# Prevention of perinatal group B streptococcal diseases: Belgian guidelines

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## Group B streptococcal early onset disease

In most industrialized countries in the 1970s, the prevalence of group B streptococcal (GBS) pneumonia, septicaemia and meningitis in young infants increased dramatically. For more than 20 years, they have remained the major cause of invasive bacterial infections in very young infants.

Group B streptococcal early onset disease (EOD) typically occurs within the first week of life. Almost 90% of babies with GBS disease present with signs of systemic infection (fulminant pneumonia, septicaemia or, less often, meningitis) at birth or within the first 24 hours of life.[1,2] Despite intensive supportive care and diagnostic and therapeutic advances, these infections are still associated with high mortality (5–20%) and morbidity. More than 30% of infants recovering from meningitis have long-term neurological sequelae: sight or hearing loss and cerebral palsy.[2–4] Group B streptococcal isolates are well distributed among the various capsular serotypes, but most group B streptococci isolated from children with meningitis belong to serotype III.

The group B streptococci that lead to colonization of infants at birth are acquired through vertical transmission from the mother. Infants can become colonized or infected in utero from ascending spread of group B streptococci, infection of the placental membranes and amniotic fluid by exposition to group B streptococci or fetal aspiration of infected amniotic fluid.[5,6] Alternatively, they may become contaminated during their passage through the birth canal. Transmission usually occurs after rupture of membranes, but it can also occur through intact membranes. The magnitude of vaginal carriage of group B streptococci at the onset of labour or rupture of membranes relates directly to the risk of vertical transmission and the likelihood of serious disease in the newborn.[6] The skin or mucous membranes of about 30–70% of neonates born to carriers of group B streptococci become transiently colonized. Most infants remain asymptomatic, but 2–4% develop a severe disease. If the vertical transmission of group B streptococci present in the mother's vagina at delivery substantially determines whether or not the newborn will acquire the organism and be at risk of invasive disease, other maternal factors are associated with an increased risk to develop EOD. These include low maternal levels of anticapsular antibody homologous to the colonizing strain,[7] labour and delivery before 37 weeks of gestation, intrapartum temperature ≥38°C, rupture of membranes sooner than 18 hours before delivery, a previous infant with invasive GBS disease and GBS bacteriuria during the current pregnancy.[8–11]

The reported incidence of EOD (birth to seven days) is 0.5–4 cases per 1000 live births.[2,9,12,13] Early onset disease accounts for about 80% of cases of neonatal GBS disease.

## Colonization and infection with group B streptococci

### *Pregnancy-related colonization and infections*

The gastrointestinal tract is the natural reservoir for group B streptococci and is the likely source of vaginal colonization.[14] Vaginal colonization is unusual in childhood but becomes more common in late adolescence.[12] Between 10% and 30% of pregnant women are colonized with group B streptococci in the vagina or rectum. This colonization is dynamic and can be chronic, transient or intermittent. Colonization with group B streptococci usually is asymptomatic, and carriers need to be identified through bacteriological screening of rectovaginal swabs.

Group B streptococcal disease is also common in women during pregnancy and in the postpartum period. Clinical manifestations include urinary tract infections (usually asymptomatic bacteriuria but also pyelonephritis), intra-amniotic infections (chorioamnionitis), endometriosis (often with bacteraemia), wound infections associated with caesarean delivery or episiotomy, puerperal sepsis and occasionally meningitis, septic thrombophlebitis or other serious complications. Group B streptococcal disease probably causes 15–25% of puerperal fever with or without bacteraemia.[2,15] In some instances, GBS disease clearly causes stillbirths.

### *Neonatal group B streptococcal late-onset disease*

Group B streptococci cause late-onset disease (LOD) in young infants aged >1 week to ≥3 months. The clinical presentation, prognosis, epidemiological characteristics and pathogenesis of GBS LOD differ from those of GBS EOD. Neonates present with fever and clinical signs of meningitis or osteoarthritis, with or without detectable bacteraemia. Most isolates from infants with GBS LOD are of serotype III. Acquisition of group B streptococci by infants is more diverse and results more often from horizontal transmission. The incidence is 0.3–1.8 (mean 0.5) per 1000 live births.[4,12]

### *Infections in adults*

Since the 1990s, group B streptococci have also been recognized as important pathogens that cause severe diseases in adults and are associated with high mortality. Skin and soft tissue infections and bacteraemia are the most common manifestations of invasive disease. The clinical spectrum also includes urosepsis, pneumonia, peritonitis, meningitis, septic arthritis and endocarditis. The incidence of GBS diseases in adults older than 20 years increases with age. Adults with chronic illnesses, such as diabetes mellitus, liver failure or cancers, are at higher risk for GBS severe infections. Death occurs in 16% of adults.

