Change in prevalence of group B *Streptococcus* maternal colonisation in Hong Kong

Michelle HY Tsui 徐行悅
Margaret Ip 葉碧瑤
PC Ng 伍百祥
Daljit S Sahota 邵浩達
TN Leung 梁子昂
TK Lau 劉子建

Objectives To re-examine the prevalence of group B *Streptococcus* colonisation in our antenatal population, and identify demographic factors associated with carriage.

Design Prospective observational study.

Setting A tertiary obstetrics unit in Hong Kong.

Participants A total of 1002 pregnant women were recruited at the booking clinic in a tertiary obstetrics unit in Hong Kong. High and low vaginal swabs and rectal swabs were taken for group B *Streptococcus* culture. Demographic data and delivery outcomes of the recruits were analysed.

Results The prevalence of group B *Streptococcus* colonisation in our antenatal population was 10.4%. The majority of carriers were identified by low vaginal swabs (78%), while high vaginal swabs and rectal swabs only identified 31% and 30% of the carriers, respectively. Professional women yielded a higher carrier rate than housewives (21% vs 10%, P=0.03). There was no increase in preterm delivery rate in group B *Streptococcus* carriers.

Conclusions We noted a dramatic increase in the prevalence of group B *Streptococcus* colonisation in the Hong Kong pregnant population at their booking visit. Professional women had a higher colonisation rate compared to other groups.

Introduction

Group B *Streptococcus* (GBS) is the most common pathogen causing neonatal sepsis.[1] According to a United Kingdom study reported in 2003, the prevalence of early-onset GBS neonatal disease was estimated to be as high as 3.6 per 1000 live births.[2] Colonisation of the maternal genital tract with GBS was strongly associated with early neonatal sepsis, as a result of vertical transmission during labour,[3] and in the western world the prevalence of such carriage during pregnancy ranged from 13 to 28%.[4-7] Intrapartum antibiotic administration effectively decreases the prevalence of early-onset neonatal GBS disease.[8] Preventive strategies—including universal antibiotic use, universal and selective screening, and risk-based intrapartum antimicrobial administration—have been proposed.[9-12] What constitutes an optimal strategy remains controversial,[13-15] and is largely dependent on the prevalence of GBS in the target population.

**The Chinese University of Hong Kong,
Prince of Wales Hospital, Shatin, Hong
Kong:**
**Department of Obstetrics and
Gynaecology**
MHY Tsui, MB, BS, FHKCOG
DS Sahota, BEng, PhD
TN Leung, MD, FHKAM (Obstetrics and
Gynaecology)
TK Lau, MD, FHKAM (Obstetrics and Gynaecology)
Department of Microbiology
M Ip, FRCPA, FHKAM (Pathology)
Department of Paediatrics
PC Ng, MD, FHKAM (Paediatrics)

Correspondence to: Prof DS Sahota
E-mail: daljit@cuhk.edu.hk

In most Hong Kong hospitals, neither universal screening nor a risk-based approach has been adopted for the prevention of neonatal GBS infections. According to a previous prevalence study conducted in the same unit in the early 1990s, in 367 unselected women between 16 and 24 weeks of gestation, the GBS carrier rate was very low (0.8%).[16] The authors hypothesised that this reflected differences in socio-cultural behaviour among Chinese women as compared to others. At that time, our unit also recorded a low incidence of preterm delivery (5%) and sexually transmitted disease.[16] In recent years, there have been changes in the epidemiology of GBS in many parts of the world. A large prospective multi-centre cross-sectional study conducted in the United States during 1994 to 1995,[5] suggested significant changes in both maternal and neonatal colonisation rates, with major differences between ethnic groups. These changes were attributed to the increasing ethnic diversity, social changes, as well as differences in medical practices. In the past decade, Hong Kong has also undergone rapid changes in terms of social and cultural conditions. In the Hong Kong Chinese population, an increasing preterm delivery rate approaching that of western countries has been observed.[17] The reason for this increase is not known. However, given the close association between preterm delivery and vaginal infection,[18]

it might be related to the changing epidemiology of vaginal colonisation. Furthermore, in our unit we observed an average of four cases of early-onset GBS disease per year between 1996 and 2000 (the annual delivery rate being 5000). The expected maternal colonisation rate was therefore expected to be much higher than the 0.8% previously reported,[16] as vertical transmission occurs in only 13.6 per 1000 carriers.[19] We therefore chose to re-examine the prevalence of GBS in our antenatal population, together with possible changes in associated demographic characteristics.

