J Microbiol Immunol Infect
2004;37:169-175

Group B streptococcal infections in children in a tertiary care hospital in southern Taiwan

Ching-Shu Wu[1,2], Shih-Min Wang[3], Wen-Chien Ko[4], Jiunn-Jong Wu[5], Yao-Jong Yang[2], Ching-Chuan Liu[2]

[1]Department of Pediatrics, Kangshan Hospital of Kaohsiung County, Kaohsiung; and Departments of [2]Pediatrics, [3]Emergency Medicine, [4]Internal Medicine, and [5]Medical Technology, National Cheng Kung University Medical College and Hospital, Tainan, Taiwan, ROC

Received: June 6, 2003 Revised: August 28, 2003 Accepted: September 29, 2003

Group B *Streptococcus* (GBS) is widely recognized as a leading cause of neonatal sepsis and meningitis. Recently, GBS infections in older children have been increasingly noted. This retrospective study investigated the clinical features, distribution of serotypes, and antimicrobial susceptibility of GBS isolates in a tertiary care center in southern Taiwan over a 12-year period. GBS isolates recovered from various infected sites in 54 children treated from June 1991 through December 2002 were studied. These children were divided into those with disease onset of up to 3 months of age (group 1) and those with disease onset after 3 months of age (group 2). Patients in group 1 were subdivided into early-onset disease (EOD, <7 days of age, 7/30) and late-onset disease (LOD, ≥7 days to 3 months of age, 23/30). Sepsis (90% vs 8%; $p<0.01$) and meningitis (40% vs 4.2%; $p<0.01$) were observed more frequently in group 1, whereas urinary tract infection (UTI; 45.8% vs 6.7%; $p<0.01$) and acute tonsillitis (33.3% vs 0%; $p<0.01$) were noted more frequently in group 2. Underlying conditions were more common in group 2 than in group 1 (50% vs 10%; $p<0.01$), especially in patients with UTI. The most frequently encountered serotype was serotype III (56%). Patients in group 1, especially those with LOD, and those who had meningitis or sepsis, were prone to develop serotype III infections ($p<0.05$). All isolates were susceptible to penicillin G and cephalothin. About 50% of isolates were susceptible to erythromycin, azithromycin, and to clindamycin. In conclusion, GBS infection in children has different characteristics in different age groups. Serotype III is the most prevalent serotype in children. GBS isolates in southern Taiwan are still very susceptible to penicillin G.

Key words: Child, microbial susceptibility tests, newborn infant, *Streptococcus agalactiae*, serotyping

Group B *Streptococcus* (*Streptococcus agalactiae,* GBS) has been known to be a leading cause of neonatal sepsis and meningitis since the 1970s [1,2]. The incidence of neonatal GBS infection varies from 0.2 to 5.4 per 1000 live births [3,4]. Two distinct clinical syndromes, early-onset disease (EOD) and late-onset disease (LOD), have been recognized in neonates and young infants [1,2].

In recent years, invasive GBS diseases in older children have also been reported [5-7]**.** Differences in the disease entity and risk factors were noted between these age groups. Sepsis and pneumonia happened more frequently in infants with EOD, while bacteremia and meningitis occurred commonly in infants with LOD. Infants with LOD often had no predisposing factors; infants with EOD were often associated with maternal obstetric complications, including chorioamnionitis, prolonged rupture of membranes, and premature labor; children older than 3 months of age often had underlying conditions [1,2,5-7].

GBS are divided into serotypes based on differences in their capsular polysaccharides. The epidemiology of the GBS serotypes varies in different countries and may change over time. There have been few reports on the serotypes of GBS isolates in Taiwanese children [8]. Knowledge of the serotype distribution is essential for developing and formulating an optimal GBS vaccine.

Because excessive as well as inappropriate use of antibiotics has been associated with the emergence of antimicrobial resistance among some organisms (including other *Streptococcus* subspecies [9,10]) in Taiwan, understanding the antimicrobial susceptibility of indigenous GBS isolates is an important issue. Early recognition of emerging resistances among GBS isolates will allow for modification of treatment of GBS infections.