## Belgian data

Belgium has not escaped the endemic situation of GBS infections observed in most industrialized countries. Table 1 shows the main characteristics of the

**TABLE 1** Characteristics of group B streptococcal (GBS) early onset disease in infants in Belgium, 1995–2001.[13]

| | |
|---|---|
| Incidence in 1999 | Two per 1000 live births |
| Mortality | >14% |
| Cases of meningitis | 10% |
| Serotypes | |
| Ia | 16% |
| Ib | 13% |
| II | 20% |
| III | 43% (the most frequent) |
| IV | Very rare |
| V | 9% |
| More than one maternal risk factor | 40% of cases |

epidemiology of GBS and of neonatal infections reported in Belgium. These data are based on different studies conducted by the Belgian Reference Laboratory for GBS in collaboration with the epidemiological section of the Belgian Institute of Public Health (ISP-WIV).[13]

In 1985 and 1990, two studies reported an incidence of three per 1000 live births for GBS EOD, which represents the natural incidence of EOD before any action to prevent the disease. In 1999, when some Belgian hospitals had implemented a prevention strategy, the incidence was two per 1000 live births. Another study that reviewed 130 cases of GBS EOD that had occurred in Belgium in 1999–2000 reported that 60% of cases were not associated with any of the additional maternal risk factors for EOD. According to reports from hospital laboratories throughout the country, about 13–25% of pregnant women are colonized with group B streptococci in the vagina or rectum.[16]

Between 1991 and 2001, GBS caused 37.9% of cases of early-onset sepsis and meningitis. The second cause of EOD was *E. coli* (11.4 %). During the past decade, a decline in the rate of infection with *E. coli* and other Gram-negative rods was observed (, personal communication, ).[17]

**[? To A: please add the name of the person whose data this is]**
**[? To A: please add year data were collected]**

## Prevention strategies

Recognition of the prevalence and severity of neonatal GBS disease has fuelled intensive investigations aimed at elucidating the pathogenesis of GBS infections. The continuing magnitude and severity of GBS disease and its attendant mortality and morbidity underscore the desirability of prevention methods. Two approaches have been proposed: chemoprophylaxis and immunoprophylaxis. Several strategies have been evaluated.

Immunization of women during or before pregnancy should be the most promising, durable and cost-effective method for prevention of GBS EOD as well as GBS LOD and peripartum maternal diseases. Unfortunately, such a strategy remains investigational. Different types of vaccines are in development or undergoing clinical trials in healthy non-pregnant adults.

In the late 1980s, different methods of chemoprophylaxis were evaluated, and several reports showed the efficacy of intrapartum penicillin G or ampicillin given intravenously for prevention of GBS EOD.[1,18,19] This approach prevents vertical transmission of group B streptococci from colonized mothers and thus infection of neonates with GBS EOD and also prevents maternal febrile morbidity.[1,4] Both β-lactams have been recommended, but penicillin is preferred for its narrower spectrum. Other agents are recommended for women allergic to penicillin.

