ORIGINAL ARTICLE

NUREXUS

Journal of MedVerse Research & Practice

ISSN: 3107-4278

Assessment of Blood Glucose Levels in Neonates in the Sick Neonatal Care Unit: A Comparison Between Glucometer and Glucose Oxidase Methods

Dr. M Kumari [1], Dr. S Ferdina[2]
Assistant Professor, Professor
Department of Paediatrics, Guntur Medical College, Guntur.
Email ID: kumarim@gmail.com,

Submission Date: 29.11.2025	Accepted Date:17.12.2025	Published Date: 31.12.2025

Abstract

Background: Neonatal hypoglycaemia is a common metabolic abnormality in sick neonates and may lead to significant neurological complications if undetected. Rapid and accurate blood glucose assessment is essential in neonatal care units. This study aimed to evaluate the diagnostic accuracy of bedside glucometers compared with the laboratory glucose oxidase method in detecting hypoglycaemia among neonates.

Methods: A hospital-based diagnostic accuracy study was conducted in the Neonatal Intensive Care Unit of Guntur Medical College and Hospital, Andhra Pradesh. A total of 150 neonates requiring blood glucose estimation were enrolled consecutively. Capillary blood samples were analyzed using a bedside glucometer, while venous samples were processed using the laboratory glucose oxidase method, which served as the reference standard. Sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy of the glucometer were calculated.

Results: Among the 150 neonates, 28% were hypoglycaemic according to laboratory glucose measurements. The glucometer identified hypoglycaemia in 30.7% of neonates. Compared with laboratory estimation, the glucometer demonstrated a sensitivity of 90.5%, specificity of 92.6%, positive predictive value of 82.6%, negative predictive value of 96.2%, and overall diagnostic accuracy of 92.0%. Mean blood glucose values were slightly lower when measured by glucometer (52.6 ± 11.4 mg/dL) than laboratory estimation (55.9 ± 10.8 mg/dL).

Conclusion: Bedside glucometers provide rapid and reliable screening for neonatal hypoglycaemia, facilitating timely clinical intervention in high-dependency care settings. However, laboratory confirmation remains essential for precise diagnosis, particularly in borderline or critically low glucose values. The combined use of point-of-care glucometer testing and laboratory methods can enhance early detection and management of hypoglycemia, potentially improving neonatal outcomes.

Keywords: Neonatal hypoglycemia; Glucometer; Glucose oxidase; Diagnostic accuracy; Sick neonates

Introduction

Neonatal hypoglycaemia is one of the most frequently encountered metabolic abnormalities during the early neonatal period and continues to be a major concern in neonatal intensive care units and sick neonatal care units [1]. It results from an imbalance between glucose supply and metabolic demand during the critical transition from intrauterine to extrauterine life. During fetal development, glucose is continuously transferred from the mother through the placenta. After birth, this constant supply is interrupted, and the neonate must rely on endogenous metabolic pathways such as glycogenolysis, gluconeogenesis, and ketone body production to maintain glucose homeostasis. Immaturity or disruption of these adaptive mechanisms increases the risk of hypoglycaemia, particularly in vulnerable neonates.

The incidence of neonatal hypoglycaemia varies widely and is influenced by gestational age, birth weight,

perinatal risk factors, and the diagnostic thresholds applied [2,3]. Preterm infants, infants of diabetic mothers, small for gestational age and large for gestational age neonates, and those with conditions such as birth asphyxia, sepsis, or respiratory distress are at higher risk. Hypoglycaemia may be transient or persistent and can present with nonspecific clinical features, including jitteriness, lethargy, poor feeding, apnoea, seizures, or hypothermia. Early identification is essential, as recurrent or prolonged hypoglycaemia has been associated with adverse neurodevelopmental outcomes such as cognitive impairment, motor deficits, and epilepsy [4,5].

Despite its clinical importance, there is no universally accepted definition or single threshold for neonatal hypoglycaemia. Many professional bodies recommend using operational thresholds based on postnatal age, clinical status, and risk profile, rather than an absolute glucose cutoff. Current guidelines emphasize maintaining adequate plasma glucose levels to prevent neurological injury while avoiding unnecessary interventions, making accurate glucose measurement a central component of neonatal care [6].

Laboratory estimation of blood glucose using enzymatic techniques such as the glucose oxidase method is considered the reference standard due to its analytical accuracy and specificity [7]. These methods measure plasma glucose and are relatively unaffected by variations in hematocrit or the presence of interfering substances. However, laboratory testing may be associated with delays related to sample transport and processing, which can limit its utility in emergency clinical situations.

