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Distribution and Prevalence of Serotypes of Group B *Streptococcus* Isolated from Pregnant Women in 30 Countries: A Systematic Review

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Abstract

Objective: This review aimed to compile scientific data on the distribution and prevalence of group B *Streptococcus* (GBS) serotypes isolated from pregnant women across 30 countries from 2010 to 2019.

Methods: This was a systematic review that addresses the distribution and prevalence of GBS in pregnant women. The search included studies published between January 2010 and December 2019 in PubMed, Virtual Health Library (BVS), ScienceDirect, Scientific Electronic Library Online (SciELO), and LILACS databases. We also surveyed relevant articles published in English, Spanish, and Portuguese between February and April 2020. Original articles, communication, short report, theses, and dissertations were included. The prevalence of GBS colonization, method for capsular serotyping, antimicrobial resistance, distribution and prevalence of serotypes were extracted from each study.

Results: In all, 795 publications were identified. After applying the eligibility criteria, 48 articles were included for the final systematic analysis; most articles were from Asia and were published during the years 2014 to 2017. For the identification of serotypes, most studies used the polymerase chain reaction technique. There were records of all 10 GBS serotypes, namely, Ia, Ib, and II–IX, among the countries analyzed. GBS susceptibility and resistance to antibiotics were addressed in 37.5% of the publications analysed.

Conclusion: This review showed that GBS serotypes are distributed differently in the 30 analyzed countries, with serotypes Ia, Ib, and II to V being the most prevalent. Furthermore, our results highlighted the relationship of GBS with maternal colonization, implications for neonates, and antibiotic resistance.

Keywords: *Streptococcus agalactiae*; Serotype; Pregnant women

Introduction

Streptococcus agalactiae or group B *Streptococcus* (GBS) is an encapsulated gram-positive bacterium that can colonize the human gastrointestinal and genitourinary tracts. GBS can trigger infections such as pneumonia, meningitis, and sepsis in neonates and is hence associated with significant rates of morbidity and mortality.[1–6] In Brazil, the severity of infections represents a public health problem.[4] Pregnant women are the main reservoir of GBS. Anovaginal and prenatal screening between the 35th and 37th weeks of gestation and intrapartum prophylactic antibiotic therapy are recommended by the Centers for Diseases Control and Prevention (CDC) and can reduce the risk of GBS infection by up to 78% in neonates.[2–4,7]

The sialylated capsular polysaccharide (CPS) is the most relevant virulence factor of GBS that provides protection against the host's immune defense system, thereby causing the microorganism to escape phagocytosis.[8–13] Based on CPS antigenicity, there are 10 identified serotypes—Ia, Ib, and II–IX.[8,14] Thus, serotype identification is vital to determine the capacity for aggression and antimicrobial resistance, in addition to contributing to the knowledge of disease epidemiology and vaccine development.[3,14,15]

Serotypes can be determined using techniques such as latex agglutination and polymerase chain reaction (PCR).[16,17] In the first technique, specific antibodies, available in reliable and easy-to-use commercial kits, are used for CPSs, whereas the PCR is based on the amplification of nucleotide sequence of the genes responsible for the capsular constituents. PCR has greater sensitivity and specificity in the identification of GBS than latex agglutination assay.[9,16]

Serotypes Ia, Ib, II, III, and V are the most infectious and most causative types worldwide.[8,14] The distribution and prevalence vary according to the geographical location, clinical origin of the strain, and the ethnic origin of the population.[3,4,17–19]

Considering the importance of this microorganism in public health and because GBS serotypes are related to maternal colonization and can influence newborn morbidity and mortality rates, the present review aimed to compile relevant publications in the last 10 years involving GBS in

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pregnant women. We hope that this review can be a useful source of consultation and enable better understanding and that the applicability of this knowledge can help adopt appropriate methods to cope with diseases caused by GBS.

Methods

This is a systematic review conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement checklist recommendation.

Eligibility criteria

Types of study

We included publications that addressed the distribution and prevalence of GBS serotypes in pregnant women, published between January 2010 and December 2019. Articles published in English, Portuguese, and Spanish were screened. Original articles, communication, short report, theses, and dissertations were included. Studies with cross-sectional, cohort type, and randomized clinical trial design were included.