Vertical transmission of group B streptococci has been shown to decrease markedly within 2–4 hours of prophylaxis. An interval of at least four hours from the start of prophylaxis to delivery is ideal. Expected efficacy is prevention of 70–75% of cases, but a few cases of GBS EOD will continue to occur even with ideal implementation. The challenge of such a strategy is identification of targets for selective intrapartum chemoprophylaxis – that is women at risk of having an infant with GBS EOD. In the 1990s, several organizations recommended different approaches for the selection of women who should receive chemopropylaxis. Such women could be identified on the basis of prenatal screening cultures positive for group B streptococci or the presence of obstetric risk factors. In 1996, the Centers for Diseases Control and Prevention (CDC) in Atlanta, USA, recommended these two approaches to identify women who should be given intrapartum chemoprophylaxis.[12] The incidence of GBS EOD has declined since these guidelines were released and the use of selective intrapartum chemoprophylaxis has increased. In the USA, a 70% decrease in the incidence was seen, but a plateau in the impact of prevention efforts seemed to have been reached in 1999 with an incidence of 0.5 cases per 1000 live births.[2,4] Different studies evaluated the efficacy of the two approaches, and, for different reasons, they showed the superiority of the prenatal screening-based strategy. An important CDC-sponsored multistate study published by Schrag in 2002 provided the first large-scale comparison of the two approaches.[20] Surveillance for GBS EOD was related to a population of more than 600,000 live births, and a total of 312 cases were recorded. The analysis found that the screening approach was 1.5 times more effective at preventing perinatal GBS disease than the risk-based approach. The superiority of screening stemmed from two main factors. First, 30–40% of women colonized with group B streptococci without obstetric factors who were identified by screening were ignored by the risk-based approach. Second, compliance differed between the two groups: women with a prenatal screening culture positive for GBS were more likely to receive intrapartum antibiotics than women with obstetric risk factors. Furthermore, obstetric risk factors were also present in non-colonized women, so the risk factor-based approach lacked specificity and unnecessarily exposed many women to intrapartum chemoprophylaxis.

In 2002, on the basis of the available evidence for a strong protective effect of prenatal GBS screening compared with the risk-based approach, the CDC issued revised guidelines for prevention of perinatal GBS EOD.[21] These revised guidelines have been endorsed by the American College of Obstetrics and Gynecology (ACOG)[11] and the American Academy of Pediatrics (AAP). A single strategy is recommended: universal prenatal GBS screening at 35–37 weeks' gestation and intrapartum chemoprophylaxis for pregnant women with GBS

colonization or, when the result of screening culture is not known at the onset of labour, on the basis of obstetric risk factors.[11,21]

At the same time, other public health organizations, such as in France and Belgium, also evaluated the effectiveness and the feasibility of different strategies rather similar to CDC's guidelines.

### Guidelines from the Belgian Superior Health Council: SHC 7721, July 2003, Ministry of public health and social affairs[3]

Different Belgian studies related to obstetric practice, microbiological procedures and paediatric management for the prevention of GBS EOD clearly demonstrated that widely accepted updated guidelines based on evidence were obviously needed to prevent GBS EOD.[22–24]

In 2002, a working group of experts and representatives of gynaecologists and obstetricians, microbiologists and paediatricians from university and non-university hospitals belonging equally to the French and Flemish communities was appointed by the Superior Health Council (SHC) to review international and Belgian studies and guidelines. The recommendations that resulted were the matter of consensus within the working group and based on available evidence and experts' opinion.

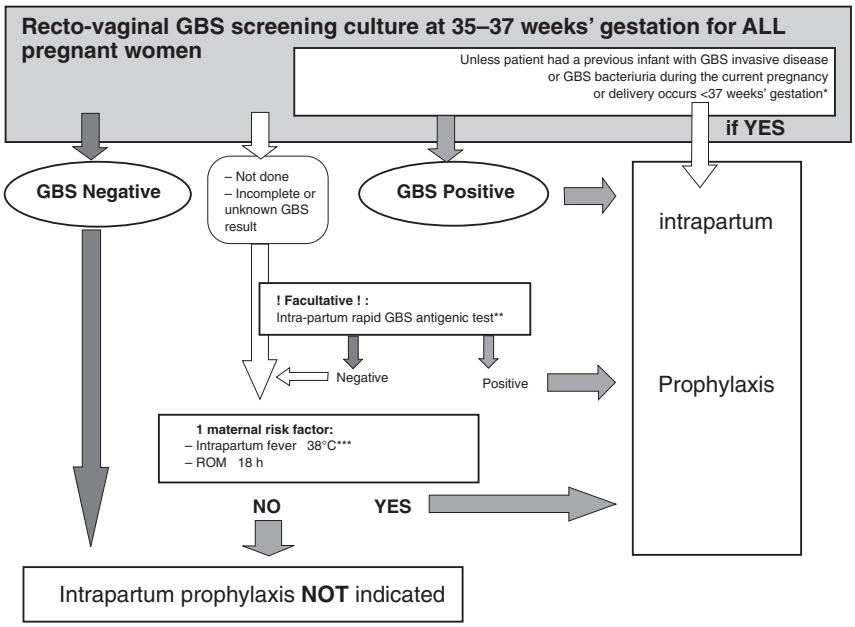
Belgian guidelines for the prevention of perinatal GBS infections were issued by the SHC in July 2003.[13] General and specific guidelines were proposed. These guidelines should be known and implemented in routine practice by gynaecologists, obstetricians, microbiologists, paediatricians and neonatalogists. They are very similar to the CDC's revised 2002 guidelines[21] except for some amendments or added suggestions. The main recommendations are:

