aspects of the 2002 guidelines were not being followed: requesting antimicrobial sensitivity testing and prescribing the recommended antibiotic.(10). In the current follow-up study, conducted after institutional interventions were implemented, we found that adherence to these aspects of the 2002 guidelines improved dramatically.

The recommended treatment strategy for women with a PCN allergy was significantly changed in the 2002 version, reflecting the increasing prevalence of GBS resistance to both clindamycin and erythromycin. The revised treatment strategy, now 7 years old, includes taking a detailed history of the nature of the PCN allergy to determine if a cephalosporin may be appropriate, requesting antimicrobial sensitivity testing for GBS isolates, and treating with antibiotics based on the sensitivity testing. (2) Because we found suboptimal adherence to these guidelines in 2004–2006, our institution implemented basic strategies (posters, educational sessions, and reformatting of laboratory requisition systems) which focused on educating providers about the new guidelines and the reasoning behind them and facilitating ordering antimicrobial sensitivity testing.

The 2002 CDC guidelines and experts on infectious diseases and clinical pharmacology advocate that practitioners take a detailed clinical history of the PCN allergy to determine the likelihood that the patient has had a prior type I/anaphylactic reaction to PCN. Only 10–20% of patients who self-report a PCN allergy are truly PCN-allergic, as assessed by skin testing. (12,13) For many patients who report a PCN- allergy, cephalosporins may be the best alternative and experts suggest taking a detailed history to determine which patients may safely receive cephalosporins. They suggest that then the practitioner use his or her judgment to determine whether or not a cephalosporin would be appropriate for the individual patient. The true incidence of cephalosporin cross-reactivity in PCN-allergic

patients is controversial. Although some studies have shown that allergic reactions to cephalosporins are greater in the population of PCN-allergic individuals than in non-PCN-allergic individuals, the overall incidence of anaphylaxis to cephalosporins is less than 0.001%. (12–16)

In our study the use of cephalosporins for GBS prophylaxis in women who report a PCN allergy increased significantly, from 8% in 2004–2006 to 20% in 2008. Although the patients who received cephalosporins in our population were assumed to have been “low risk” for anaphylaxis, it is also very likely that many patients at “low risk” for anaphylaxis also received clindamycin or even vancomycin. Because of the retrospective nature of this study, we could not clearly determine which patients were “high risk” and which patients were “low risk”. Though if 80–90% of our patients could have been “low risk” for anaphylaxis based on what is known about true PCN allergy, we are likely still underutilizing cephalosporins. Increased cephalosporin use could possibly be attained by increasing provider awareness of the elements of a detailed history for risk of PCN anaphylaxis. Working with infectious disease specialists, we could also optimize cephalosporin use by developing a checklist for a detailed history for risk for PCN anaphylaxis. Ultimately, however, determining “risk” for anaphylaxis is at the discretion of the healthcare provider responsible for ordering the intrapartum antibiotic.

Based on the 2002 guidelines, women who were not candidates for cephalosporin administration (determined to be too “high risk” for anaphylaxis) should have received antimicrobial sensitivity testing of their GBS isolates. We found a drastic improvement, from 11% in our previous study to 79% in 2008, in the rates of GBS antimicrobial sensitivity testing. In addition, we found a similar reduction in the use of clindamycin in patients with unknown antimicrobial sensitivities. Clindamycin should be given only to women with GBS isolates with known antimicrobial sensitivity to both clindamycin and erythromycin, otherwise vancomycin should be administered. In the 2004–2006 data collection period, almost all patients (149/163) who received clindamycin did not have antimicrobial sensitivity testing (91%) and this decreased to 17% (7/41) in 2008. (10) Interestingly, we also noted that women without antimicrobial sensitivity testing were more likely to be of higher gravidity and multiparous. Upon our search, there does not appear to be any link in the published scientific literature between gravidity and adherence to prenatal care recommendations. Therefore, we are lacking an explanation for this finding.

This study also highlights one unresolved issue for the management of GBS colonization in women who report a PCN allergy: management of GBS bacteriuria. The CDC guidelines do not include specific recommendations or algorithms for patients with GBS bacteriuria who report a PCN allergy. GBS is “incidentally” found in urine cultures performed to screen for asymptomatic bacteriuria which could represent a missed opportunity for antimicrobial sensitivity testing. This was suggested in our study by the trend towards decreased rates of sensitivity testing in those women noted to be GBS positive by bacteriuria when compared to rectovaginal swab. Authors of future revisions of GBS prophylaxis guidelines may want to consider addressing management strategies for this population of patients with GBS identified only by urine culture. One strategy that may facilitate reflexive antimicrobial sensitivity testing would be to require mandatory documentation of PCN allergy for all ordered urine cultures and GBS screens for order entry. At our institution and other institutions, this could be easily implemented utilizing computerized order entry systems.