Exclusion criteria

Review articles, case reports, and articles published in languages other than English, Portuguese, and Spanish were excluded.

Types of participants

Pregnant women with anovaginal samples showing evidence of GBS colonization.

Type of outcome measures

Determination of the distribution and prevalence of isolated GBS serotypes in pregnant women.

Search

For the search strategy, 5 databases were consulted: PubMed, Virtual Health Library (BVS), ScienceDirect, Scientific Electronic Library Online (SciELO), and LILACS. The following keywords were used as the search terms: serotypes, streptococcus agalactiae, pregnant women, serogroup, and distribution.

The search strategy in each database was performed as described in the Appendix Table 1. The search was carried out by two authors (M.M.S. and E.A.S.) independently, between February and April 2020. The studies were limited to humans and published between January 2010 and December 2019, including the most relevant, selected studies according to the previously established eligibility criteria.

Study selection

The two aforementioned authors (M.M.S. and E.A.S.) independently carried out article selection. Subsequently, duplicate articles were checked and excluded, followed by reading and selecting abstracts. Those that did not deal with the distribution and prevalence of serotypes of pregnant women were excluded. Finally, the full texts of the articles that met the eligibility criteria were read. Doubts were resolved by consensual decision of the authors. In case of doubt or disagreement, the opinion of a third author (M.V.O.) was considered regarding the inclusion or exclusion of the study.

Data collection process

After reading all the articles, information was selected to compose the list of data that would be necessary for the analyses.

Data items

The following information was extracted from each study: year of publication, language, geographic location, objectives, methodology, prevalence of GBS colonization, gestational period, method for capsular serotyping, antimicrobial resistance, and distribution and prevalence of serotypes. Data from each included study were extracted using a standardized table available (Supplementary Table, http://links.lww.com/MFM/A20).

Results

Study selection

After applying the search terms, 795 articles were identified: 167 in PubMed, 176 in BVS, 448 in ScienceDirect, two in SciELO, and two in LILACS.

Using previously established eligibility criteria, 48 publications were selected for the final systematic analysis, with 44 articles, two theses, and two dissertations. Figure 1 shows the selection and distribution of publications according to the databases from the first search to application of all selection criteria.

Study characteristics

Most studies were published in the period between 2014 and 2017 (50.0%, n = 24), followed by publications between 2010 and 2013 (20.8%, n = 10) and between 2018 and 2019 (29.2%, n = 14). The predominant language of publications was English (87.5%, n = 42), followed by Portuguese (8.3%, n = 4) and Spanish (4.2%, n = 2).

Regarding the distribution of articles regarding geographical location, it was found that Asia (33.3%, n = 16), America (25.0%, n = 12), Africa (22.9%, n = 11), and Europe (16.7%, n = 8) were the continents with the highest number of publications on the topic, followed by Western Australia where the number of publications was relatively lower (2.1%, n = 1).

The methodological characteristics of the analyzed studies, anatomical sites of biological sample collection, gestational age at the time of collection, and techniques used to identify GBS are described in Table 1.

All studies aimed (primary or secondary) to determine the prevalence and distribution of GBS serotypes in pregnant women. This objective was achieved by identifying 8389 isolates of a total of 46,208 pregnant women with GBS colonization who were recruited for the studies included in our analysis, with colonization rates ranging from 4.9% to 33.7%.

There were records of all 10 GBS serotypes (Ia, Ib, and II–IX), with I to V being the most commonly detected serotypes. In studies carried out in Brazil included in this review (16.7% of the selected articles), serotypes Ia, III, and V were the most prevalent. General information on the distribution and prevalence of each serotype identified in the analyzed studies is presented in Table 2.

Another relevant aspect observed in this review concerns the susceptibility and resistance to antibiotics such as penicillin, clindamycin, erythromycin, and vancomycin, which have been associated with GBS serotype in some studies (37.5%, n = 18).

