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Diagnostic Accuracy of Gastric Aspirate Culture in the Diagnosis of Neonatal Sepsis Taking Blood Culture as the Gold Standard

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ABSTRACT

OBJECTIVE: To determine the diagnostic accuracy of gastric aspirate culture in the diagnosis of neonatal sepsis, taking blood culture as the gold standard.

METHODOLOGY: This cross-sectional study was conducted at the Department of Pediatrics, Ziauddin University Hospital, Karachi, Pakistan, during July 2025 to February 2026. Neonates of either gender aged 0 to 28 days with clinically suspected neonatal sepsis were enrolled through non-probability consecutive sampling. Demographic and clinical data were recorded, and blood and gastric aspirate samples were collected simultaneously for culture. Blood culture was taken as the reference standard. Diagnostic performance of gastric aspirate culture was assessed using a 2 × 2 contingency table. Data were analyzed in IBM SPSS Statistics version 26.0.

RESULTS: Among 140 neonates, the median age at presentation was 4.0 (2.0-7.0) days; 81 (57.9%) were male. Preterm birth was recorded in 62 (44.3%) neonates, low birth weight in 68 (48.6%), perinatal asphyxia in 26 (18.6%), umbilical cord infection in 17 (12.1%), bottle feeding in 45 (32.1%), and prelacteal feeding in 53 (37.9%). Blood culture was positive in 56 (40.0%) neonates. Gastric aspirate culture was positive in 54 (38.6%). Of 56 blood culture-positive neonates, 30 were gastric aspirate positive, while 24 of 84 blood culture-negative neonates were gastric aspirate positive. Sensitivity was 53.6%, specificity 71.4%, positive predictive value 55.6%, negative predictive value 69.8%, and diagnostic accuracy 64.3%.

CONCLUSION: Gastric aspirate culture showed moderate diagnostic performance for neonatal sepsis and performed better as a supportive test than as a definitive diagnostic tool.

KEYWORDS: Blood culture, low birth weight, premature, neonate, sepsis.

INTRODUCTION

Neonatal sepsis encompasses bloodstream infection, meningitis, and pneumonia[1]. The number of deaths due to neonatal sepsis annually is estimated to be 1.6 million globally, of which 99% occur in developing nations[2,3]. Severe neonatal sepsis is a high priority concern in relation to public health problems, especially for a developing nation like Pakistan. In addition to high mortality rates, neonatal sepsis contributes greatly to disabilities in later years of life as well[4]. Blood culture is considered the gold standard for diagnosing neonatal sepsis, but its positivity rates may be influenced by blood volume inoculated, prenatal antibiotic utilization, levels of bacteremia, and laboratory efficiencies[5].

Before the initiation of feeding, the neonatal stomach contains fluid swallowed in utero or during passage through the birth canal[6]. Gastric aspirate (GA) therefore offers a potential window into exposure to amniotic fluid and maternal genital tract flora. Although gastric aspirate culture has been regarded as having limited value for the diagnosis of early-onset neonatal sepsis since the 1970s, interest in this specimen has re-emerged in recent years, particularly for its possible role in identifying intra-amniotic infection and perinatal microbial exposure[7].

There is an ongoing debate about the parameter with ideal sensitivity and specificity for neonatal screening. GA as a screening tool for neonatal sepsis has not been explored much in Pakistan, and findings of this research may help clinicians with early clinical identification of sepsis and timely care to reduce complications and death. This study aimed to determine the diagnostic accuracy of GA culture in the diagnosis of neonatal sepsis, taking blood culture as the gold standard.

METHODOLOGY

This cross-sectional study was conducted at the Department of Pediatrics, Ziauddin University Hospital, Karachi, during July 2025 to February 2026 after approval from the Institutional Ethical Review Committee (No: 10480525SMPED, dated: June 11, 2025). The sample size was calculated using the expected sensitivity of GA culture as 50%, specificity as 70.4%, prevalence of neonatal sepsis as 69.3% [5], a 95% confidence level, and a desired precision of 10%, yielding a sample size of 140 neonates. A non-probability consecutive sampling technique was used.