Point-of-care testing using bedside glucometers is widely practiced in neonatal units due to rapid turnaround time and minimal blood volume requirements. However, the accuracy of glucometers in neonates, especially at low glucose concentrations, remains a concern. Factors such as hematocrit levels, peripheral perfusion, sample type, device calibration, and operator technique can influence measurements [8].

Several studies have reported discrepancies between glucometer readings and laboratory glucose values in neonates, particularly in the hypoglycaemic range, which may lead to misclassification and inappropriate clinical management [9]. In sick neonatal care units, where rapid decision-making is critical, evaluating the performance of glucometers against standard laboratory methods is essential to ensure safe and effective care [10]. The present study aims to estimate blood glucose levels in sick neonates admitted to the Sick Neonatal Care Unit and to assess the validity of bedside glucometer measurements by comparing them with the laboratory glucose oxidase method.

Materials and Methods

Study Design

This hospital-based diagnostic accuracy study was conducted to compare blood glucose measurements obtained using a bedside glucometer with those measured by the laboratory glucose oxidase method among sick neonates admitted to the Neonatal Intensive Care Unit (NICU).

Study Setting and Duration

The study was conducted in the Neonatal Intensive Care Unit of Guntur Medical College and Hospital, Andhra Pradesh, a tertiary care teaching hospital providing intensive neonatal care to both inborn and outborn neonates. Eligible neonates admitted during the study period were enrolled consecutively.

Study Population

The study population comprised neonates aged 0 to 28 days who required blood glucose estimation as part of their routine clinical management in the NICU. A total of 150 neonates were included using consecutive sampling.

Sample Size

A total of 150 neonates fulfilling the eligibility criteria were enrolled in the study. The sample size was determined based on the expected number of eligible NICU admissions requiring blood glucose estimation during the study period.

Inclusion Criteria

Neonates aged 0–28 days admitted to the NICU who required blood glucose estimation as part of routine clinical care and whose parents or legal guardians provided written informed consent were included in the study.

Exclusion Criteria

Neonates older than 28 days, those with packed cell volume (PCV) below 40% or above 65%, and neonates with inadequate, clotted, or hemolysed blood samples were excluded because these factors could influence the accuracy of bedside glucometer measurements.

Data Collection Tool

After obtaining written informed consent from the parents or legal guardians, blood samples were collected under strict aseptic precautions. Capillary blood was obtained by heel prick, and after discarding the first drop of blood, the subsequent sample was immediately analyzed using a bedside glucometer. The glucose value displayed by the glucometer was recorded as the plasma-equivalent blood glucose concentration. Simultaneously, approximately 2 mL of venous blood was collected and transported without delay to the central laboratory for estimation of blood glucose by the glucose oxidase enzymatic method, which served as the reference standard. Laboratory samples were processed promptly to minimize pre-analytical errors. Demographic and clinical details of the neonates were recorded using a structured case record form. Based on comparison with laboratory glucose values, glucometer readings were classified as true positive, true negative, false positive, or false negative for assessment of diagnostic accuracy.

Ethical Considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee of Guntur Medical College and Hospital, Andhra Pradesh, prior to commencement of the study. Written informed consent was obtained from the parents or legal guardians of all participating neonates before enrolment. Confidentiality and anonymity of participant information were strictly maintained throughout the study by assigning unique identification numbers and restricting access to study data to the investigators.