- Obstetricians, with the collaboration of supporting bacteriological laboratories and midwives, should comply with the strategy illustrated in Figure 1.
- The goal for prenatal screening cultures should be to predict the vaginal intrapartum GBS colonization status.
- The decision to give intrapartum antimicrobial prophylaxis (IAP) should be guided by screening results. At the onset of labour or rupture of membranes, IAP should be given to all women colonized with group B streptococci. Other indications and conditions for IAP are described in Figure 1.

For more specific conditions or more detailed descriptions, the full text is available in English, Flemish or French on SHC's website at www.health.fgov.be/CSH_HGR/.[13] Additional algorithms for the management of threatened preterm delivery and women colonized with group B streptococci due to undergo planned caesarean deliveries are also provided in the full text.

#### *Prenatal screening for GBS*

The sensitivity and specificity of antenatal cultures six or more weeks before delivery for identifying the colonization status at delivery are rather low, and the




*An algorithm for prophylaxis of group B streptococci for patients in whom onset of labour or rupture of amniotic membranes occurs before 37 weeks' gestation and the risk of preterm delivery is significant (as assessed by the clinician) is suggested in the guidelines.[13]
**Currently, only one test – the Strep B OIA (Thermo BioStar) – shows appropriate sensitivity and specificity.
***If amnionitis is suspected, broad-spectrum antibiotic therapy that includes an agent known to be active against group B streptococci should replace the GBS prophylaxis.

**FIGURE 1** Indications for intrapartum antibiotic prophylaxis to prevent perinatal group B streptococcal (GBS) disease under a universal prenatal screening strategy. Adapted from Belgian guidelines[13]

results will not accurately predict this status. Predictive values increase as delivery nears, but so does the number of women who deliver before culture or results are available.[25] For the best compromise between prediction of colonization and timing of screening, the guidelines advise the practitioner to obtain cultures at 35–37 weeks' gestation. According to numerous studies, careful attention must address the anatomical sites swabbed and the precise bacteriological methods used to enhance the accuracy of prenatal screening. The guidelines detail both topics. To increase the yield of group B streptococci and the detection of very low inocula, lower vaginal and rectal swabs must be collected, and cultured in a selective enrichment broth followed by subculture on to a Granada-like agar is recommended. Granada medium agar allows easy identification of group B streptococci on the basis of the production of a specific orange pigment. The full procedure is provided in the SHC guidelines. Specific guidelines for collection and transport of specimens for screening are summarized in Table 2.

**TABLE 2** Obstetrician's procedure for collecting specimens for prenatal screening for GBS. Adapted from Belgian guidelines.[13]

| | |
|---|---|
| **When** | • Collect specimen **at 35–37 weeks'** gestation |
| **Who** | • **All** pregnant women at the time of pregnancy |
| **Which site** | • **Vaginal swab**: lower vagina<br>• **Rectal swab**: through anal sphincter |
| **Material** | • **One** (or two) **swab**(s) **for collection of both sites** placed in non-nutritive transport medium (eg Amies or Stuart without charcoal) |
| **Storage and transport** | • Transfer specimens to laboratory within the day<br>• If any delay, refrigerate specimens (2–8°C) for no longer than 48 hours |
| **Requesting form** | • **Clearly request** culture for GBS screening<br>• **Communicate** the address of expected delivery facility |

For all pregnant women identified as carriers of group B streptococci, intrapartum chemoprophylaxis must be scheduled. It is important to remember, however, that antibiotics should not be given during pregnancy to treat GBS colonization unless the pregnant women has a bacteriuria with group B streptococci. Such treatment is not helpful in eradicating GBS colonization or preventing perinatal GBS infections and, furthermore, is associated with adverse effects.

**[QtoA: Contradiction ? Stated that antibiotics should not be given during pregnancy, but previous para recommends intrapartum penicillin – distinction *pregnancy* and *delivery*?]**

### *Regimens for antimicrobial prophylaxis*

To date, all human isolates of group B streptococci remain uniformly susceptible to penicillin G and other members of the penicillin family. Penicillin is the first-line antibiotic for intrapartum prophylaxis of GBS disease because of its narrow spectrum of action and the resultant decreased potential for selection of resistant strains and because of evidence of its efficacy. The recommended regimen and alternatives for women allergic to penicillin are summarized in Table 3.