Discussion

This review compiles information from 48 publications across 30 countries on the distribution and prevalence of GBS serotypes isolated from colonized pregnant women. The colonization rate

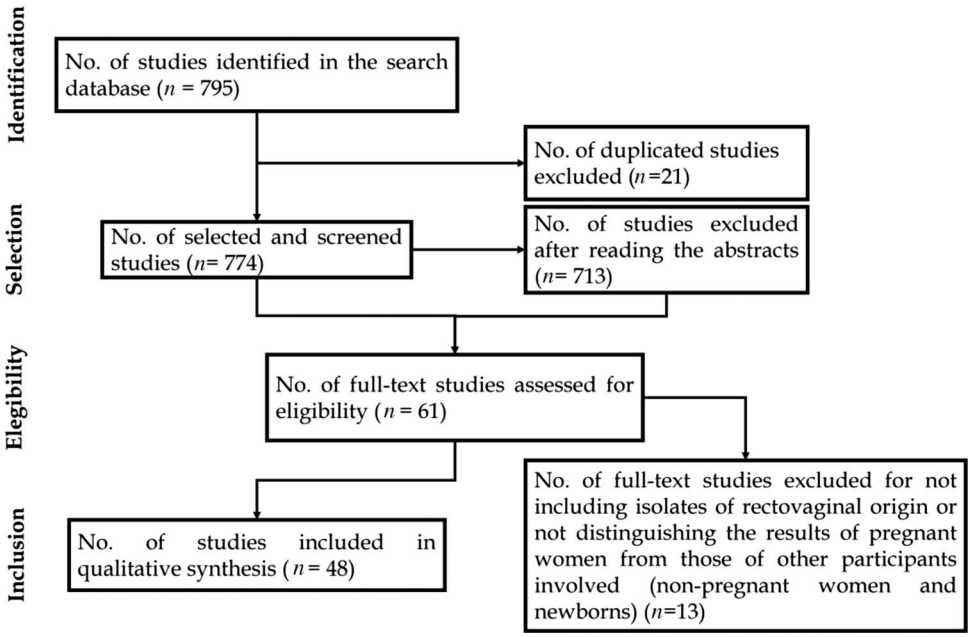

Figure 1. Summary of the study selection process. Adapted from PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses).

Table 1

General characteristics of the studies (*n* = 48).

Items	*n*	%
Study design		
Descriptive and analytical cross-sectional	41	85.4
Cohort	6	12.5
Randomized clinical trial	1	2.1
Data source		
Biological sample	32	66.7
Biological sample, interview, and questionnaire	11	22.9
Biological sample and others (files, laboratory record, examination registration form, and personal data sheet)	5	10.4
Biological sample collection sites		
Vagina and rectum (single swab)	28	58.3
Vagina (single swab)	10	20.8
Vagina and rectum (2 swabs, one for each site)	7	14.6
Vagina, rectum, and a combined vagina/rectum specimen (one swab for each site)	3	6.3
Gestational age at the time of collection		
35th and 37th weeks	17	35.4
Third quarter	14	29.2
Birth	7	14.6
Did not report gestational period	7	14.6
Prenatal and childbirth	2	4.2
Any gestational period	1	2.1
Techniques used		
Molecular biology (polymerase chain reaction)	20	41.7
Latex agglutination	14	29.2
Both techniques	14	29.2
Types of projects		
Single-center	32	66.7
Multi-center	16	33.3

ranged from 4.9% to 33.7%, reported in China[25] and Gambia,[42] respectively. Colonization may be asymptomatic in the vagina and rectum,[23] but GBS is a causative agent of disease in neonates.[35] Approximately 50% to 70% of colonized pregnant women can transmit GBS to the neonate in the uterus via the ascending route or at the time of delivery, with 1% to 3% of colonized neonates developing invasive diseases[23,30,31,34,35] if prophylactic measures are not taken.[38] In this way, colonization by GBS in pregnant women is quite relevant, as it promotes and increases the risk of these diseases.[21,38] With regard to distribution and prevalence, studies have shown that all 10 GBS serotypes were found in the countries analyzed. Serotypes Ia to V were the most prevalent, and serotypes VI to IX were the rarest.