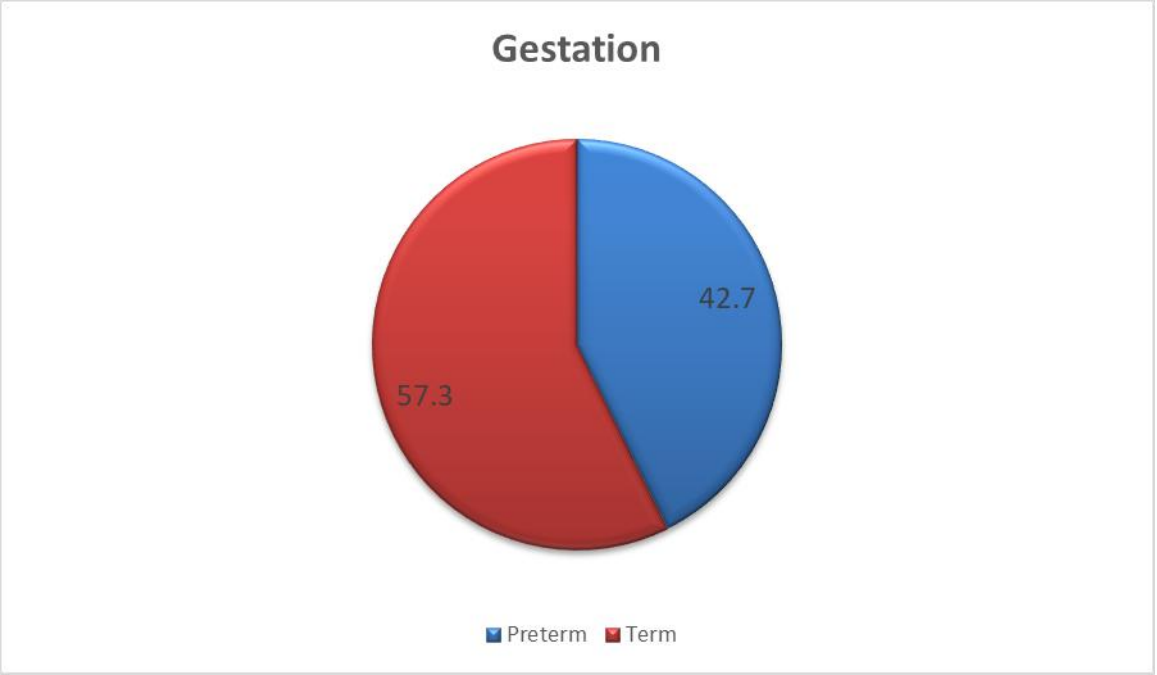
Statistical Analysis

Data were entered into Microsoft Excel for coding and cleaning before being analyzed using the Statistical Package for the Social Sciences (SPSS) software version 26.0. Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were presented as frequencies and percentages. Diagnostic performance of the bedside glucometer was evaluated by calculating sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy, considering the glucose oxidase method as the reference standard. Agreement between the two methods was assessed using appropriate statistical tests, including Bland–Altman analysis and Cohen's kappa coefficient where applicable. A *p*-value of less than 0.05 was considered statistically significant.

Results

Table 1. Baseline characteristics of neonates (n = 150)

Variable	Frequency	Percentage
Male	88	58.7
Female	62	41.3
Preterm	64	42.7
Term	86	57.3
Low birth weight	72	48.0
Normal birth weight	78	52.0



Among the 100 CHB patients, the mean age was 42.6 years, with 61 percent males. Most were HBeAg-negative (67 percent). Liver enzymes were moderately elevated, and platelet counts were generally preserved. The APRI and FIB-4 values indicated varying degrees of liver injury. Fibrosis staging showed that 45 percent had early fibrosis (S0–S1), 24 percent had moderate fibrosis (S2), and 31 percent had advanced fibrosis (S3–S4).

Table 2. Distribution of blood glucose levels by glucometer and laboratory method

Method	Mean (mg/dL)	SD
Glucometer	52.6	11.4
Laboratory glucose oxidase	55.9	10.8

The mean blood glucose level measured using the bedside glucometer was 52.6 mg/dL with a standard deviation of 11.4 mg/dL, whereas the mean glucose level estimated by the laboratory glucose oxidase method was higher at 55.9 mg/dL with a standard deviation of 10.8 mg/dL. This indicates that glucometer readings tended to be slightly lower than laboratory values, though variability was comparable between the two methods.

Table 3. Classification of neonates based on glucose status by both methods

Glucose status	Glucometer n (%)	Laboratory n (%)
Hypoglycaemic	46 (30.7)	42 (28.0)
Normoglycaemic	104 (69.3)	108 (72.0)
Total	150 (100)	150 (100)

Based on glucometer measurements, hypoglycaemia was detected in 46 neonates (30.7 percent), while 104 neonates (69.3 percent) were classified as normoglycaemic. Using the laboratory glucose oxidase method, hypoglycaemia was identified in 42 neonates (28.0 percent), and 108 neonates (72.0 percent) were found to have normal glucose levels. Overall, the glucometer identified a slightly higher proportion of hypoglycaemic cases compared to laboratory estimation.

Table 4. Comparison of glucometer readings with the laboratory method

Glucometer / Laboratory	Hypoglycaemia Present	Hypoglycaemia Absent	Total
Hypoglycaemia detected	38 (TP)	8 (FP)	46
Normoglycaemia detected	4 (FN)	100 (TN)	104
Total	42	108	150

When glucometer readings were compared with laboratory glucose oxidase estimation, 38 neonates were correctly identified as hypoglycaemic by both methods (true positives), while 100 neonates were correctly classified as normoglycaemic (true negatives). The glucometer falsely identified hypoglycaemia in 8 neonates who were normoglycaemic by laboratory estimation (false positives) and failed to detect hypoglycaemia in 4 neonates who were confirmed to be hypoglycaemic by the laboratory method (false negatives). This comparison demonstrates good overall agreement between the bedside glucometer and the laboratory glucose oxidase method.