**TABLE 3** Recommended regimens for intrapartum antimicrobial prophylaxis for prevention of perinatal GBS disease.
Adapted from Belgian guidelines.[13]

| *Recommended regimen* | *Regimen recommended for women allergic to penicillin* |
|---|---|
| • 5 millions units penicillin G intravenously followed by 2.5 millions units intravenously every eight hours until delivery | • Patients not at high risk for anaphylaxis:<br>  ○ 2 g cefazoline intravenously followed by 1 g<br>• Patients at high risk for anaphylaxis:<br>  ○ 900 mg clindamycin intravenously every eight hours until delivery<br>  ○ If group B streptococci resistant to clindamycin, request microbiologist's opinion |

### *Management of neonates at risk for group B streptococcal early-onset disease*

Although the management of ill neonates with suspected infection and/or neonates at high risk of infection is well defined, the management of asymptomatic neonates is more problematic. Numerous unnecessary diagnostic evaluations have been performed and too many useless antimicrobial treatments initiated for fear of missing the first signs and symptoms of infection in infants born to women who received antibiotics.[26] An algorithm for the empirical management of infants has been developed to minimize unnecessary investigations and antimicrobial treatments of infants whose mothers received intrapartum prophylaxis to prevent GBS EOD or treat suspected chorioamnionitis. The key parameters to take into account in this decision algorithm are gestational age (<35 weeks or >35 weeks), time between the beginning of antimicrobial prophylaxis and delivery (<4 hours or >4 hours) and the presence of some obstetric risk factors. Stratified and defined diagnostic evaluations, their expected values and the possible treatments are described in detail in the full text of the Belgian guidelines.[13] Unlike the CDC's guidelines, the Belgian guidelines suggest a rational diagnostic approach as well as an empirical treatment to be initiated at birth for asymptomatic infants at very high risk of developing a severe GBS EOD – that is, infants born to women who were given antibiotics for prolonged premature rupture of membranes or suspected chorioamnionitis.

In summary, for asymptomatic newborns with a gestational age ≥35 weeks whose mother received a full IAP (≥4 hours), neither diagnostic evaluation nor empirical antimicrobial prophylaxis is required. Empirical treatment and evaluation for sepsis are recommended, however, for symptomatic infants with suspected sepsis and neonates at very high risk of having GBS EOD. For all other conditions, rational diagnostic evaluations are suggested.[13] Paediatricians should be told which strategy was used, so they can optimally manage newborns.

## Adverse and unintended consequences

Even if the guidelines issued by CDC or the Belgian SHC are currently the most effective to prevent GBS EOD, areas of concern have accompanied these guidelines and are still being debated. More than 20% of women receive antibiotics during labour, and antibiotics can have adverse and unintended effects.[27] The most important are mild allergic reactions, anaphylaxis and selection of antimicrobial resistant pathogens, or the antibiotics could affect the incidence of EOD with organisms other than group B streptococci. [27] Although penicillin allergies occur and the risk of anaphylaxis exists, very few allergic events have been reported since the release of the CDC's 1996 guidelines,[28] and they are greatly offset by reductions in the incidence of maternal and neonatal invasive GBS disease.[20]

Among the unintended consequences of an increased use of intrapartum antibiotics is the potential increased incidence or resistance in non-GBS early-onset pathogens (*Enterobacteriaceae*, ampicillin-resistant *E. coli*, etc). Most studies, including population-based multicentre studies, have found stable or

decreasing rates in non-GBS early-onset sepsis during a period of increasing use of intrapartum antibiotic prophylaxis for group B streptococci.[21] The rare reported increases in antibiotic-resistant early-onset infections in a few studies are not of sufficient magnitude to outweigh the benefits of intrapartum antibiotic prophylaxis. To assure early detection of increases in the rate of disease or deaths caused by organisms other than GBS, our surveillance system of neonatal sepsis by a network of sentinel laboratories must be maintained.