Methods

Subjects and recruitment

This study was conducted between January and May 2002, in a tertiary obstetrics unit in Hong Kong that serves a population of 1 million. The first 20 consecutive women, who presented to the antenatal booking clinic each day, were recruited. A maximum of 20 was set so that the specimens received by the microbiology laboratory could be processed the same day with minimal disturbance to routine workflow. There were no exclusion criteria. It was determined that a minimum sample size of 863 was needed, assuming a prevalence of 10%, an error rate of less than 2%, and a type I error rate of 5%. An additional 15% were recruited to allow for possible loss to follow-up, giving an overall target sample size of 1000. Women who attended the clinic for booking were given an information pamphlet and further explanations by the obstetrician. Written informed consent was obtained from each recruit. The entire study was approved by the Clinical Research Ethics Committee of our institution.

Sample and demographic data collection

Each recruited subject had a high vaginal swab (HVS) and a low vaginal swab (LVS) during a speculum examination, and a rectal swab taken for GBS culture. These were routinely obtained by all attending clinicians. The LVS was obtained by inserting a sterile swab 1 to 2 cm into the lower entrance of the vagina and the sides of the vagina were swabbed. The HVS was obtained by inserting a sterile swab into the vagina and swabbing the vaginal fornices. The rectal swab was obtained by inserting a swab into the rectum past the external sphincter. Each cotton-tipped swab was placed in Stuart's transport medium. Any abnormal discharge noted during speculum examination was recorded. Demographic and other data were prospectively documented for future analysis.

Culture

The swabs collected were transferred within 24 hours into separate Todd Hewitt broths (Oxoid, UK)

香港孕婦B型鏈球菌現患率的轉變

目的 　再探討香港孕婦B型鏈球菌現患率，和確認帶菌者的人口因素。

設計 　預後觀察研究。

安排 　香港一所大學產科部門。

參與者 　於產科預約部邀請了1002位孕婦參與本研究。分別從參與者取得高位陰道拭子、低位陰道拭子及肛拭子作B型鏈球菌培養，並分析人口數據及參與者的分娩結果。

結果 　參與本研究的孕婦的B型鏈球菌現患率為10.4%。低位陰道拭子檢出大部份的帶菌者（78%），而高位陰道拭子及肛拭子分別檢出31%和30%的帶菌者。從事專業行業的孕婦的帶菌率比家庭主婦的孕婦高（21%比10%；P=0.03）。B型鏈球菌孕婦帶菌者的早產率並沒有上升。

結論 　本研究發現本港孕婦的B型鏈球菌現患率顯著上升，而從事專業行業的孕婦的帶菌機會比其餘組別的孕婦高。

containing nalidixic acid and gentamicin (Sigma, UK) and incubated for 16 to 24 hours at 35ºC. The broth was subcultured onto Columbia agar containing 5% horse blood, incubated at 35ºC overnight, and inspected for beta-haemolytic or suspected non-haemolytic colonies morphologically typical of GBS. The identity of GBS was confirmed by a combination of Gram stain, catalase test and grouping, using the Streptex latex agglutination kit (Murex Diagnostics, Dartford, UK).

Management of group B *Streptococcus* carriers

No action was taken if women screened negative for GBS. Women who were found to be GBS carriers at booking were informed of their carrier status, but antibiotics were not prescribed antenatally. These women were given prophylactic antibiotics only when they had rupture of membranes or were in labour (intravenous ampicillin 2 g loading dose, then 1 g every 6 hours until delivery, or intravenous clindamycin 900 mg every 8 hours if the patient was allergic to penicillin). Paediatricians were also informed of such cases at delivery.

Collection of delivery and neonatal data

For all patients recruited into the study, delivery details and neonatal outcomes were retrieved from the labour ward and paediatrics database for analysis. These included gestational age, birth weight, mode of delivery, tocolytic use, pyrexia during labour, and Apgar scores at 1 and 5 minutes. All neonates of GBS carriers were observed in the neonatal unit for 48 hours before

TABLE 1. Demographic and other characteristics at booking among group B *Streptococcus* (GBS) carriers and non-carriers