Corresponding author: Dr. Ching-Chuan Liu, Department of Pediatrics, National Cheng Kung University Hospital, 138, Sheng Li Road, Tainan, Taiwan 704, ROC.
E mail: liucc@mail.ncku.eud.tw

The objectives of this study were: (1) to describe and compare the clinical features of GBS infections in children of different age groups; (2) to determine the serotype distribution in different age groups and diseases; and (3) to identify the antimicrobial susceptibility of GBS isolates.

Materials and Methods

Patients

From June 1991 through December 2002, children less than 18 years of age with GBS recovered from various infectious sites at National Cheng Kung University Hospital were studied. Demographic data, clinical manifestations and outcomes, serotypes, and antimicrobial susceptibility were reviewed. Patients were divided into 2 groups based on the age of the patient at the time of disease onset as follows: group 1, onset of symptoms/signs during the first 3 months of life; group 2, disease onset after the third month of age. Infants in group 1 were subdivided into those with EOD (<7 days of age) and those with LOD (≥7 days and ≤3 months of age).

Serotyping

Serotyping was performed in 34 of the 54 GBS isolates. Serotyping was determined by the agglutination method. Sera containing 6 type-specific agglutinins against GBS serotypes Ia, Ib, II, III, IV, and V were purchased from Denka Seiken (Tokyo, Japan). The procedures were performed according to the manufacturer's instructions. Briefly, Todd-Hewitt broth containing the isolate to be tested was incubated at 30°C overnight and centrifuged. Swine pancreatic extract and phenol-red solution were added to 0.5 mL of sediment. The pH of the mixture was adjusted to 8 to 8.5, and then the mixture was incubated at 37°C for 1 hour. After centrifugation, 0.5 mL of phosphate-buffered saline (pH 7.2) was added to the sediment and a homogenous suspension was made. The bacterial suspension was heated at 120°C for 30 minutes and agglutination tests were performed on a glass slide with antiserum. When a strong agglutination was visible within 1 minutes, the serotype of the serum was determined to be that of the bacterial strain.

Antimicrobial susceptibility testing

A total of 54 isolates were available for *in vitro* susceptibility testing. The antibiotics tested were penicillin G, cephalothin, cefotaxime, erythromycin, azithromycin, tetracycline, clindamycin, chloramphenicol, vancomycin, and ofloxacin. Azithromycin was kindly provided by Pfizer Inc. (Broton, CT, USA). All other drugs were purchased from Sigma Chemical Co. (St. Louis, MO, USA). The minimal inhibitory concentration (MIC) of each antibiotic was determined by the agar dilution method. Mueller-Hinton agar supplemented with 5% sheep blood and serial 2-fold dilutions of antibiotics were inoculated with bacterial inocula of $1 \sim 3 \times 10^4$ and incubated at 35°C in ambient air for 20 to 24 hours.

The selected ranges of antimicrobial concentrations were as follows: penicillin G, 0.03 to 8.0 μg/mL; cephalothin and cefotaxime, 0.03 to 64 μg/mL; erythromycin and azithromycin, 0.03 to 256 μg/mL; tetracycline and clindamycin, 0.12 to 256 μg/mL; chloramphenicol, 0.5 to 256 μg/mL; ofloxacin, 0.03 to 32 μg/mL; and vancomycin, 0.5 to 64 μg/mL. The MIC of each antibiotic was defined as the lowest concentration which inhibited visible growth of the organism. MIC breakpoints for susceptibility or resistance were those recommended by the US National Committee for Clinical Laboratory Standards MIC interpretative standards for *Streptococcus* spp. other than *Streptococcus pneumoniae* [11]. *Streptococcus pneumoniae* ATCC 49619 served as the control strain.