Table 5. Diagnostic performance of a glucometer

Parameter	Value (%)
Sensitivity	90.5
Specificity	92.6
Positive predictive value	82.6
Negative predictive value	96.2
Diagnostic accuracy	92.0

The bedside glucometer demonstrated high diagnostic performance in detecting neonatal hypoglycaemia. The sensitivity was 90.5 percent, indicating a strong ability to correctly identify hypoglycaemic neonates. The specificity was 92.6 percent, reflecting accurate identification of normoglycaemic infants. The positive predictive value was 82.6 percent, while the negative predictive value was notably high at 96.2 percent, suggesting reliable exclusion of hypoglycaemia.

Discussion

In this diagnostic accuracy study involving 150 sick neonates, bedside glucometer measurements demonstrated high sensitivity (90.5%) and specificity (92.6%) for detecting neonatal hypoglycaemia, with an overall diagnostic accuracy of 92.0%. These findings indicate strong agreement between point-of-care glucometer readings and laboratory glucose oxidase measurements, supporting the utility of glucometers as effective tools for rapid screening in neonatal care settings.

Our findings are comparable to those reported by Naaz and Gulati, who observed high specificity (98.2%) and acceptable sensitivity when comparing glucometer measurements with the laboratory glucose oxidase method in neonates, emphasizing the role of glucometers in early identification of hypoglycaemia [12]. Similarly, Mehta and Munde demonstrated good correlation between glucometer and laboratory glucose measurements in high-risk neonates, concluding that glucometers are useful for bedside screening, particularly in resource-constrained settings [16]. Sreenivasa and Kumar also reported a strong correlation between glucometer and laboratory values, though they cautioned about reduced accuracy at very low glucose concentrations [17].

In contrast, Ogunbosi et al. reported lower sensitivity but maintained high specificity for glucometer measurements, suggesting that some point-of-care devices may underestimate hypoglycaemia, particularly at critically low glucose levels [13]. Such variability highlights the influence of device type, calibration standards, sampling techniques, and clinical conditions on glucometer performance.

Older but seminal work by Ho et al. also cautioned against the exclusive reliance on glucometers at low glucose ranges, recommending laboratory confirmation before definitive clinical decisions are made [14]. Similar observations were made by Nuntnarumit et al., who reported variability in glucometer accuracy depending on the device model and glucose range, particularly in neonates with severe hypoglycaemia [15].

Evidence from systematic reviews and meta-analyses further supports these observations. Richmond et al. demonstrated that point-of-care glucometers generally exhibit high specificity, while sensitivity varies depending on device methodology and clinical context, reinforcing the role of glucometers as screening rather than confirmatory tools [18]. Roth-Kleiner et al. also evaluated multiple point-of-care devices in neonatal settings and found acceptable agreement with laboratory methods, although discrepancies were more pronounced at lower glucose concentrations [19]. Pre-analytical and physiological factors, including hematocrit variation, peripheral perfusion, and operator technique, are known to affect glucometer accuracy in neonates. Hay highlighted that neonatal glucose metabolism is highly dynamic, further complicating accurate bedside measurement [20]. Audits conducted in neonatal intensive care units have shown that strict adherence to sampling protocols, regular calibration, and quality control measures significantly improve the reliability of glucometer readings [21].

Strengths

This study compared bedside glucometer measurements with the glucose oxidase method, the laboratory gold standard for blood glucose estimation, thereby providing a reliable assessment of diagnostic accuracy in sick neonates. Simultaneous collection of capillary and venous blood samples minimized temporal variation in glucose levels and enhanced the validity of the comparison.

Limitations

The study was conducted at a single tertiary care neonatal intensive care unit, which may limit the generalizability of the findings to other healthcare settings. Additionally, factors such as peripheral perfusion status, neonatal illness severity, and operator-dependent variability in capillary blood sampling may have influenced bedside glucometer readings.

Conclusion

This study demonstrates that bedside glucometers provide a rapid and reliable method for screening neonatal hypoglycaemia in sick neonates, showing high sensitivity, specificity, and overall diagnostic accuracy when compared with the laboratory glucose oxidase method. While glucometers are particularly useful for timely detection and clinical decision-making in high-dependency neonatal units, confirmatory laboratory testing remains essential for precise diagnosis, especially in borderline or critically low glucose values. Integrating point-of-care glucometer testing with standard laboratory methods can enhance early identification and management of hypoglycaemia, potentially reducing the risk of adverse neurodevelopmental outcomes in vulnerable neonates.