Characteristic	GBS carrier (n=104)*	GBS non-carrier (n=898)*	P value/odds ratio (95% confidence interval)
General information			
Maternal age (years)	30±5	30±5	0.35
Years in Hong Kong	16±13	15±13	0.42
Booking gestation (weeks)	18±7	17±6	0.21
Gravidity	2±1	2±1	0.35
Parity	1±1	1±1	0.92
Citizenship and ethnic origin			
Hong Kong citizens	91 (88)	761 (85)	1.26 (0.69-2.32)
Mainland citizens	12 (12)	121 (13)	0.84 (0.45-1.57)
Other ethnic groups	1 (1)	16 (2)	0.54 (0.07-4.08)
Level of education			
Primary or below	7 (7)	71 (8)	0.84 (0.38-1.88)
Secondary	81 (78)	722 (80)	0.86 (0.53-1.40)
Tertiary or above	16 (15)	105 (12)	1.37 (0.78-2.43)
Occupation			
Professional	10 (10)	37 (4)	2.48 (1.19-5.14)[†]
Housewife	51 (49)	466 (52)	0.92 (0.61-1.38)
Manual worker	1 (1)	19 (2)	0.45 (0.06-3.39)
Other sedentary work	42 (40)	377 (42)	0.94 (0.62-1.42)
Partner's occupation			
Professional	6 (6)	33 (4)	1.60 (0.66-3.93)
Manual worker	17 (16)	184 (20)	0.76 (0.44-1.31)
Unemployed	1 (1)	23 (3)	0.37 (0.05-2.76)
Other sedentary work	63 (61)	482 (54)	1.33 (0.88-2.01)
No partner/unknown partner occupation	17 (16)	176 (20)	0.80 (0.46-1.38)
Family income (Euro per month)			
<1000	20 (19)	210 (23)	0.78 (0.47-1.30)
1000 to <3000	53 (51)	484 (54)	0.89 (0.59-1.33)
3000 to <5000	19 (18)	126 (14)	1.37 (0.80-2.33)
>5000	9 (9)	51 (6)	1.57 (0.75-3.30)
Unknown/unsure	3 (3)	27 (3)	0.96 (0.29-3.21)
Previous contraception			
Barrier	41 (39)	341 (38)	1.06 (0.70-1.61)
Intrauterine contraceptive device	4 (4)	16 (2)	2.07 (0.68-6.28)
Hormonal	4 (4)	32 (4)	1.08 (0.38-3.12)
Nil	55 (53)	509 (57)	0.97 (0.65-1.46)
Abnormal discharge noted at booking	2 (2)	5 (1)	3.50 (0.67-18.28)

* Data are shown as mean ± standard deviation or No. (%)
† Statistically significant

discharge. Serial C-reactive protein (CRP) and surface swab results were recorded. Chest radiographs, and blood and cerebrospinal fluid (CSF) cultures were also obtained if the infants manifested signs and symptoms suggestive of infection. Those who did not deliver in the same unit were contacted by phone to collect obstetrical and neonatal outcome data.

Statistical analysis

Demographic characteristics and delivery outcomes of GBS carriers and non-carriers were compared using the Chi squared test. Student's *t* test was used for comparisons of parametric data. All analyses were performed using the Statistical Package for the Social Sciences (Windows version 10.0; SPSS Inc, Chicago [IL], US).

Results

During the study period, 1901 new cases attended the booking clinic. Of these, 1007 (53%) were invited to join the study and 1002 (almost 100%) agreed to participate. Reasons for refusal were not recorded as the study refusal rate was very low. The demographic characteristics and other data of recruited GBS carriers and non-carriers are summarised in Table 1.

Maternal demographic factors

A significantly higher percentage of GBS carriers were professionals. Among women who were professionals, 21% were GBS carriers, compared to 10% of housewives (P=0.03). Manual workers had the lowest colonisation rate (5%), although there was no significant difference when compared with other groups, possibly due to the small number of subjects.

Group B *Streptococcus* prevalence at booking

The results of GBS cultures from HVS, LVS, and rectal swabs were available for analysis for all cases. At booking, 104 subjects had at least one positive culture for GBS, giving a prevalence of 10.4%. Low vaginal swabs had the highest yield, with 81 positive cultures, which detected 78% of carriers. High vaginal swabs and rectal swabs were only able to detect 32 (31%) and 31 (30%) of the carriers, respectively. The results are summarised in Table 2.

Obstetrics outcome

Obstetrics outcome was available for analysis in 952 (95%) subjects. A total of 861 women delivered in our unit; the details of 91 women who delivered elsewhere were successfully traced by phone. A total of 50 (5%) of the women were lost to follow-up.