Statistical analysis

Chi-squared test or 2-tailed Fisher's exact test was employed for categorical variables. A p value of <0.05 was considered statistically significant.

Results

A total of 54 patients with GBS infections treated during the study period were included. There was an equal number of male and female patients. Among these patients, 30 (56%) were categorized in group 1 (7 EOD, 23 LOD) and 24 (44%) in group 2. The median age of group 1 and group 2 patients was 18 days (range, 1 days to 9 weeks) and 8 years 6 months (range, 15 weeks to 16 years), respectively.

The clinical diagnoses of each group are summarized in Table 1. Ninety percent of infants in group 1 had bacteremia, whereas only 8% of children in group 2 had sepsis (p<0.01). Meningitis was observed more frequently in group 1 (40%) than in group 2 (4.2%) [p<0.01]. However, group 2 had more urinary tract infection (UTI) [45.8% vs 6.7%; p<0.01] and acute tonsillitis (33.3% vs 0%; p<0.01). All patients with pneumonia belonged to the EOD group (p<0.01).

Table 1. Clinical diagnosis according to the time of disease onset in 54 children with group B *Streptococcus* infections

Clinical diagnosis	Group 1[a] (n = 30)		Group 2[b] (n = 24)
	EOD (n = 7)	LOD (n = 23)	
Sepsis	7	20	2
Pneumonitis	3	0	0
Meningitis	2	10	1
UTI	2	0	11
Soft tissue infection	0	2	2
Omphalitis	0	2	0
Vaginitis	0	1	1
Arthritis	0	2	0
Acute tonsillitis	0	0	8

Abbreviations: EOD = early-onset disease; LOD = late-onset disease; UTI = urinary tract infection

[a]Disease onset during the first 3 months of life.

[b]Disease onset after the third month of age.

Twelve of 24 children (50%) in group 2 had underlying diseases, whereas only 3 infants (10%) in group 1 had underlying conditions ($p<0.01$). The underlying conditions of these cases are shown in Table 2. The most common underlying condition noted in group 2 was diabetes mellitus (4/12), followed by vesicoureteral reflux (3/12) and autoimmune diseases (2/12).

The distribution of serotypes of the 34 GBS isolates in each age group is shown in Table 3. Twenty one isolates were from group 1, and 13 were from group 2. The predominant serotype among the 34 isolates was serotype III, accounting for 56% of the isolates. Serotype III was more prevalent in group 1 than in group 2 (86% vs 8%; $p<0.01$). Patients with LOD were more likely to have infections caused by serotype III than patients with EOD (94% vs 33%; $p=0.041$). The serotype distribution of GBS isolates from group 2 was relatively balanced among type Ia, Ib, II, III, V and non-typable. Serotype distribution was different among patients with various clinical diagnoses (Table 4). Serotype III isolates were responsible for all meningitis and 86% of cases of sepsis. UTIs were mainly caused by non-type III serotypes ($p<0.01$).

The 54 isolates of GBS were uniformly susceptible to penicillin G, cephalothin, cefotaxime, and vancomycin. All but 1 of the isolates were susceptible to ofloxacin. Half of the isolates were susceptible to erythromycin, azithromycin, clindamycin, and chloramphenicol. In contrast, nearly all isolates were resistant to tetracycline (Table 5).

Table 2. Characteristics of group B *Streptococcus* infections in children with underlying conditions

Patient	Age	Clinical manifestation	Underlying condition
1	1 day	Sepsis, pneumonitis	ASD, type II
2	1 day	Bacteremia	Large PDA
3	16 days	Sepsis, meningitis	Midline liver, atrial shunting
4	11 years	UTI	Lupus nephritis
5	9 years	UTI	Grade III V-U reflux
6	11 years	UTI	Right renal atrophy
7	15 years	UTI	IDDM, glaucoma
8	15 years	UTI	IDDM, grade I V-U reflux, neurogenic bladder
9	7 years	UTI	Left grade II-III V-U reflux
10	10 years	UTI	Dermatofibromatosis
11	8 years	UTI	NIDDM
12	10 years	Sepsis, spontaneous bacterial peritonitis	Nephrotic syndrome
13	7 years	Soft tissue infection	Meningomyelocele, VP shunt
14	8 years	Soft tissue infection	Juvenile rheumatoid arthritis
15	12 years	Vaginitis	IDDM

