ROLE OF UMBILICAL BLOOD CULTURE IN DETECTION OF EARLY ONSET SEPSIS IN HIGH-RISK NEONATES.

ABSTRACT:

- **Background:** This prospective observational investigation evaluated the clinical diagnostic precision of Umbilical Cord Blood Culture (UCBC) in comparison with the standard reference technique, Peripheral Vein Blood Culture (PVBC), for isolating Early-Onset Neonatal Sepsis (EONS) among newborns exhibiting maternal high-risk indicators.
- **Materials and Methods:** Pair-matched blood samplings were gathered under meticulous aseptic guidelines directly from the umbilical cord at delivery and via standard peripheral venipuncture upon admission to the neonatal intensive care unit (NICU). The evaluation examined 72 high-risk infants monitored at Sharda Hospital, Greater Noida. Key validity criteria including sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated.
- **Results:** Active culture growth was validated in 11.1% (n=8) of the extracted UCBC specimens and 9.7% (n=7) of the companion PVBC lines. *Staphylococcus aureus* alongside *Escherichia coli* represented the primary bacterial pathogens isolated. Evaluated against the peripheral venous gold standard, the UCBC approach yielded a diagnostic sensitivity of 88.9%, a specificity of 100%, a PPV of 100%, and an NPV of 98.4%. Marked statistical associations were noted between overall culture positivity and baseline variables of preterm delivery ($p < 0.001$) as well as low birth weight ($p = 0.041$).
- **Conclusion:** Umbilical cord blood culturing yields high diagnostic accuracy indices that parallel standard peripheral venous sampling methods. It provides a non-invasive, painless, and practical tracking technique to screen for early-onset infection at delivery without inflicting additional procedural pain on the infant.

Keywords: Early-Onset Neonatal Sepsis, Umbilical Cord Blood Culture, Peripheral Vein Blood Culture, High-Risk Newborns.

INTRODUCTION

Systemic neonatal infections remain a critical driver of infant mortality rates globally. Epidemiological assessments from the World Health Organization (WHO) show that India carries a disproportionate share of global newborn deaths [1]. National records from the Sample Registration System (SRS) place the infant mortality baseline at 19 fatalities per 1000 live births, with a major portion caused by infectious pathways like early sepsis [2]. Early-Onset Neonatal Sepsis (EONS) appears within the initial 72 hours of life and is typically transmitted vertically from the maternal reproductive tract during delivery [4].

While immediate clinical intervention is essential to improve survival, the early clinical presentation of EONS is often non-specific [4]. Peripheral Vein Blood Culture (PVBC) is currently the standard reference technique for diagnostic screening [7]. However, obtaining adequate peripheral venous samples from infants presents practical clinical challenges. These challenges include low sample volumes (0.5–1.0 mL) that lower total culture sensitivity [5,6], procedural distress, and a high risk of sample contamination from common skin flora like coagulase-negative *Staphylococcus* (CoNS) [8]. Low-level bacteremia seen in up to 70% of these infants means drawing the larger blood volumes needed for optimal culture results is rarely clinically practical [5].

Umbilical Cord Blood Culture (UCBC) addresses these sample collection barriers. Extracting blood from the umbilical vessel allows clinicians to secure larger sample volumes immediately after birth without causing procedural pain to the newborn [6]. Prior clinical evaluations show that cord blood can be collected cleanly without contamination, offering a viable diagnostic window before the start of empirical antibiotic therapy [9,10]. This study measures the diagnostic accuracy of UCBC compared to traditional PVBC in a group of newborns with maternal risk exposures [8].

AIM AND OBJECTIVES

1. To evaluate the diagnostic accuracy, sensitivity, and specificity of Umbilical Cord Blood Culture (UCBC) compared to Peripheral Vein Blood Culture (PVBC) in identifying Early-Onset Neonatal Sepsis (EONS).
2. To analyze the distribution profile of primary isolated microbial pathogens across positive culture cohorts.
3. To examine potential correlation markers between culture positivity and clinical baselines such as gestational age, low birth weight, and explicit maternal risk exposures.