The mean gestational age at delivery was not significantly different for GBS carriers and non-carriers (38.4±3.0 vs 38.8±3.2 weeks; P=0.23). The prevalence of preterm delivery due to preterm labour and preterm pre-labour rupture of membranes

TABLE 2. Group B *Streptococcus* (GBS) cultures as listed by specimen type

GBS culture results*	No. (%) of patients (n=1002)
Patients with all swabs negative	898 (89.6)
Patients with 1 swab positive	
LVS only	49 (4.9)
HVS only	13 (1.3)
Rectal only	8 (0.8)
Patients with 2 swabs positive	
LVS and HVS	11 (1.1)
LVS and rectal	15 (1.5)
HVS and rectal	2 (0.2)
Patients with all 3 swabs positive	6 (0.6)
Patients with at least 1 swab positive	104 (10.4)

* LVS denotes low vaginal swab, and HVS high vaginal swab

(PPROM) was 4.3%. As shown in Table 3, there was no significant difference in the incidence of preterm labour or PPROM in GBS carriers and non-carriers. For women who presented with preterm labour or PPROM, the HVS and LVS were repeated at the time of admission. Of the 41 cases of preterm labour and PPROM, only two yielded GBS from their vaginal swabs on admission. One of them had a positive GBS culture at booking, whilst the other was previously screened negative.

Neonatal outcome

There was only one case of confirmed early-onset neonatal GBS sepsis among the 952 cases with known neonatal outcomes (Table 3). The mother booked at 33 weeks of gestation, and GBS screening at the time was negative. She had a spontaneous preterm delivery at 36 weeks. The baby developed early-onset GBS septicaemia and meningitis soon after birth. A HVS performed after onset of preterm labour subsequently grew GBS. The baby was treated with intravenous penicillin and gentamicin and was discharged at the age of 3 weeks.

Three other babies had clinical sepsis after birth and yielded GBS on surface swabs (Table 3). They all had elevated CRP levels ranging from 28 to 76 mg/L (normal level, <10 mg/L), and two of them had pneumonic changes on chest radiographs. These babies also belonged to mothers classified as GBS non-carriers at booking.

Among babies whose mothers were GBS carriers, nine (9%) out of 96 developed clinical sepsis within 3 days of delivery, with elevated CRP levels (12.7-71.7 mg/L). Seven of these cases had pneumonic changes on chest radiographs, though none yielded GBS from surface swabs, CSF or blood cultures.

Discussion

The prevalence of GBS colonisation in our cohort was 10.4%, which was substantially more than the previous reported rate of 0.8% in the same unit in 1992.[16] This difference may partly be due to detection methodology. In the previous study,[16] only HVS and LVS examination was performed at booking, and the swabs were directly plated on horse blood agar. In the current study, rectal swabs were obtained to improve the detection rate,[20,21] although this only helped to identify eight extra carriers. We also used selective broth medium for culture, which improves detection

TABLE 3. Obstetrics outcomes in group B *Streptococcus* (GBS) carriers and non-carriers

Obstetrics outcome*	No. (%)		Odds ratio (95% confidence interval)/P value
	GBS carrier (n=96)	GBS non-carrier (n=856)	
Preterm delivery			
≤37 weeks	6 (6)	49 (6)	1.10 (0.46-2.63)
≤37 weeks due to preterm labour/PPROM	3 (3)	38 (4)	0.69 (0.21-2.29)
Pregnancy loss after booking	1 (1)	3 (0.4)	2.99 (0.31-29.06)
Tocolytics use	1 (1)	3 (0.4)	2.99 (0.31-29.06)
Apgar score <7			
at 1 min	1 (1)	32 (4)	0.27 (0.04-2.01)
at 5 min	2 (2)	7 (1)	2.58 (0.53-12.60)
Mode of delivery			
IVD	7 (7)	77 (9)	0.80 (0.36-1.78)
Emergency CS	10 (10)	121 (14)	0.71 (0.36-1.40)
Pyrexia during labour	0	17 (2)	0.32
Neonatal GBS meningitis	0	1 (0.1)	0.18
Neonatal sepsis, with positive GBS surface swabs	0	3 (0.4)	0.70

* PPROM denotes preterm pre-labour rupture of membranes, IVD instrumental vaginal delivery, and CS caesarean section

rates by about 50%.[21,22] However, the 13-fold increase in prevalence we encountered was unlikely to be due to differences in methodology alone. We therefore believe that the increase in prevalence we noted also reflects a genuine rise in GBS colonisation rate in our population.

In our study population, vaginal swabs identified 92% of GBS carriers, whilst rectal swabs identified only 30%. This distribution of colonisation sites differs from what has been reported in other studies. In a study by Philipson et al,[21] rectal swabs detected 89.7% of carriers while vaginal swabs detected only 58.6%. Unlike studies performed in the United States[5,20] where 15.7 to 26.4% of all carriers were detected solely by rectal swabs, in our study only 8% (8/104) were identified by rectal swabs alone. In our cohort, the LVS yielded the most common site for GBS colonisation, detecting 78% of all carriers. This figure will be useful in the design of future screening strategies in our population.