Neonates of either gender aged 0 to 28 days with clinically suspected sepsis were recruited. Clinically suspected neonatal sepsis was defined as systemic inflammatory response syndrome occurring within the first 28 days of life. Systemic inflammatory response syndrome was considered present when at least two of the following four signs were identified: temperature instability, respiratory dysfunction, cardiac dysfunction, or perfusion abnormalities. Neonates who had died before assessment and sampling, had received antibiotics before admission, had congenital abnormalities, or whose parents or guardians refused consent were excluded.

Written informed consent was obtained from the parents or guardians. Demographic and clinical details included age, birth weight, gestational age, gender, place of residence, Apgar score, duration of hospital stay, umbilical cord infection, history of bottle feeding, history of prelacteal feeding, and perinatal asphyxia. Perinatal asphyxia was diagnosed based on Apgar score, and a neonate was labeled as having perinatal asphyxia if the Apgar score remained between 0 and 3 for longer than 5 minutes. Blood and GA samples were collected at the same time and sent to the institutional laboratory for culture evaluation. Blood culture samples were obtained by venipuncture under strict aseptic measures after skin preparation with spirit and betadine. Two milliliters of blood were drawn with a sterile syringe and transferred into a BacT/ALERT PF bottle using another sterile needle. GA was obtained within 12 hours of life through an infant feeding tube and sent to the laboratory in a plain sterile tube. The blood culture and GA culture reports were reviewed and recorded as soon as the laboratory issued them. Blood culture was taken as the gold standard.

Data were entered and analyzed using IBM SPSS Statistics version 26.0. Quantitative variables were shown as mean±SD, or median (IQR), as appropriate. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy of GA were calculated using blood culture as the reference. Potential effect modifiers were addressed through stratification, and post-stratification, diagnostic indices were recalculated. The independent-samples t-test or Mann-Whitney U test was used to compare quantitative variables. The chi-square test or Fisher's exact test was applied for comparing categorical variables, as appropriate. P-value < 0.05 was considered statistically significant.

RESULTS

In a total of 140 neonates, the median age at presentation was 4.0 (2.0-7.0) days, and 81 (57.9%) were male. The mean gestational age and birth weight were 35.9±2.8 weeks and 2.36±0.61 kg, respectively. Preterm birth was recorded in 62 (44.3%) neonates, while 68 (48.6%) had low birth weight (LBW). Perinatal asphyxia was documented in 26 (18.6%) neonates, umbilical cord infection in 17 (12.1%), history of bottle feeding in 45 (32.1%), and history of prelacteal feeding in 53 (37.9%). The median Apgar scores at 1 minute and 5 minutes were 6.0 (5.0 to 7.0) and 8.0 (7.0 to 9.0), respectively. Using blood culture as the reference standard, 56 (40.0%) neonates had culture-proven sepsis. Comparative baseline demographic and clinical characteristics according to blood culture status are shown in **Table I**.

Table I: Neonatal characteristics according to blood culture findings (n=140)

Variables	Blood culture		P-value
	Positive (n=56)	Negative (n=84)	
Age at presentation, days	5.0 (2.0-8.0)	4.0 (2.0-6.0)	0.186
Male gender	33 (58.9%)	48 (57.1%)	0.834
Gestational age, weeks	35.3±2.9	36.3±2.6	0.037
Preterm	29 (51.8%)	33 (39.3%)	0.145
Birth weight, kg	2.24±0.57	2.45±0.62	0.044
Low birth weight	32 (57.1%)	36 (42.9%)	0.098
Perinatal asphyxia	13 (23.2%)	13 (15.5%)	0.250
Umbilical cord infection	9 (16.1%)	8 (9.5%)	0.244
History of bottle feeding	21 (37.5%)	24 (28.6%)	0.269
History of prelacteal feeding	25 (44.6%)	28 (33.3%)	0.178
Apgar score at 1 minute	6.0 (5.0-7.0)	6.0 (5.0-7.0)	0.391
Apgar score at 5 minutes	8.0 (7.0-9.0)	8.0 (7.0-9.0)	0.518

GA culture was positive in 54 (38.6%) neonates and negative in 86 (61.4%). GA culture yielded a sensitivity of 53.6%, specificity of 71.4%, PPV 55.6%, and NPV 69.8%. The overall diagnostic accuracy of GA culture was 64.3% (**Figure 1**).