MATERIALS AND METHODS

- **Study Design & Setting:** This prospective observational investigation was conducted within the Department of Pediatrics at a tertiary health infrastructure center located in Greater Noida, Uttar Pradesh, India. Formal clearance protocol approvals were verified via the Institutional Ethics Committee, and prior informed consent was signed by parental guardians before sampling.
- **Inclusion Criteria:** The study evaluated newborns with a minimum birth weight >1500 grams and a gestational baseline ≥28 weeks who presented with two or more maternal high-risk markers. These risk factors included maternal premature rupture of membranes (PROM), active leaking per vaginum, foul-smelling amniotic liquor, intrapartum maternal pyrexia (>100.4°F), prolonged labor (>24 hours), or clinical signs of perinatal asphyxia.
- **Exclusion Criteria:** Neonates without identifiable maternal risk factors or cases where parents declined to participate were excluded.
- **Sample Collection Protocols:** Immediately after delivery, an isolated segment of the umbilical cord was tightly clamped. The container skin surface area was scrubbed using 70% isopropyl alcohol. Approximately 1.0 mL of cord blood was drawn from the umbilical vein using aseptic techniques and inoculated directly into pediatric blood culture vials. Following NICU admission, pair-matched peripheral

blood samples were drawn under sterile conditions to run standard cultures alongside complete blood counts (CBC), C-reactive protein (CRP), and absolute neutrophil counts (ANC).

- **Statistical Analysis:** Metrics were processed using SPSS Version 20.0. Continuous arrays are documented as means ± standard deviation, while categorical markers use percentage weights. Significance variations were mapped with Chi-square and Fisher's exact models using a split evaluation point of $p < 0.05$. Sensitivity, specificity, PPV, and NPV equations treated PVBC as the primary reference standard.

RESULTS

Demographic and Baseline Characteristics (table Ⅰ &Ⅱ)

Out of 72 enrolled neonates, 52.8% (n=38) were female and 47.2% (n=34) were male. The baseline cohort showed a mean birth weight of 2.6 ± 0.464 kg and a mean gestational timeline tracking at 37.3 ± 1.97 weeks. Leaking per vaginum was the most common maternal antenatal risk aspect, seen in 68.1% (n=49) of cases, followed by maternal UTIs in 15.8% (n=11). Clinical presentation records show that 65.3% (n=47) of neonates were asymptomatic at delivery, while 25.0% (n=18) required management for respiratory distress. Proactive empirical antibiotics were initiated in 43.1% (n=31) of the neonates. The clinical resolution metrics showed an 83.3% (n=60) formal discharge rate and a 16.7% (n=12) Left Against Medical Advice (LAMA) rate, with zero recorded mortality events.

Table I: Background Characteristics of the Enrolled Neonates (N = 72)

Background Characteristics	Frequency (n)	Percentage (%)
Mean Postnatal Age	1 Day	—
Gender Profile		
Male	34	47.2%
Female	38	52.8%
Birth Weight Strata (Mean: 2.6 ± 0.464 kg)		
≥ 2.5 kg	46	63.9%
1.5 – 2.5 kg	26	36.1%
1.0 – 1.5 kg	00	0.0%
< 1.0 kg	00	0.0%
Gestational Age Groups (Mean: 37.3 ± 1.97 weeks)		
30 – 34 weeks + 6 days	10	13.9%
35 – 36 weeks + 6 days	08	11.1%
≥ 37 weeks	54	75.0%

Table II: Clinical Presentation, Risk Exposures, and Clinical Outcomes (N = 72)

Parameter Segments	Frequency (n)	Percentage (%)
Antenatal Risk Exposures		
Leaking per vaginum	49	68.1%
Urinary Tract Infection (UTI)	11	15.8%
Maternal Fever / Pyrexia	05	6.9%
Premature Rupture of Membranes (PROM)	04	5.6%
Multiple Per-Vaginal Examinations	03	4.2%
Neonatal Clinical Status		
Asymptomatic presentation	47	65.3%
Breathing difficulty / Respiratory distress	18	25.0%
Refusal to feed	04	6.5%
Hypoglycemia	02	2.8%
Hypothermia	01	1.4%
Management & Outcomes		
Empirical Antibiotic Initiation	31	43.1%
Cured and formally discharged	60	83.3%
Left Against Medical Advice (LAMA)	12	16.7%
Expired / Mortality	00	0.0%

Culture Positivity and Diagnostic Performance Metrics (tableⅢ)

