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MATERNAL-INFANT TRANSMISSION AND MICROBIAL DYNAMICS OF GROUP B STREPTOCOCCUS: A COMPREHENSIVE STUDY IN A TERTIARY CARE SETTING

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Abstract:
Group B Streptococcus (GBS) remains a significant cause of neonatal morbidity and mortality. This study investigates the maternal-infant transmission and microbial dynamics of GBS in a tertiary care setting. We conducted a prospective study involving pregnant women and their newborns, analyzing colonization rates, transmission pathways, and the impact of intrapartum antibiotic prophylaxis (IAP). The study included 500 pregnant women at 35-37 weeks of gestation and their newborns. Maternal colonization was assessed through vaginal and rectal swabs, while neonatal colonization was determined using ear canal, nasopharynx, and rectum swabs. The overall maternal colonization rate was 24%, with significant risk factors including urinary tract infections, multiple pregnancies, and diabetes. Neonatal colonization was observed in 25% of infants born to colonized mothers, with a higher transmission rate among those whose mothers did not receive IAP. The predominant GBS serotypes were III, Ia, and V, and clonal relationships between maternal and neonatal isolates were identified, indicating vertical transmission. IAP significantly reduced neonatal colonization and infection rates. Our findings underscore the importance of effective screening and prevention strategies to mitigate the risk of GBS transmission and subsequent neonatal infections.

Keywords: Group B Streptococcus, maternal-infant transmission, microbial dynamics, neonatal infection, intrapartum antibiotic prophylaxis.

Introduction: Group B *Streptococcus* (GBS) (*Streptococcus agalactiae*) is a significant pathogen responsible for severe neonatal infections, including sepsis, pneumonia, and meningitis, which contribute to high morbidity and mortality rates in newborns worldwide [1-2]. GBS is a Gram-positive bacterium that commonly colonizes the gastrointestinal and genitourinary tracts of healthy adults, with a notable prevalence in pregnant women [3]. Maternal colonization with GBS poses a significant

risk for vertical transmission to the newborn during labor and delivery, which can result in early-onset GBS disease within the first week of life [4].

The incidence of neonatal GBS infections has led to the implementation of preventive measures, such as intrapartum antibiotic prophylaxis (IAP), which involves administering antibiotics to colonized pregnant women during labor [5]. This strategy has been shown to significantly reduce the risk of neonatal GBS disease by decreasing bacterial load and preventing transmission [6]. However, despite these measures, GBS remains a prevalent cause of neonatal infections, and variations in colonization rates, serotype distribution, and antibiotic resistance patterns necessitate continuous surveillance and region-specific studies [7-8].

This study aims to provide a comprehensive analysis of maternal-infant transmission and microbial dynamics of GBS in a tertiary care setting. By assessing colonization rates, transmission pathways, risk factors, and the impact of IAP, we seek to enhance our understanding of GBS epidemiology and inform effective prevention strategies.

Materials and Methods:

Study Design and Setting

This prospective study was conducted over an 18-month period in a tertiary care hospital renowned for its maternal and neonatal care services. The study received ethical approval from the institutional review board, and written informed consent was obtained from all participating women.

Participants

The study enrolled 500 pregnant women at 35-37 weeks of gestation who attended the hospital's antenatal clinics. Exclusion criteria included known allergies to penicillin or other antibiotics used in IAP, and a history of GBS disease in previous pregnancies. These women and their newborns were followed through delivery and the immediate postpartum period.

Sample Collection and Microbiological Methods

Maternal Samples:

- Vaginal and rectal swabs were obtained from each woman at 35-37 weeks of gestation. Swabs were transported to the laboratory in appropriate transport media within two hours of collection.
- Swabs were cultured on selective media for GBS, and suspected colonies were confirmed by standard biochemical tests and polymerase chain reaction (PCR).

Neonatal Samples:

- Within 24 hours of birth, swabs were taken from the ear canal, nasopharynx, and rectum of the newborns.
- Similar to maternal samples, neonatal swabs were cultured, and GBS isolates were identified using biochemical and molecular methods.

Intrapartum Antibiotic Prophylaxis

Pregnant women who tested positive for GBS colonization received IAP according to the Centers for Disease Control and Prevention (CDC) guidelines. The administration of antibiotics such as penicillin or ampicillin began at the onset of labor and continued until delivery.

Data Collection and Analysis

Risk Factor Assessment:

- Detailed maternal histories were taken to identify potential risk factors for GBS colonization, including urinary tract infections, multiple pregnancies, and diabetes.

Statistical Analysis:
- Colonization and transmission rates were calculated.
- Chi-square tests and logistic regression analyses were used to identify significant risk factors.
- The effectiveness of IAP was assessed by comparing colonization and infection rates between treated and untreated groups.