Abbreviations: ASD = atrial septal defect; PDA = patent ductus arteriosus; UTI = urinary tract infection; V-U reflux = vesicoureteral reflux; IDDM = insulin dependent diabetes mellitus; NIDDM = non-insulin dependent diabetes mellitus; VP = ventriculoperitoneal

Table 3. Serotypes and age groups for 34 group B *Streptococcus* isolates

Serotype	Group 1		Group 2
	EOD	LOD	
Ia	1	0	3
Ib	0	0	3
II	0	0	2
III	1	17	1
V	1	0	2
NT	0	1	2
Total	3	18	13

Abbreviations: EOD = early-onset disease; LOD = late-onset disease; NT = non-typable

Table 4. Serotypes and clinical diagnoses for 34 group B *Streptococcus* isolates

Serotype	No. of isolates			
	Sepsis	Meningitis	UTI	Others
Ia	1	0	1	3
Ib	1	0	1	1
II	0	0	2	0
III	19	8	1	6
V	1	0	2	0
NT	0	0	0	3
Total	22	8	7	13

Abbreviations: NT = non-typable; UTI = urinary tract infection

Discussion

GBS infections in children have diverse clinical characteristics in patients with different ages at disease onset. Early- versus late-onset GBS disease in neonates and young infants was first delineated in 1973 by Baker et al [1,2]. While early-onset GBS disease is a well-known cause of neonatal sepsis and meningitis, little information is available on GBS diseases in pediatric patients older than 3 months of age [5,7,12,13]. Previous studies showed that pneumonitis was a common manifestation of EOD, and that sepsis and meningitis were common in both EOD and LOD [12,14]. This study found similar results. The clinical manifestations of patients older than 3 months of age were reported to be similar to those in infants, with typical late-onset infection with bacteremia without a focus and meningitis being the most common presentations [5,13]. By contrast, UTI and acute tonsillitis were the most common clinical manifestations in children older than 3 months of age in this study, whereas sepsis and meningitis were only found in a few patients.

The role of GBS as a cause of UTI has been generally recognized only in pregnant women, in whom it is associated with a significant increase in the frequency of spontaneous abortion, premature rupture of membranes, endometritis, and neonatal infection [15]. Muñoz et al, however, found that GBS is a significant urinary pathogen in non-pregnant adults, especially women. They found that most non-pregnant adults with UTI caused by GBS had at least 1 underlying condition, with urinary tract abnormalities and chronic renal failure being the leading problems [16]. Diabetes mellitus has also been suggested to predispose patients to GBS infections [17].

In this study, UTI was defined as a pure growth of $>10^5$ colony-forming units (cfu)/mL in a mid-stream collected urine sample. Underlying conditions were found in 73% of UTI patients, with urinary tract abnormalities and diabetes mellitus the most common. All 3 patients without underlying conditions had symptoms such as fever, dysuria, and flank pain. However, patients with underlying conditions were

Table 5. Susceptibility of 54 group B *Streptococcus* isolates to 10 antimicrobial agents

Antibiotic	MIC (μg/mL)			Percentage of total isolates		
	MIC_{90}	MIC_{50}	Range	S	I	R
Penicillin G	0.06	<0.03	<0.03-0.12	100	0	0
Cephalothin	0.25	0.12	0.06-0.25	100	0	0
Cefotaxime	0.12	0.06	0.03-0.25	100	0	0
Erythromycin	>256	0.25	<0.03->256	51	0	49
Azithromycin	>256	0.5	<0.03->256	53	2	45
Clindamycin	>256	0.25	0.06->256	51	2	47
Tetracycline	256	32	0.12-256	2	0	98
Chloramphenicol	16	4	1-32	55	2	43
Ofloxacin	2	1	0.5-4	98	2	0
Vancomycin	0.5	0.5	0.25-0.5	100	0	0