Diseases caused by GBS and prophylactic measures

Diseases caused by GBS in neonates can be of early (manifesting up to the seventh day of life) or late (manifesting between seven days and up to three months of life)[30,36,37,41] onset, characterized as the main causes of neonatal morbidity and mortality[25,27,43] and can trigger pneumonia, sepsis, or meningitis, with 30% to 50% of neonates progressing with neuropsychomotor sequelae and 10% having a fatal outcome.[34]

Among the measures adopted to reduce the vertical transmission of GBS, many of the analyzed studies endorsed the CDC recommendations, that is, universal screening for detection in the anovaginal tract between the 35th and 37th weeks of pregnancy and prophylactic intrapartum antibiotic therapy.[3,19,20,24,30,34,37,38,41] The demarcation of this period is important, because the state of positive colonization during pregnancy can change, and it is at this stage of the gestational period that an increase in the prevalence of colonization can be detected.[16,22] However,

Table 2

Prevalence of GBS in the countries analyzed.

No.	Countries/continent	References	Distribution and prevalence of GBS serotypes isolated from pregnant women, %										
			Ia	Ib	II	III	IV	V	VI	VII	VIII	IX	NT
1	Africa	Chukwu *et al.*,[18] 2015	22.9	11.5	5.7	34.3	8.5	14.3	—	—	—	—	2.8
		Mukesi *et al.*,[15] 2019	9.0	3.0	52.2	17.9	1.5	16.4	—	—	—	—	—
		Slotved *et al.*,[6] 2017	3.6	—	1.7	3.5	5.5	5.3	—	42.8	5.5	32.1	—
		Belard *et al.*,[20] 2015	12.8	22.9	6.5	27.5	—	30.3	—	—	—	—	—
		A'Hearn-Thomas *et al.*,[21] 2019	21.0	4.0	4.0	23.0	2.0	46.0	—	—	—	—	—
		Kwatra *et al.*,[22] 2014	36.2	4.6	7.2	35.0	2.0	11.9	—	—	—	1.8	1.3
2	United States of America	Burcham *et al.*,[8] 2019	12.8	15.4	15.4	25.6	2.6	28.2	—	—	—	—	—
3	China	Lu *et al.*,[23] 2014	21.4	11.9	7.0	41.8	—	14.9	1.5	0.5	—	—	1.0
		Yan *et al.*,[5] 2016	22.5	10.4	5.2	35.9	—	21.2	1.3	0.9	—	—	2.6
		Wang *et al.*,[19] 2015	17.9	16.1	5.4	32.1	—	14.3	—	—	—	—	14.2
		Ji *et al.*,[24] 2017	17.7	13.1	—	54.9	—	6.5	1.3	—	0.7	—	5.9
		Wang *et al.*,[25] 2018	22.2	7.6	—	49.1	1.9	18.2	1.0	—	—	—	—
		Lin *et al.*,[26] 2016	—	12.5	—	25.0	—	25.0	37.5	—	—	—	—
4	Germany	Kunze *et al.*,[27] 2011	16.0	19.0	12.0	28.0	6.0	15.0	—	—	—	—	4.0
5	Asia	Turner *et al.*,[28] 2012	15	1.7	24.2	12.5	7.3	12.5	15.0	7.3	—	—	4.5
		Saha *et al.*,[29] 2017	40.0	1.5	14.0	12.0	1.5	23.0	6.0	2.0	—	—	—