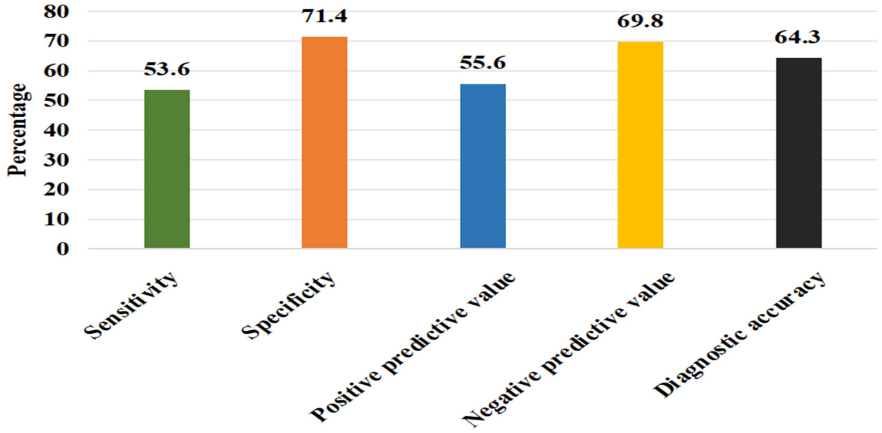

Figure 1: Overall diagnostic performance of gastric aspirate culture taking blood culture as the reference standard

Sensitivity of GA culture was higher among preterm than term neonates (58.6% vs 48.1%), and was also higher in neonates with perinatal asphyxia than in those without perinatal asphyxia (61.5% vs 51.2%). Specificity was relatively higher among term neonates than preterm neonates (76.5% vs 63.6%), and was higher among neonates with normal birth weight than those with LBW (83.3% vs 55.6%). Diagnostic accuracy was 61.3% in preterm neonates and 66.7% in term neonates. Among LBW neonates, diagnostic accuracy was 54.4%, whereas among neonates with normal birth weight it was 73.6%. In neonates with perinatal asphyxia, diagnostic accuracy was 61.5%, compared with 64.9% in those without perinatal asphyxia. Stratified diagnostic performance according to various effect modifiers is presented in **Table II**.

Table II: Diagnostic performance of gastric aspirate culture according to effect modifiers taking blood culture as the reference standard (N=140)

Effect modifiers		Sensitivity %	Specificity %	PPV %	NPV %	Accuracy %
Gestational age	Preterm	58.6	63.6	58.6	63.6	61.3
	Term	48.1	76.5	52.0	73.6	66.7
Birth weight	Low birth weight	53.1	55.6	51.5	57.1	54.4
	Normal birth weight	54.2	83.3	61.9	78.4	73.6
Perinatal asphyxia	Present	61.5	61.5	61.5	61.5	61.5
	Absent	51.2	73.2	53.7	71.2	64.9

DISCUSSION

This study found that GA culture had modest overall diagnostic utility for neonatal sepsis when blood culture was used as the reference standard. Blood culture was positive in 40.0% of neonates with clinically suspected sepsis, while GA culture was positive in 38.6%. GA culture showed sensitivity of 53.6%, specificity of 71.4%, PPV 55.6%, NPV 69.8%, and overall diagnostic accuracy of 64.3%. These findings place GA culture in the range of an adjunctive test rather than a standalone diagnostic method. These values are closer to those reported from Indore, India, where GA cytology showed sensitivity of 53.2%, specificity of 62.3%, PPV 51.3%, and NPV of 63.4% among 100 neonates with suspected septicemia[8]. These observations strengthen the impression that GA-based testing can identify a subset of infected neonates but may miss too many culture-positive cases to be relied upon in isolation. A study by Jiang and colleagues in 600 preterm neonates with high risk factors also supports a limited but potentially useful role for GA-based microbiology[9]. In that study, the positive rate of GA culture was significantly higher in the sepsis group, and it was suggested that GA culture may have better diagnostic yield in premature neonates born vaginally. This evidence suggests that GA-derived tests may reflect perinatal microbial exposure and early gastrointestinal colonization, but their performance is not consistent enough to replace blood culture.