## Effectiveness of the recommended strategy

### *Comparison of cost-effectiveness: screening-based approach versus risk factor-based approach*

Although there might be some fear that the screening-based option will lead to more women being treated, the numbers will be the same for both options if all risks are effectively considered. Direct expenses before delivery of course are higher in the screening-based option and are related to prenatal cultures and the amount of intrapartum prophylaxis given to prevent a case of GBS EOD. When direct and indirect costs associated with a case are considered, however, the percentage of prevented cases is much higher with the screening-based approach, which makes this option more cost-effective than the risk-based approach.[29] In a nice mathematical model of the American population, Benitz, from the Stanford University School of Medicine, clearly showed the superiority of the screening-based approach. A rough simulation applied to Belgian epidemiology and costs reaches the same conclusion.

**[QtoA: need ref here]**

### *Encouraging results of effectiveness in Belgium*

For 10 years, laboratories belonging to the Belgian surveillance network of sentinel laboratories have sent all strains of group B streptococci isolated from invasive infections plus clinical data to the Belgian reference laboratory for group B streptococci. On the basis of cases of early and late onset neonatal disease reported per year from 1999 to 2004, an increase of the ratio of LOD:EOD has been observed: 0.16 in 1999 to 0.52 in 2004.[30] The number of cases of GBS LOD remains quite stable, but the number of cases of EOD is decreasing (Figure 2). These observations should be confirmed for 2005–06, as the Belgian guidelines for prevention of GBS perinatal disease are now implemented in most delivery facilities and laboratories. With the policy chosen in Belgium, further reduction of the cases of GBS EOD is expected.

## Future prevention strategy

While effective and safe vaccines are awaited, other approaches should be designed and evaluated.

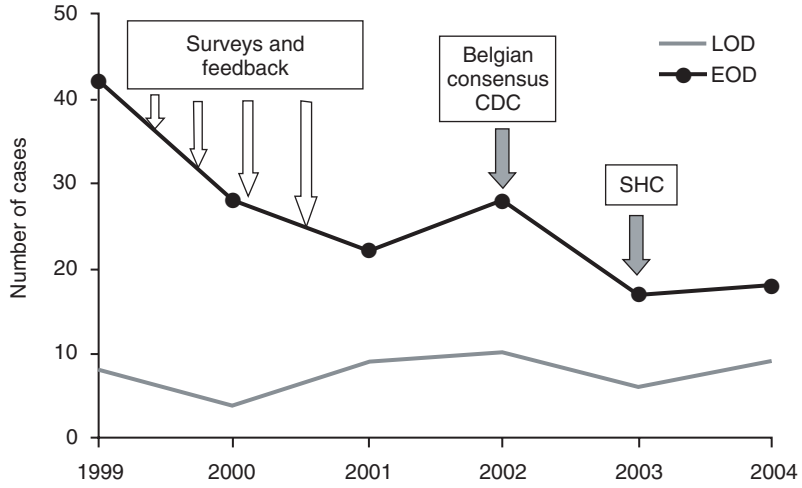



**FIGURE 2** Number of cases of group B streptococcal (GBS) early-onset disease (EOD) and late-onset disease (LOD) declared per year to the reference laboratory for group B streptococci by the Belgian surveillance network of sentinel laboratories. SHC, definition to be included

### *Intrapartum screening for group B streptococci*

Use of a rapid screening test performed on a vaginal swab collected at the onset of labour or at the time of rupture of the membranes should more accurately identify women at risk of giving birth to a neonate with GBS EOD and thus substantially reduce unnecessary intrapartum antibioprophylaxis. A sensitive and specific test will decrease the numbers of false negatives and false positives seen with prenatal screening or the risk-based approach, but its turnaround time should not exceed one hour or too many women identified as GBS carriers will not receive adequate intrapartum chemoprophylaxis before delivery (>4 hours). Furthermore, it should be easy-to-use and convenient for integration into a laboratory 24 hours a day, seven days a week.

Recently, real-time polymerase chain reaction (PCR) tests for detection of group B streptococci have been evaluated and are very promising. The most recent in this category is the GBS GeneXpert test from Cepheid, which is a sophisticated genetic tool designed for fully automated detection in about one hour from an unprocessed vaginal swab to a result. New clinical trials are needed to confirm the expected superiority of a strategy that uses such tests.

### *Vaginal disinfection approach*

Several studies, particularly from northern Europe, showed that vaginal douching with chlorhexidine during labour reduced both maternal and early neonatal infectious morbidity associated with group B streptococci.[31,32] Other studies,

however, did not demonstrate the advantages of this simple, cheap and harmless method. These conflicting results were related to different protocols, concentrations, volumes and forms of chlorhexidine.