6	Jordan	Clouse *et al.*,[1] 2019	24.0	20.0	—	48.0	—	8.0	—	—	—	—	—
7	Portugal	Pinto *et al.*,[30] 2018	19.4	17.9	10.4	22.4	7.5	17.9	1.5	—	—	—	3.0
8	Poland	Brzychczy-Włoch *et al.*,[2] 2012	20.0	8.0	15.0	35.0	5.0	17.0	—	—	—	—	—
9	Brazil	Andrade *et al.*,[17] 2017	46.0	7.0	17.0	10.0	—	20.0	—	—	—	—	—
		Soares *et al.*,[31] 2014	6.0	6.0	9.1	39.4	—	24.3	—	—	—	—	15.2
		Botelho *et al.*,[3] 2018	37.3	11.2	19.9	6.8	3.5	9.1	—	—	—	—	12.2
		de Almeida Corrêa *et al.*,[32] 2011	33.2	1.7	15.0	5.0	1.7	15.0	—	—	1.7	—	26.7
		Nascimento,[33] 2019	47.2	2.3	4.5	20.4	—	15.9	—	—	—	2.9	6.8
		Feuerschuette,[34] 2018	35.5	1.5	21.5	9.7	3.7	26.7	—	0.7	0.7	—	—
		Siqueira,[4] 2017	49.0	7.5	9.0	1.5	—	31.1	—	—	1.5	—	0.4
		Botelho,[16] 2014	41.0	11.0	26.0	11.0	—	11.0	—	—	—	—	—
10	Iraq	Hassan and Saleh,[35] 2019	22.2	11.2	5.5	8.4	30.5	19.5	2.7	—	—	—	—
11	Ethiopia	Ali *et al.*,[36] 2019	20.5	11.4	31.8	13.5	—	18.2	—	—	—	—	4.6
12	Canada	Teatero *et al.*,[37] 2017	23.0	13.0	9.0	25.0	5.0	19.0	1.0	—	—	—	5.0
13	Spain	López *et al.*,[38] 2018	17.9	4.2	31.6	26.3	10.5	9.5	—	—	—	—	—
14	Nigeria	Elikwu *et al.*,[39] 2016	23.9	19.5	17.5	21.7	—	15.2	2.2	—	—	—	—
15	Argentina	Oviedo *et al.*,[40] 2013	40.0	9.0	10.0	21.0	—	12.0	—	—	—	4.0	4.0
16	Japan	Morozumi *et al.*,[41] 2015	15.6	20.8	4.5	16.9	3.2	17.6	12.4	—	8.4	—	0.6
17	Gambia	Le Doare *et al.*,[42] 2016	8.4	8.0	16.4	10.1	—	55.0	—	—	—	—	2.1
18	Lebanon	Seoud *et al.*,[43] 2010	14.6	6.6	10.9	16.1	0.7	22.6	—	—	—	—	28.5
19	Korea	Lee *et al.*,[10] 2019	—	21.1	10.5	42.1	5.3	15.7	5.3	—	—	—	—
20	Iran	Sadeh *et al.*,[11] 2016	16.6	6.7	20.0	50.0	—	6.7	—	—	—	—	—
21	Zimbabwe	Mavenyengwa *et al.*,[14] 2010	15.7	11.5	8.3	38.8	—	24.0	—	—	—	—	1.7
22	Switzerland	Fröhlicher *et al.*,[44] 2014	19.2	6.8	10.6	29.4	3.8	25.5	0.3	0.5	0.3	3.6	—
23	Egypt	Shabayek *et al.*,[13] 2014	14.0	8.0	17.0	15.0	1.0	33.0	12.0	—	—	—	—
24	Japan	Kimura *et al.*,[45] 2013	7.0	12.0	11.0	10.0	—	15.0	13.0	1.0	9.0	—	22.0
25	Colombia	García *et al.*,[46] 2011	0.3	—	—	—	—	—	—	—	—	—	99.7
26	Spain	Liébana-Martos *et al.*,[47] 2015	23.1	2.8	15.1	29.9	4.7	17.5	—	0.5	—	4.2	2.2
27	Greece	Liakopoulos *et al.*,[48] 2014	—	20.5	—	52.0	26.4	1.1	—	—	—	—	—
28	Norway	Brigtsen *et al.*,[9] 2015	15.8	9.9	13.8	24.9	14.1	16.9	0.5	—	0.7	2.7	0.7
29	Western Australia	Furfaro *et al.*,[49] 2019	27.9	8.4	16.3	20.9	2.8	15.7	5.1	—	0.5	0.5	1.9
30	Korea	Hong *et al.*,[50] 2010	13.0	6.8	5.6	35.6	2.3	24.3	—	—	—	—	12.4