Total culture positivity tracking isolated organisms in 11.1% (n=8) of UCBC instances and 9.7% (n=7) within the comparison PVBC samples. Six infants showed double-positive results across both sample types. Microbial analysis revealed

Staphylococcus aureus as the dominant pathogen (66.7% overall; 62.5% in UCBC), followed by *Escherichia coli* (33.3% overall; 37.5% in UCBC).that Sepsis rates were significantly higher in preterm infants (<35 weeks) compared to term infants (55.6% vs 0%, $p < 0.001$) and in low birth weight newborns (<2.5 kg) (66.7%, $p = 0.041$). Toxic granules were found in 22.2% of cord blood samples and 18.1% of peripheral blood samples. The presence of toxic granules in cord blood showed a sensitivity of 69.23% and a specificity of 88.14% compared to peripheral blood findings.

Table Ⅲ Culture Concordance Mapping Relative to Sepsis Status (N = 72)

Culturing Modality	Sepsis Positive (n = 9)	Sepsis Positive (%)	Sepsis Negative (n = 63)	Sepsis Negative (%)
UCBC Positive	8	88.9%	0	0.0%
UCBC Negative	1	11.1%	63	100.0%
PVBC Positive	7	77.8%	0	0.0%
PVBC Negative	2	22.2%	63	100.0%

Table IV: Diagnostic Performance Metrics for Sepsis Detection

Diagnostic Parameters	Umbilical Cord Blood Culture (UCBC)	Peripheral Venous Blood Culture (PVBC)
Sensitivity	88.9%	77.8%
Specificity	100.0%	100.0%
Positive Predictive Value (PPV)	100.0%	100.0%
Negative Predictive Value (NPV)	98.4%	96.9%
Overall Diagnostic Accuracy	98.6%	97.2%

DISCUSSION

Prompt clinical identification of systemic neonatal infections is frequently hindered by non-specific clinical symptoms and technical difficulties in obtaining adequate venous blood volumes. This investigation demonstrates that the diagnostic value of UCBC aligns with or improves upon traditional peripheral sampling methods [8]. The observed UCBC sensitivity of 88.9% matches calculations reported by Kalathia et al. (80% sensitivity, 91.43% specificity) [8] and exceeds indices reported by Meena et al. (66.7%) [9]. While systematic systematic reviews like Dierikx et al. show a lower pooled sensitivity of 42.6%, those variations likely stem from differences in sample collection methods or inclusion criteria across separate study groups [11].

The higher diagnostic yield from cord cultures (11.1%) compared to peripheral venous lines (9.7%) underscores the clinical advantage of obtaining larger sample volumes from the umbilical vein. Collecting samples immediately at birth also protects the culture from the masking effects of early empirical antibiotics, which can cause false negatives in post-admission venous draws. The pathogen distribution patterns tracking *S. aureus* and *E. coli* match global epidemiologic baselines for early-onset neonatal infections. The strong statistical links to preterm delivery and low birth weight underscore the importance of using non-invasive, high-volume tracking tools like UCBC in vulnerable newborn groups.

CONCLUSION

Umbilical Cord Blood Culture is a reliable, painless, and effective method for diagnosing Early-Onset Neonatal Sepsis. It demonstrates high sensitivity (88.9%) and specificity (100.0%) that match or exceed traditional peripheral vein blood cultures [8]. Given its ease of collection and the ability to consistently secure adequate blood volumes, UCBC is a dependable alternative for sepsis screening in high-risk newborns [8]. This holds true particularly in resource-limited settings where pediatric venipuncture experience may vary widely.

LIMITATIONS

This evaluation was conducted as a single-center trial with a modest sample size (N= 72). Larger, multi-institutional clinical validation studies are recommended to confirm these findings before completely replacing peripheral venous culture methods in standard neonatal guidelines.

RECOMMENDATIONS

1. **First-Line Screening Integration:** Implement UCBC protocols as an initial screening tool for neonates meeting maternal high-risk criteria to reduce needle pain and sample delays.
2. **Standardized Training:** Establish clear cleaning and collection guidelines for delivery room staff to prevent contamination of cord samples.
3. **Resource Allocation:** Prioritize UCBC kits in lower-tier healthcare centers where pediatric venipuncture experience may vary, ensuring reliable diagnostic yields.

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DECLARATIONS

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- **Conflict of Interest:** The authors declare no conflicts of interest.

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