Abbreviations: S = susceptible; I = intermediate; R = resistant; MIC = minimal inhibitory concentration

associated with asymptomatic UTI (5/8, 62.5%). These results suggest that GBS can be considered as a significant uropathogen in children who are more than 3 months of age, and should be suspected in patients with clinical signs and symptoms of uroinfections and immunological deficiencies (diabetes mellitus, patients treated with immunosuppressant agents, etc.) or urinary tract abnormalities.

Acute tonsillitis was the second most common manifestation in group 2. GBS may sometimes colonize on the pharynx, and was considered as the pathogen when identified in the pharynx of patients with exudative pharyngotonsillitis [18]. Antibiotic treatment of patients with GBS led to a more rapid disappearance of symptoms than in those untreated patients with a similar infection [18]. Thus, GBS should not be dismissed as a non-pathogen in children with acute pharyngotonsillitis and should be treated appropriately. Although concomitant viral infection could not be completely ruled out in this study, GBS should still be considered as the pathogen in these children. However, further study of the role of GBS in acute pharyngotonsillitis is needed.

Bacteremia and meningitis in patients beyond 3 months of age were less common in this study compared with previous reports [5,13]. One infant presented with sepsis and meningitis at 15 weeks of age. The other patient was a 10-year-old girl with nephrotic syndrome receiving steroid therapy who had sepsis and spontaneous bacterial peritonitis caused by GBS. Invasive GBS disease in children beyond early infancy was relatively uncommon in this study.

Diabetes mellitus, human immunodeficiency virus (HIV) infection and malignancy have been identified as risk factors for invasive GBS disease in adults [6]. Previous study reported that 67% of children older than 3 months of age had an underlying condition, including the placement of cerebrospinal fluid drainage devices or central venous catheters, HIV infection, diabetes, congenital heart disease or prematurity [5]. Half the children in group 2 of this study had at least 1 underlying disease, the most common being diabetes mellitus, followed by vesicoureteral reflux and autoimmune diseases. All children with tonsillitis were previously healthy, whereas 75% of other patients in group 2 had underlying conditions. Therefore, GBS infections presenting as conditions other than tonsillitis in children older than 3 months of age may suggest the presence of underlying diseases such as diabetes mellitus, urinary tract abnormalities, and autoimmune diseases.

The serotype distribution of GBS isolates in this study was similar to those reported in other countries [5,14,19]. The most frequent serotype in these studies was type III. Patients in group 1 of this study, especially those with LOD, were prone to develop serotype III infections, whereas in group 2 the serotypes were more evenly distributed between type Ia, Ib, II, III, V and non-typable. There was a strong association between type III strains and meningitis or sepsis. We found no mention of our finding of a relationship between UTI and non-type III serotypes in our review of previous studies. Further studies are needed to confirm this clinical finding.

Penicillin G has been recommended as the drug of choice in the treatment of GBS infection for many years. Many reports have stated that penicillin has retained its activity against GBS [20-22]; however, decreasing susceptibility of GBS to penicillin has been noted in Taiwan [8,23,24]. No clinical isolates were found to be of intermediate susceptibility or resistant to penicillin in this study. However, the ranges of penicillin MIC were <0.03 μg/mL to 0.12 μg/mL with the MIC_{90} of 0.06 μg/mL. Hence, penicillin remains the drug of choice for the treatment of GBS infections in southern Taiwan. However, the policy of frequent surveillance for penicillin resistance in clinical GBS isolates is certainly advisable.