—: Serotypes not detected.

NT: Not typable.

Furfaro *et al.*[49] demonstrated that there was no significant change in colonization between the second and third trimesters, calling attention to the need for early screening, mainly because of its implications for pregnant women at high risk of premature birth. According to these authors, many women in this condition are not screened for GBS.[49]

Six studies reported that colonized pregnant women were referred for prophylaxis,[2–4,6,14,16] and the others presented

screening information, but without an approach about prophylactic measures.[18–20,26,29,30,41,42,49,50] Among the pregnant women screened at delivery, only some were treated with antibiotics, whereas there was no report of any type of intervention in this regard in other studies.[1,9,21,25,27,43,47] Two studies dedicated to the study of GBS colonization in other gestational periods reported treatment through the use of antibiotics of pregnant women.[15,24] The others provided only screening data for GBS.

In the United States, the adoption of therapeutic measures for pregnant women colonized with GBS is a common practice in late pregnancy and/or childbirth because of the high risk of infection in the newborn.[8] Teatero *et al.*[37] reinforced that screening and adoption of prophylactic measures used in collaboration considerably reduced early-onset disease in both the United States and Canada. Other countries have also adopted these recommendations. The national guidelines in Germany recommend screening, whereas in Argentina, screening is mandatory in all pregnant women between 35th and 37th weeks.[19,41] Japan recommends screening for pregnant women between the 33rd and 37th weeks and intrapartum antibiotic prophylaxis for positive cases, whereas the Polish guidelines have been created for preventing GBS in line with the CDC guidelines.[2,41] However, not all countries adopt such strategies.

In Brazil, the Pediatrics Society recommends screening for GBS since 2011. However, compliance with the CDC's recommendations is incipient, and the adhesion is low.[3] A study carried out in 2017 in the Brazilian Federal District reported that screening was not routinely performed in hospitals and private clinics. It also added that knowledge about GBS, its prevalence, resistance, and risk of infection in neonates would be necessary for future implementation of a guideline that promotes the reduction of maternal colonization and neonatal infection.[4] Another study highlighted the need for regional investigations that demonstrate the incidence of sepsis to conduct prophylaxis and reiterated the absence of national studies to assess the cost-effectiveness of intrapartum prophylaxis.[33] Feuerschuette[34] and Botelho[16] agreed that there is no formal guidance or consensus on screening for GBS in Brazil. The other studies did not discuss this aspect.[31,32,40]

Regarding the relationship between clinical manifestations of diseases and GBS serotypes, a publication pointed out that most diseases in neonates are linked to serotypes Ia, Ib, II, or III.[4,41,45] Serotype III has been associated with cases of meningitis and sepsis (60%–85% late-onset diseases), and in the case of meningitis, serotype III has been linked to both early- and late-onset disease.[33,39] Associations of other serotypes with invasive disease in adults and neonates have also been observed. For example, serotypes IV and VI were associated with early disease in neonates and invasive infections in pregnant women, and serotype IV was associated with disease in nonpregnant women.[14,26,31,35,38] The other serotypes VII, VIII, and IX were detected in pregnant women but were not associated with clinical manifestations.[6,24]

Prevalence and distribution of serotypes

In Asian and European countries, serotype III was the most prevalent.[1,2,9–11,18,20,23,29,39,41,48,49] In these regions, the predominance of serotypes Ia, IV, and V has also been reported and, to a lesser extent, serotypes VI, VIII, and IX.[9,27,31,32,35,50] According to Lee *et al.*,[10] the prevalence and distribution of GBS depend on the region of the study. Wang *et al.*[19] indicated that the difference in distribution can also be associated with both the source of origin of the isolates and the technique used to identify them.

Studies carried out in the African continent detected serotypes II, V, VII, III, and Ia, following the order of highest prevalence.[6,13,14,42,45] Slotved *et al.*[6] addressed an interesting aspect regarding the variation of serotypes, wherein the geographic location was identified as one of the causes of changes in the distribution of GBS serotypes among African countries.

In Western Australia, serotype Ia was the most prevalent.[49] The same study identified serotype IX for the first time in the country. The authors believed that the distribution of serotypes was consistent with those predominant in other countries and that the understanding of this regional distribution could assist in clinical practice and definition of therapeutic strategies.

In South American countries, serotypes Ia, III, and V were the most prevalent.[4,15,19,33,44] In Brazil, a study carried out in Santa Catarina showed a higher prevalence of serotypes Ia and V and pointed out as possible justification the better adaptation of these GBS serotypes to colonize as commensals of the anovaginal tract of pregnant women.[34] However, it has been reported that this mechanism has not yet been elucidated, but there could be a deficiency in the maternal immune response that is more effective for such serotypes.[34] It is also important to note that a study carried out in São Paulo and another in Rio de Janeiro identified, respectively, serotypes VI and VIII as the least prevalent, but both records were unpublished in the country.[16,32]