The diagnostic indices in this study have practical implications. Sensitivity of 53.6% means that nearly half of blood culture-positive neonates would have been missed if GA culture had been used alone. Specificity of 71.4% is somewhat better, but PPV of 55.6% shows that a positive GA culture did not reliably confirm bloodstream infection. By contrast, the NPV approached 70%, suggesting slightly greater usefulness in helping to exclude sepsis than in confirming it, though even that value remains insufficient for confident clinical decision-making in a critically ill neonate. This pattern is consistent with contemporary literature, which continues to regard blood culture as the diagnostic reference standard and does not recommend superficial or non-blood cultures as replacements for it in suspected neonatal sepsis[10,11]. In resource-constrained settings, GA culture may still contribute when interpreted alongside clinical assessment and sepsis markers, especially when a rapid bedside impression is needed before blood culture results are available[12].

Subgroup analyses in this study are clinically relevant as sensitivity was higher in preterm than term neonates and specificity was higher in term neonates. This pattern may indicate that GA culture is more likely to capture genuine perinatal microbial exposure in preterm neonates, who have greater biological vulnerability and are more often exposed to obstetric and neonatal risk factors associated with early sepsis[13,14]. Recent data continue to identify prematurity and LBW among the strongest neonatal risk factors for sepsis[15,16]. The present finding that blood culture-positive neonates had lower mean gestational age and lower mean birth weight also fits with that wider literature[17].

Gastric aspirate is obtained very early in life and may therefore capture microbial exposure occurring before or during delivery rather than established bloodstream invasion alone[18]. This may partly explain why gastric aspirate culture showed only moderate concordance with blood culture in the present study. A positive gastric aspirate culture may reflect intra-amniotic infection, exposure to maternal genital tract organisms, or early gastrointestinal colonization, whereas blood culture more directly reflects invasive infection [19]. This distinction is clinically important because it may suggest that gastric aspirate culture may be better viewed as an early risk indicator than a definitive diagnostic test[20]. In settings where early-onset sepsis is strongly suspected, gastric aspirate culture may still provide useful supportive information when interpreted alongside maternal risk factors, neonatal examination, and blood-based investigations[21]. This also highlights the need for future studies

to examine organism-specific concordance between gastric aspirate and blood culture to clarify whether both specimens identify the same infectious process or different stages of perinatal microbial exposure.
This study has several limitations that should be recognized. The study was carried out at a single tertiary centre, which limits external validity. The sample size was relatively modest, and subgroup estimates for potential effect modifiers need to be interpreted cautiously. The analysis did not incorporate organism-level concordance between blood and GA cultures, which could have been valuable in determining whether positive GA cultures reflect true invasive infection, maternal genital tract exposure, or postnatal colonization.

CONCLUSION

Gastric aspirate culture showed moderate diagnostic performance for neonatal sepsis and performed better as a supportive test than as a definitive diagnostic tool. Its performance varied across gestational age, birth weight, and perinatal asphyxia subgroups, suggesting that clinical context influences how informative the test may be. Blood culture should remain central to diagnosis, while gastric aspirate culture may be considered an adjunct in settings where early bedside decision-making is needed and laboratory resources are constrained.

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AUTHOR CONTRIBUTION

Ali SMU: Data collection, drafting, responsible for data, approved for publication.
Iqbal M: Conception and design, critical revisions, approved for publication.
Khan L: Literature review, drafting, critical revisions, responsible for data, approved for publication.
Noor H: Literature review, drafting, critical revisions, proofreading, approved for publication.
Mairaj E: Data collection, data analysis, data Interpretation, proofreading, critical revision, approved for publication.
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