Rates of resistance to erythromycin and clindamycin among GBS isolates have been reported to range from 7.4 to 46%, and 3.4 to 43%, respectively [20-27]. Among these reports, significantly higher rates of macrolide and clindamycin resistance were noted in recent isolates of GBS from Taiwan [21,24]. The rates of resistance to erythromycin (49%), azithromycin (47%), and clindamycin (47%) of GBS isolates in this study were close to those reported by other series in Taiwan [21, 24]. These 3 drugs should thus not be considered as an effective alternative for penicillin-allergic patients. According to the guidelines from the US Centers for Disease Control and Prevention (CDC) in 2002, cefazolin is suggested for penicillin-allergic women who are at low risk of anaphylaxis [28]. Previous reports [23, 25,26] and this study found that almost all GBS isolates were sensitive to cefazolin and cephalothin. Therefore, a first-generation cephalosporin may be an alternative for the treatment of GBS infections in older children.

In conclusion, GBS can cause infections not only in young infants but also in children older than 3 months of age, especially those with underlying illness. Sepsis and meningitis occurred more frequently in young

infants, whereas UTI and acute tonsillitis were more frequent in older children. Serotype III is the most common serotype in pediatric GBS infections in southern Taiwan, especially in infants younger than 3 months of age and patients with meningitis or bacteremia. GBS isolates are still sensitive to penicillin G in southern Taiwan. For penicillin-allergic patients who are at low risk of anaphylaxis, a first-generation cephalosporin may be an alternative to macrolides or clindamycin.

Acknowledgments

We would like to thank Ms YL Lin and CP Liaw for testing the antimicrobial susceptibility of the GBS isolates.