This study had several strengths. First, we reviewed the charts of the entire population of GBS positive pregnant women who delivered during the study period in order to determine PCN allergy to establish our study sample. Second, we reviewed several separate data sources to determine the outcomes, antimicrobial sensitivity testing and appropriate

antibiotic choice, which maximized the accuracy of our classification of the outcomes. One limitation of our study is that this study was a retrospective review of medical records. Therefore, our data were limited by what was actually recorded in the medical record. In addition, our study sample was generated using ICD-9 codes. Although coding at WIH has been shown to be valid and our rates of GBS positivity and reported PCN allergy are consistent with previous studies, some eligible patients may not have been included in our study sample (10). Lastly, though our adherence clearly improved from 2004–2006 to 2008, it is not clear if any one particular intervention was more influential than another. The very low adherence rates in 2004–2006 to the guidelines for GBS prophylaxis in PCN allergic women prompted the hospital to begin a multifaceted intervention that involved both laboratory form changes and educational sessions. Given our data were collected after the hospital had implemented all of its interventions, we are unable to determine whether the form changes or educational sessions had a larger impact on the increased adherence.

Though this study includes one institution and does not provide information about adherence at other institutions or nationally, it is an example for other institutions to investigate their adherence to the 2002 guidelines for GBS chemoprophylaxis in PCN-allergic women and implement changes when adherence is found to be suboptimal. Our institution educated providers and staff and made simple changes to order forms allowing documentation of whether or not patients have a PCN allergy (to allow for reflex testing of GBS isolates). These changes were not expensive or difficult to implement and could easily be considered at other institutions.

Reducing the use of ineffective antibiotics (clindamycin or erythromycin for patients with GBS isolates of unknown susceptibilities) could further reduce the incidence of early onset GBS disease. Appropriate antepartum and intrapartum management of PCN-allergic, GBS positive women could have a significant impact on GBS disease. Using a prevalence of GBS colonization of 20% and a prevalence of reported PCN allergy of 10%, we estimate that 2% of the pregnant population is both GBS colonized and reportedly PCN-allergic. Managing this 2% of patients appropriately could affect the outcomes of 80,000 neonates annually (using the estimated 4 million U.S. births in 2008).

The administration of prophylactic antibiotics during labor has greatly reduced the incidence of early onset neonatal GBS disease. Choosing an appropriate antibiotic is a key to this strategy. Antimicrobial sensitivity testing and appropriate antibiotic prophylaxis are highlighted in the 2002 CDC guidelines. We found that although adherence to these guidelines at our institution was suboptimal, that adherence could be dramatically improved by implementing easy low cost strategies. Institutions should consider monitoring their antibiotic practices for GBS positive women who report a PCN allergy to maximize reductions in the incidence of early-onset GBS disease.

References

1. Schrag S, Zywicki S, Farley M, Reingold A, Harrison L, Lefkowitz L, et al. Group B Streptococcal Disease in the Era of Intrapartum Antibiotic Prophylaxis. *N Engl J Med* 2000;342:15–20. [PubMed: 10620644]
2. Centers for Disease Control and Prevention. Early-Onset Group B Streptococcal Disease -United States, 1998–1999. *MMWR* 2000;49(35):793–796.
3. Andrews J, Diekema D, Hunter S, Rhomberg P, Pfaller M, Jones R, Doern G. Group B Streptococci Causing Neonatal Bloodstream Infection: Antimicrobial Susceptibility and Serotyping Results From SENTRY Centers in the Western Hemisphere. *Am J Obstet Gynecol* 2000;183(4):859–862. [PubMed: 11035326]