Serotypes, antibiotic susceptibility, and resistance

Another aspect that drew attention concerns the susceptibility and resistance of GBS to antibiotics. Intrapartum antibiotic prophylaxis is the main measure to prevent transmission of the microorganism to the newborn.[3,8,19] It has been indicated that penicillin is the first line of treatment to treat colonized pregnant women, and clindamycin, erythromycin, and vancomycin are alternatives in case of allergy to penicillin.[4,8,28] However, there are concerns about resistance to antibiotics, as it may involve prophylaxis and inadequate treatment.[25] In studies conducted in Brazil, for example, resistance to clindamycin and/or erythromycin was found in isolates of serotypes Ia, Ib, II, III, V, VIII, and IX.[4,17,18,31,33,45] As a result of the increase in this resistance, a study reinforced the more recent guidance of the CDC (2010), which recommends carrying out susceptibility tests in the samples of GBS before treating colonized pregnant women.[15]

In China, high rates of resistance to clindamycin (61.5%) and erythromycin (51.9%) have been detected among isolates of serotypes Ia, Ib, III, and V. In addition to these serotypes, another Chinese study registered serotype II isolates with resistance to these antibiotics.[5,40] In Germany, strains resistant to erythromycin belonged to serotypes Ia, II, III, and V.[40] Based on the verification of resistant strains, this study signaled that antibiotics should be prescribed with caution and emphasized the need for periodic surveillance so that the therapeutic choices are adequate for circulating strains.[19]

In Korea, serotypes III and V showed high rates of resistance to erythromycin and clindamycin.[10] However, in Japan,

increased resistance to erythromycin and clindamycin was shown when compared with previous studies. In the interval of 13 years, resistance to erythromycin changed from 3% to 10.1%, and that of clindamycin increased from 1% to 5% in vaginal samples of pregnant women. There was no link between resistance and GBS serotype, but the need for careful monitoring of antimicrobial susceptibility was highlighted.[32]

In the United States, a study showed that strains of serotypes Ia, Ib, II, III, IV, and V, in addition to being resistant to clindamycin and/or erythromycin, were also resistant to vancomycin, and isolates resistant to penicillin were found among serotypes II, IV, and V.[8] This study was very important, because in addition to demonstrating the rise in resistance to penicillin in vaginal isolates and its possible link to specific serotypes, it suggested that serotyping may be effective to guide treatment in pregnant women colonized by GBS before delivery.

Methods for identifying serotypes

Another important aspect in this review was the highlight of 2 main methods for GBS capsular serotyping. The first was observed in 29.2% publications with the latex agglutination test. In several studies, the use of the Strep-B-Latex kit (Statens Serum Institute, Copenhagen, Denmark) has been verified.[6,16–21,30,43,44,48] However, this method is likely to fail owing to the quality of the antibodies used or the absence or low expression of the CPS. In addition, it can generate a rate considered high for nontypable strains and misclassification.[16] Among the studies that used this test and presented nontypable strains, the rates varied between 3.57% and 27.45%.[18,28] The second method was the use of PCR in 41.7% studies. The most commonly used protocols were those established in 2007 by Poyart *et al.*[51] (22.9%, $n = 11$) and the multiplex PCR protocol developed in 2010 by Imperi *et al.* (31.3%, $n = 15$), which allows the detection of all 10 GBS serotypes in a single reaction and identifies strains not typable by latex.[16] Three studies used real-time PCR (6.3%, $n = 3$), with a protocol for identifying serotypes Ia, Ib, and III only.[1,36,38] The studies that used these protocols resulted in nontypable strains, whose rates varied between 0.622% and 5.88%.[36] It should be noted that a nontypable strain is defined as one whose serotype cannot be identified regardless of the identifying method used.[18]

The strength of the present review is the compilation of serotype data for several countries, which allows the comparison of their distribution by different regions. However, the inclusion of studies only in English, Portuguese, and Spanish as one of the search strategies introduces a selection bias and is a limitation of the review.

Conclusion

There are a large number of publications related to the distribution of GBS serotypes in pregnant women. Serotypes are distributed differently across countries, and some are more prevalent than others. This review suggests that the adoption of measures such as screening for GBS in pregnant women and intrapartum prophylaxis may be good strategies for reducing the occurrence of diseases in neonates. Thus, understanding the distribution and prevalence of serotypes is essential for more efficient decision-making, adequate coping strategies, and the reduction of undesirable complications associated with GBS by the health system.

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Conflicts of Interest

None.

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