References

1. Franciosi RA, Knostman JD, Zimmerman RA. Group B streptococcal neonatal and infant infections. J Pediatr 1973; 82:707-18.
2. Baker CJ, Barrett FF, Gordon RC, Yow MD. Suppurative meningitis due to streptococci of Lancefield group B: a study of 33 infants. J Pediatr 1973;82:724-9.
3. Baker CJ, Edwards MS. Group B streptococcal infections. In: Remington JS, Klein JO, eds. Infectious diseases of the fetus and newborn infant. 4th ed. Philadelphia: W.B. Saunders; 1995: 980-1054.
4. Aavitsland P, Hoiby EA, Lystad A. Systemic group B streptococcal disease in neonates and young infants in Norway 1985-94. Acta Paediatr 1996;85:104-5.
5. Hussain SM, Luedtke GS, Baker CJ, Schlievert PM, Leggiadro RJ. Invasive group B streptococcal disease in children beyond early infancy. Pediatr Infect Dis J 1995;14:278-81.
6. Farley MM, Harvey RC, Stull T, Smith JD, Schughat A, Wenger JD, et al. A population-based assessment of invasive disease due to group B streptococcus in nonpregnant adults. New Engl J Med 1993;328:1807-11.
7. Bonadio WA, Jeruc W, Anderson Y, Smith D. Systemic infection due to group B beta-hemolytic streptococcus in children: a review of 75 outpatient-evaluated cases during 13 years. Clin Pediatr 1992;31:230-3.
8. Liao CH, Huang LM, Lu CY, Lee CY, Hsueh PR, Tsao PN, et al. Group B *Streptococcus* infection in infancy: 21-year experience. Acta Pediatr Tw 2002;43:326-9.
9. Fung CP, Hu BS, Lee SC, Liu PY, Jang TN, Leu HS, et al. Antimicrobial resistance of *Streptococcus pneumoniae* isolated in Taiwan: an island-wide surveillance study between 1996 and 1997. J Antimicrob Chemother 2000;45:49-55.
10. Hsueh PR, Teng LJ, Lee LN, Yang PC, Ho SW, Luh KT. Dissemination of high-level penicillin-, extended-spectrum cephalosporin-, and erythromycin-resistant *Streptococcus pneumoniae* clones in Taiwan. J Clin Microbiol 1999;37: 221-4.
11. National Committee for Clinical Laboratory Standards: Performance standards for antimicrobial susceptibility testing. Eleventh informational supplement. NCCLS M100-S11. Wayne, PA: National Committee for Clinical Laboratory Standards; 2001.
12. Yagupsky P, Menegus MA, Powell KR. The changing spectrum of group B streptococcal disease in infants: an eleven-year experience in a tertiary care hospital. Pediatr Infect Dis J 1991; 10:801-8.
13. Di John D, Krasinski K, Lawrence R, Borkowsky W, Johnson JP, Schieken LS, et al. Very late onset of group B streptococcal disease in infants infected with the human immunodeficiency virus. Pediatr Infect Dis J 1990;9:925-8.
14. Kalliola S, Vuopio-Varkila J, Takala AK, Eskola J. Neonatal group B streptococcal disease in Finland: a ten-year nationwide study. Pediatr Infect Dis J 1999;18:806-10.
15. Wood EG, Dillon HC Jr. A prospective study of group B streptococcal bacteriuria in pregnancy. Am J Obstet Gynecol 1981;140:515-20.
16. Muñoz P, Coque T, Rodríguez-Créixems M, Bernaldo de Quirós JC, Moreno S, Bouza E. Group B *Streptococcus*: a cause of urinary tract infection in nonpregnant adults. Clin Infect Dis 1992;14:492-6.
17. Persson KM, Grabe M, Kristiansen P, Forsgren A. Significance of group B streptococci in urine cultures from males and non-pregnant females. Scand J Infect Dis 1988;20:47-53.
18. Chretien JH, McGinniss CG, Thompson J, Delaha E, Garagusi VF. Group B beta-hemolytic streptococci causing pharyngitis. J Clin Microbiol 1979;10:263-6.
19. Harrison LH, Elliott JA, Dwyer DM, Libonati JP, Ferrieri P, Billmann L, et al. Serotype distribution of invasive group B streptococcal isolates in Maryland: implications for vaccine formulation. J Infect Dis 1998;177:998-1002.
20. Andrews JI, Diekema DJ, Hunter SK, Rhomberg PR, Pfaller M A, Jones RN, et al. Group B streptococci causing neonatal bloodstream infection: antimicrobial susceptibility and serotyping results from SENTRY centers in the western hemisphere. Am J Obstet Gynecol 2000;183:859-62.
21. Ko WC, Lee HC, Wang LR, Lee CT, Liu AJ, Wu JJ. Serotyping and antimicrobial susceptibility of group B streptococcus over an eight-year period in southern Taiwan. Eur J Clin Microbiol Infect Dis 2001;20:334-9.
22. Lin FY, Azimi PH, Weisman LE, Philips III JB, Regan J, Clark P, et al. Antibiotic susceptibility profiles for group B streptococci isolated from neonates, 1995-1998. Clin Infect Dis 2000;31:76-9.
23. Liu JW, Wu JJ, Ko WC, Chuang YC. Clinical characteristics

and antimicrobial susceptibility of invasive group B streptococcal infections in nonpregnant adults in Taiwan. J Formos Med Assoc 1997;96:628-33.

24. Hsueh PR, Teng LJ, Lee LN, Ho SW, Yang PC, Luh KT. High incidence of erythromycin resistance among clinical isolates of *Streptococcus agalactiae* in Taiwan. Antimicrob Agents Chemother 2001;45:3205-8.
25. Rouse DJ, Andrews WW, Lin FY, Mott CW, Ware JC, Philips III JB. Antibiotic susceptibility profile of group B streptococcus acquired vertically. Obstet Gynecol 1998;92:931-4.
26. Pearlman MD, Pierson CL, Faix RG. Frequent resistance of clinical group B streptococci isolates to clindamycin and erythromycin. Obstet Gynecol 1998;92:258-61.
27. Morales WJ, Dickey SS, Bornick P, Lim DV. Change in antibiotic resistance of group B *Streptococus*: impact on intrapartum management. Am J Obstet Gynecol 1999;181: 310-4.
28. 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.