Evaluation of an approach that combines vaginal douching with chlorhexidine during labour for women without obstetric risks with intrapartum antimicrobial prophylaxis for GBS carriers with obstetric risk factors will soon start with two trials – one in the obstetrics department of the University Hospital of Liege, Belgium, and the second in the University Hospital of Leon, Nicaragua. While maintaining effectiveness at preventing neonatal GBS EOD and maternal morbidity, this strategy should significantly reduce antibiotic prophylaxis and should be effective even for women not screened during pregnancy or for whom screening results are not available.

## Conclusion

The Belgium group of experts of the SHC recommended intrapartum antimicrobial prophylaxis to prevent neonatal GBS EOD based on a universal prenatal screening for GBS. On the basis of evidence, this is currently the most effective method to prevent neonatal GBS EOD and related maternal morbidity. These guidelines are considered as an interim policy until GBS vaccines achieve licence.

Even with ideal implementation, cases of GBS EOD will continue to occur. The goal is a reduction of 70% of cases, which equates to 300 cases per year in Belgium. For ideal implementation, all means of improving collaboration and communication between gynaecologists, bacteriologists and paediatricians must be used. Another key for success is the integration of these recommendations in to the routine management of women and neonates during pregnancy and at delivery without incurring excessive costs or increased workload.

Many details of the proposed strategies are important for optimal efficacy and minimal adverse effects. Conditions for prenatal screening are crucial to reach satisfactory predictive values of the GBS colonization status at delivery, as are the means for reporting and communicating those screening results.

**[? To A: is this what you meant?]**

In the near future, evaluation of new strategies, such as the use of rapid, real-time PCR testing for intrapartum screening or vaginal douching with chlorhexidine during labour, could lead to a revision of the current recommendations.

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## Discussion

**EGIL LINGAAS:** Intravaginal chlorhexidine may also prevent neonatal HIV infection.

**PIERRETTE MELIN:** It may possibly also prevent herpes – a colleague is currently evaluating prevention of viral infections.

**EGIL LINGAAS:** Does your colleague use neutralizer, which could risk a false-negative culture, when taking cultures from neonates?

**PIERRETTE MELIN:** I am not familiar with this aspect of the protocol.

**RICHARD HILL:** Does intravaginal douching with chlorhexidine have side-effects?

**PIERRETTE MELIN:** It does not seem to have side-effects, and none have been reported in the papers seen thus far.

**EGIL LINGAAS:** What is your current regimen for empirical therapy for newborns with symptoms of invasive infection after intrapartum penicillin? Do you use penicillin, ampicillin or something else?

**PIERRETTE MELIN:** We use ampicillin as the β-lactam but in combination with an aminoglycoside. After 48 hours (once laboratory results are available) penicillin can be given for group B streptococci. For GBS bacteraemia, we recommend a course of 10 days but the duration of treatment is longer (at least two weeks) for meningitis.

**EGIL LINGAAS:** Is neonatal *Klebsiella* infection a potential side-effect of ampicillin?

**PIERRETTE MELIN:** Reference laboratories and a system of sentinel laboratories report all neonatal infections that occur during the first month of life. We see very few cases of infection with *Klebsiella*. Over the last three years, we have seen a decrease in all Gram-negative pathogens, an increase in *S. aureus* and a slight increase in cases of group A streptococci in some centres.

**PETER HEEG:** How do you give the chlorhexidine and at what concentration?

**PIERRETTE MELIN:** We give 120 ml of 0.2% aqueous solution (made up by the pharmacy) via a catheter with a large syringe every six hours. The catheter is withdrawn slowly as the chlorhexidine begins to flow. The solution remains in situ. We have tried a gel, but it does not work. The concentration of 0.2% was decided after literature review and discussions with Dr Pedersen.

**RICHARD HILL:** Is there any value in using aqueous chlorhexidine to disinfect the skin of newborn babies?

**PIERRETTE MELIN:** I do not know at the moment, but we are just completing a full review of the literature.

**RICHARD HILL:** Have you studied the sites of colonization in newborn babies?

**PIERRETTE MELIN:** We have sampled the ears, throat, umbilicus and sometimes groin in large epidemiological studies. One to multiple sites can be colonized and the intensity of colonization also varies.