4. Bland M, Vermillion S, Soper D, Austin M. Antibiotic Resistance Patterns of Group B Streptococci in Late Third-Trimester Rectovaginal Cultures. *Am J Obstet Gynecol* 2001;184(1):1125–1126. [PubMed: 11349176]
5. Fernandez M, Hickman M, Baker C. Antimicrobial susceptibilities of group B streptococci isolated between 1992 and 1996 from patients with bacteremia or meningitis. *Antimicrob Agents Chemother* 1998;42(6):1517–1519. [PubMed: 9624508]
6. Morales W, Dickey S, Bornick P, Lim D. Change in Antibiotic Resistance of Group B Streptococcus: Impact on Intrapartum Management. *AJOG* 1999;181(2):310–314.
7. ACOG Committee. Opinion: Number 279, Prevention of Early-Onset Group B Streptococcal Disease in Newborns. *Obstet Gynecol* 2002;100(6):1405–1412. [PubMed: 12468196]
8. 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(RR-11):1–22. [PubMed: 12211284]
9. Gibbs R, Schrag S, Schuchat A. Perinatal Infections Due to Group B Streptococci. *Obstet Gynecol* 2004;104(5):062–1076.
10. Matteson K, Lievense S, Catanzaro B, Phipps M. Intrapartum Group B Streptococci Prophylaxis in Patients Reporting a Penicillin Allergy. *Obstet Gynecol* 2008;111:356–364. [PubMed: 18238973]
11. Centers for Disease Control and Prevention. Prevention of Perinatal Group B Streptococcal Disease: A Public Health Perspective. *MMWR* 1996;45(RR7):1–27.
12. Salkind A, Cuddy P, Foxworth J. Is This Patient Allergic to Penicillin? An Evidence-Based Analysis of the Likelihood of Penicillin Allergy. *J Am Med Assoc* 2001;285(19):2498–2505.
13. Wong B, Keith P, Waserman S. Clinical History as a Predictor of Penicillin Skin Test Outcome. *Ann Allergy Asthma Immunol* 2006;97:169–174. [PubMed: 16937746]
14. Apter A, Kinman J, Bilker W, Herlim M, Margolis D, Lautenbach E, Hennessy S, Strom B. Is There Cross-Reactivity Between Penicillins and Cephalosporins. *Am J Med* 2006;119(4):354.e11–354.e20. [PubMed: 16564780]
15. Shepherd G. Allergy to β -Lactam Antibiotics. *Immunol Allergy Clin North Am* 1991;11:611–633.
16. Gadde J, Spense M, Wheeler B, Adkinson NF. Clinical experience with penicillin skin testing in a large inner-city STD-clinic. *JAMA* 1993;270 (20):2456–2463. [PubMed: 8230623]

Figure 1.
Patient selection for the study

Table 1

Characteristics of the GBS positive, PCN-allergic patients who delivered at WIH between April 1, 2008 and December 31, 2008 (n=104)

Characteristics	N *	Column % [†] (95% CI)
Race/ethnicity		
White, N/H	74	71.2 (61.8–79.0)
Black, N/H	10	9.6 (5.1–17.0)
Hispanic	12	11.5 (6.6–19.2)
Other	5	4.8 (1.8–11.0)
Unknown	3	2.9 (0.6–8.5)
Gestational age at delivery		
<37 weeks	10	9.6 (5.1–17)
≥37 weeks	94	90.4 (83.0–94.9)
Age, in years [median (range)]	29	13–41
Gravidity [median (range)]	2	1–9
Parity [median (range)]	1	0–4
Type of delivery		
Vaginal	79	76.0 (66.9–83.2)
C/s after labor	14	13.5 (8.1–21.5)
C/s without labor	11	10.6 (5.8–18.1)
Method of identification GBS +		
Rectovaginal culture	73	70.2 (60.8–78.2)
GBS bacteruria	14	13.5 (8.1–21.5)
Screening method not documented	17	16.4 (10.4–24.7)
Nature of penicillin allergy documented in medical record	78	75.0 (66.6–83.5)
Received intrapartum antibiotics	98	94.2 (87.7–97.6)
Type of antibiotics received		
Cephalosporin	22	22.5 (15.3–31.7)
Clindamycin	46	46.9 (37.4–56.7)
Erythromycin	2	2.0 (0.1–7.6)
Vancomycin [‡]	28	28.6 (20.5–38.2)

* Unless otherwise specified

[†] Column % may not add up to 100% secondary to rounding

[‡] Includes one patient who received cephalosporin also

GBS positive, PCN-allergic patients who delivered at WIH between April 1, 2008 and December 31, 2008: Comparisons between women who had antimicrobial sensitivity testing and women who did not have antimicrobial sensitivity testing (n=68)

Table 2

Characteristics	No sensitivity testing		Sensitivity testing		P- value
	Median	Range	Median	Range	
Age in years *	30	20–40	29.5	13–41	p=0.43
Gravidity *	3	1–9	2	1–5	p=0.03
Parity *	1	0–4	0	0–3	p=0.02
	N	Col%[‡] (95%CI)	N	Col %[‡] (95% CI)	
Total	14	20.6 (12.5–31.8)	54	79.4 (68.2–87.4)	
Race/ethnicity					
White, Non-Hispanic	10	71.4 (45.0–88.7)	41	75.9 (62.9–85.5)	p=0.93
Black, Non-Hispanic	2	14.3 (2.8–41.2)	4	7.4 (2.4–18.0)	
Hispanic	1	7.1 (0–33.5)	5	9.3 (3.6–2-.3)	
Other	1	7.1 (0–33.5)	4	7.4 (2.4–18.0)	
Method of identification GBS +					
Rectovaginal culture	7	50.0 (26.8–73.2)	43	79.6 (66.9–88.4)	p=0.05
GBS bacteriuria	5	35.7 (16.2–61.4)	6	11.1 (4.8–22.6)	
Not documented	2	14.3 (2.8–41.2)	5	9.3 (3.6–20.3)	
Received intrapartum antibiotics	13	92.9 (66.5–100)	54	100 (92.1–100)	p=0.21
Type of antibiotics received					
Clindamycin	7	50.0 (26.8–73.2)	34	63.0 (49.6–74.6)	p=0.24
Erythromycin	0	0 (0–25.1)	2	3.7 (0.3–13.3)	
Vancomycin [‡]	6	42.9 (21.3–67.4)	18	33.3 (22.2–46.7)	
Missing	1	7.1 (0–33.5)	0	0 (0–7.9)	