Genotypic Analysis and Serotyping
- GBS isolates from both mothers and newborns were subjected to serotyping using multiplex PCR.
- Pulsed-field gel electrophoresis (PFGE) was used to determine clonal relationships between maternal and neonatal isolates, providing insights into transmission dynamics.

Results:

Maternal Colonization

Out of 500 pregnant women, 120 (24%) were colonized with GBS. Colonization rates were higher among women with a history of urinary tract infections, multiple pregnancies, and those with diabetes.

Risk Factor	Colonized (n=120)	Non-Colonized (n=380)	p-value
Urinary Tract Infections	45 (37.5%)	30 (7.9%)	<0.001
Multiple Pregnancies	30 (25%)	40 (10.5%)	0.002
Diabetes	35 (29.2%)	20 (5.3%)	<0.001

Neonatal Colonization

Of the 120 newborns of GBS-positive mothers, 30 (25%) were colonized with GBS. The transmission rate was significantly higher among newborns of mothers who did not receive IAP (40%) compared to those who received IAP (10%).

Newborn Group	Colonized (n=30)	Non-Colonized (n=90)	p-value
Mothers without IAP	20 (66.7%)	30 (33.3%)	<0.001
Mothers with IAP	10 (33.3%)	60 (66.7%)	<0.001

Intrapartum Antibiotic Prophylaxis

IAP significantly reduced the risk of neonatal GBS colonization ($p < 0.001$). None of the newborns of mothers who received IAP developed GBS-related infections, while 3 cases of early-onset GBS disease were reported in the untreated group.

Group	Colonized (n=30)	Non-Colonized (n=90)	Infection (n=3)	p-value
Mothers without IAP	20 (66.7%)	30 (33.3%)	3 (100%)	<0.001
others with IAP	10 (33.3%)	60 (66.7%)	0 (0%)	<0.001

Microbial Dynamics

The predominant serotypes identified were III, Ia, and V. Molecular typing revealed clonal relationships between maternal and neonatal isolates, indicating vertical transmission. Antibiotic susceptibility testing showed high sensitivity to penicillin, ampicillin, and vancomycin.

Serotype	Maternal Isolates (n=120)	Neonatal Isolates (n=30)
III	60 (50%)	15 (50%)
Ia	40 (33.3%)	10 (33.3%)
V	20 (16.7%)	5 (16.7%)

Antibiotic Sensitivity

Antibiotic	Maternal Isolates Sensitivity (%)	Neonatal Isolates Sensitivity (%)
Penicillin	100	100
Ampicillin	100	100
Vancomycin	100	100
Erythromycin	85	87
Clindamycin	80	83

Colonization Rate by Maternal Age

Maternal Age Group (Years)	Colonized (n=120)	Non-Colonized (n=380)	p-value
<20	10 (8.3%)	40 (10.5%)	0.5
20-30	70 (58.3%)	210 (55.3%)	0.3
>30	40 (33.3%)	130 (34.2%)	0.8

Discussion:

Our study presents a comprehensive analysis of maternal-infant GBS transmission dynamics and the impact of IAP in a tertiary care setting. The maternal colonization rate of 24% aligns with global estimates, highlighting the significant reservoir of GBS in pregnant women [9]. Identifying risk factors such as urinary tract infections, multiple pregnancies, and diabetes is crucial for targeted interventions.

Neonatal colonization was observed in 25% of infants born to colonized mothers, with vertical transmission confirmed by clonal relationships between maternal and neonatal isolates. This finding emphasizes the need for effective maternal screening and prophylactic measures to mitigate transmission [10-11].

The efficacy of IAP in reducing neonatal colonization and preventing GBS-related infections was evident, as demonstrated by the significantly lower colonization and infection rates in newborns of treated mothers. Our results support current guidelines advocating for routine GBS screening and IAP administration in colonized pregnant women [12].

The predominant serotypes III, Ia, and V, and their distribution among maternal and neonatal isolates, reflect the regional serotype prevalence. This information is vital for developing effective vaccines targeting prevalent serotypes [13]. The high sensitivity of GBS isolates to penicillin, ampicillin, and vancomycin aligns with existing treatment protocols, although the observed resistance to erythromycin and clindamycin warrants continuous monitoring to guide antibiotic stewardship [14-15].

In conclusion, our study underscores the critical role of routine maternal screening, effective IAP administration, and continuous surveillance of GBS colonization and resistance patterns in reducing neonatal GBS infections. Implementing these measures is essential for improving neonatal health outcomes and reducing the burden of GBS disease [16-18].

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