There is little information regarding differences between pregnant women who have rectal versus vaginal colonisation. Meyn et al[23] compared subjects with vaginal and rectal colonisation in non-pregnant women and found that the former was associated with increased recent sexual activity, whereas no such association was found for the latter. Since the majority of our carriers had vaginal colonisation (92%), in our population it may be worth investigating their sexual practices during pregnancy. In a study performed in our unit a decade ago,[24] the frequency of coitus evidently declined abruptly during the first trimester of pregnancy, and continued to decrease as gestation advanced. In the latter study, 37% and 65% of women abstained from coitus in the first and third trimesters respectively,[24] in which figures are high compared to those reported for western pregnant populations. The authors have attributed this difference to conservative attitudes towards sexual activity in pregnancy as part of Chinese culture.[24] With the increasing westernisation of our population, it is possible that sexual practices during pregnancy have also changed. Further studies on the effects of coital frequency on the GBS colonisation rate in pregnancy are warranted.

When comparing the demographic characteristics between subjects in our cohort and those recorded in a previous study from our unit,[16] educational levels and occupation characteristics had changed significantly in the past decades. Now there were more women with a tertiary education (12% vs 6%), and fewer were performing manual work (2% vs 15%). Those with only primary education levels or less constituted 8% of our study population, whereas the previous figure was 22%. The significantly higher GBS carrier rate in professionals (21%) was unexpected, as in previous studies GBS carriage was associated with lower socio-economic status,[15] or not different.[5] Only one study from New Zealand on 240 women reported that those who were socially advantaged had a higher GBS colonisation rate.[25] Whether this difference in the risk of GBS colonisation could be due to lifestyle (including sexual behaviour) requires further investigation.

The association between GBS vaginal colonisation and preterm deliveries is controversial.[26,27] In our study, we did not demonstrate any such association. The mean gestation times of GBS carriers and non-carriers were similar (38.4 vs 38.8 weeks). For GBS carriers identified at booking, the odds ratio for preterm labour or PPROM was not increased (0.69; 95% confidence interval, 0.21-2.29). For those who presented with preterm labour or PPROM, the prevalence of GBS colonisation on admission was also low (5%). Screening for GBS colonisation at booking and the use of antenatal antibiotics treatment is therefore unlikely to be useful for the prediction and prevention of preterm delivery.

The patient with early neonatal GBS sepsis, whose mother was screened negative 3 weeks prior to delivery, reflects the challenge of implementing GBS prevention strategies. Since this baby was delivered preterm at 36 weeks, a strategy of universal screening at 36 to 37 weeks would not have identified the subject. However, the mother would have been given antibiotics if the risk-based approach was adopted, whereby chemoprophylaxis was offered according to obstetrics risk factors (such as preterm labour). Thus, with a maternal GBS colonisation rate of 10.4%, there is now a need to look at various preventive strategies for the Hong Kong population. Based on a maternal colonisation rate of 25% in the United Kingdom, a publication by the Royal College of Obstetricians and Gynaecologists (RCOG) estimated that 1000 women would need intrapartum antibiotic treatment to prevent 1.4 cases of early-onset neonatal GBS disease.[28] They also found a large number needed to treat if risk-based screening was to be adopted. The RCOG has not recommended any screening programme following their analysis.[28] Adopting any type of screening programme in our locality requires more local data, including determining the maternal colonisation rate at term, and the rates of various obstetrical risk factors.

There were a number of limitations of our study. In most studies, maternal GBS screening was performed at term between 36 and 37 weeks, as such culture results would be more representative of colonisation status at delivery.[29] The mean booking to gestation in our study population was 17.6 weeks. Since the aim of this study was to determine the prevalence of GBS carriage and associated demographic factors in our population, swabs taken at booking served our purpose. Furthermore, earlier screening allowed us to look for possible associations between positive

results and subsequent second-trimester pregnancy loss and preterm birth. In this population, a longitudinal cohort study of carrier status at delivery would have been of interest, especially if correlated with neonatal outcomes.

In conclusion, we found a dramatic increase in the prevalence of GBS colonisation in pregnant women, from a previous rate of 0.8% to a current rate of 10.4%. This 13-fold increase within a decade is substantial, and cannot be explained by improved detection methodology alone. In our study, highly educated and socially advantaged professional women were more likely to be carriers, with a GBS colonisation prevalence comparable to that of western populations. Further studies are required to identify specific aspects of lifestyle and behaviour that may be associated with an increased likelihood of GBS colonisation.

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