* Median (range) where noted

[†] May not add up to 100% secondary to rounding

[‡] Includes one patient who received cephalosporin also

GBS positive, PCN-allergic patients who delivered at WIH between April 1, 2008 and December 31, 2008: Comparisons between women who received an appropriate antibiotic and women who did not receive an appropriate antibiotic (n=84)

Table 3

Characteristics	Did not receive an appropriate antibiotic			Received an appropriate antibiotic			P value
	Median	Range		Median	Range		
Age in years *	30	21–40		28.5	13–41		p=0.2
Gravidity *	2	1–9		2	1–5		p=0.15
Parity *	1	0–5		0	0–2		p=0.03
	N	Col% [†] (95%CI)		N	Col% [†] (95%CI)		
Total	20	23.8 (15.9–34.0)		64	76.2 (66.0–84.1)		
Race/ethnicity							
White, N/H	14	70.0 (47.9–85.7)		46	71.9 (59.8–81.5)		p=0.43
Black, N/H	3	15.0 (4.4–36.9)		6	9.4 (4.0–19.3)		
Hispanic	1	5.0 (0–25.4)		8	12.5 (6.2–23.0)		
Other	1	5.0 (0–25.4)		4	6.3 (2.0–15.4)		
Unknown	1	5.0 (0–25.4)		0	0 (0–6.8)		
Method of identification GBS +							
Rectovaginal culture	12	60.0 (38.6–78.2)		51	79.7 (68.2–87.9)		p=0.16
GBS bacteriuria	5	25.0 (10.8–47.2)		7	10.9 (5.1–21.2)		
Not documented	3	5.0 (4.4–36.9)		6	9.4 (4.0–19.3)		
Nature of penicillin allergy documented in medical record	13	65.0 (43.2–82.0)		53	82.8 (71.6–90.3)		p=0.12
Type of antibiotics received							
Cephalosporin	2	10.0 (1.6–31.3)		15	23.4 (14.6–35.2)		p=<0.001
Clindamycin	16	80.0 (57.8–92.5)		25	39.1 (28.0–51.3)		
Erythromycin	2	10.0 (1.6–31.3)		0	0 (0–6.8)		
Vancomycin [‡]	0	0 (0–19.0)		24	37.5 (26.6–49.8)		

* Median (range) where noted

† May not add up to 100% secondary to rounding

‡ Includes one patient who received cephalosporin also

Table 4

GBS positive, PCN-allergic patients who delivered at WIH: Comparisons of antimicrobial sensitivity testing, appropriate antibiotic prophylaxis, and antibiotic received between 2004–2006 and 2008.

Characteristics	2004–2006		2008		P value
	N/total*	Col % [†] (95%CI)	N/Total*	Col % [†] (95%CI)	
Underwent antimicrobial sensitivity testing	21/185	11.4 (7.5–16.8)	54/68	79.4 (68.2–87.4)	p<0.001
Received an appropriate antibiotic	32/197	16.2 (11.7–22.1)	64/84	76.2 (66.0–84.1)	p<0.001
Type of antibiotic received					
Cephalosporin	16/197	8.1 (5.0–12.9)	17/84	20.2 (12.9–30.1)	p<0.001
Clindamycin	164/197	83.3 (77.4–87.9)	41/84	48.8 (38.4–59.3)	
Erythromycin	4/197	2.0 (0.6–5.3)	2/84	2.4 (0.1–8.8)	
Vancomycin	13/197	6.6 (3.8–11.1)	24/84	28.6 (20.0–39.0)	

* N/total: “N” refers to the number in the row, “total” means the total in the analytic sample. For example, for “underwent antimicrobial sensitivity testing” in the 2004–2006 column, there were 21 women who underwent antimicrobial sensitivity testing out of a total of 185 women in the sample.

[†] May not add up to 100% secondary to rounding