Declaration
Conflict of interest: Nil
Source Of Fund: Nil

Reference

1. Stanley CA, Rozance PJ, Thornton PS, De Leon DD, Harris D, Haymond MW. Re-evaluating neonatal hypoglycemia: mechanisms and implications for management. J Pediatr. 2015;166(6):1520–1525.
2. Thornton PS, Stanley CA, De Leon DD, Harris D, Haymond MW, Hussain K, et al. Recommendations from the Pediatric Endocrine Society for evaluation and management of persistent hypoglycemia in neonates. J Pediatr. 2015;167(2):238–245.

3. Adamkin DH. Neonatal hypoglycemia. Semin Fetal Neonatal Med. 2017;22(1):36–41.
4. McKinlay CJD, Alsweiler JM, Anstice NS, Burakevych N, Chakraborty A, Chase JG, et al. Association of neonatal glycemia with neurodevelopmental outcomes at 4.5 years. JAMA Pediatr. 2017;171(10):972–983.
5. Burns CM, Rutherford MA, Boardman JP, Cowan FM. Patterns of cerebral injury and neurodevelopmental outcomes after symptomatic neonatal hypoglycemia. Pediatrics. 2008;122(1):65–74.
6. British Association of Perinatal Medicine. Identification and management of neonatal hypoglycaemia in the full term infant. BAPM Framework. 2022.
7. Sacks DB. Measurement of blood glucose: accuracy and sources of error. Clin Chem. 2011;57(2):173–176.
8. Tang Z, Lee JH, Louie RF, Kost GJ. Effects of hematocrit and other interference on glucose measurements by point-of-care devices. Clin Chem. 2000;46(7):901–910.
9. Ho HT, Yeung WK, Young BW. Evaluation of point-of-care glucose meters for neonatal use. Arch Dis Child Fetal Neonatal Ed. 2004;89(4):F356–F359.
10. Alsweiler JM, Harding JE. Neonatal hypoglycaemia: what are the implications of point-of-care testing? Curr Opin Clin Nutr Metab Care. 2021;24(3):226–231.
11. Selvakumar P, Vivek G. Blood glucose measurement by glucometer in comparison with standard method in the diagnosis of hypoglycemia in sick neonates. *Pediatr Rev Int J Pediatr Res*. 2017;4(7):469–473.
12. Naaz F, Gulati RK. Comparative study of glucometer and laboratory glucose oxidase method for the estimation of blood glucose levels in neonates. *Pediatr Rev Int J Pediatr Res*. 2019;6(3):113–117.
13. Ogunbosi BO, Jarrett OO, Orimadegun AE, Ayoola OO, Osinusi K. Comparison of point-of-care glucometers and laboratory based glucose oxidase test in determining blood glucose levels. *Niger J Paediatr*. 2024;49(3):266–271.
14. Ho HT, Yeung W, Young B. Evaluation of “point of care” devices in the measurement of low blood glucose in neonatal practice. *Arch Dis Child Fetal Neonatal Ed*. 2004;89(4):F356–F359.
15. Nuntnarumit P, Chittamma A, Pongmee P, et al. Clinical performance of new glucometer devices in neonatal hypoglycemia. *Pediatr Int*. 2011;53(3):218–223.
16. Mehta YP, Munde BP. Study of blood sugar levels in high-risk neonates using glucometer method and laboratory glucose oxidase peroxidase method. *Int J Contemp Pediatr*. 2017;4(4):1185–1192.
17. Sreenivasa B, Kumar GV. Comparative study of blood glucose levels in neonates using glucometer and laboratory glucose oxidase method. *J Evol Med Dent Sci*. 2015;4(16):2652–2663.
18. Richmond E, Howard A, et al. Glucose testing methods: a systematic review and meta-analysis of point-of-care devices for neonatal hypoglycemia. *PubMed*. 2024.
19. Roth-Kleiner M, Stadelmann Diaw C, Urfer J, Ruffieux C, Werner D. Evaluation of different point-of-care devices for glucose measurement in a clinical neonatal setting. *Eur J Pediatr*. 2010;169:1387–1395.
20. Hay WW Jr. Neonatal glucose metabolism. *NeoReviews*. 2013;14:e7–e16.
21. Glucometer Use in the NICU: An audit of procedural adherence and quality improvement outcomes. *J Contemp Clin Pract*. 2025;25:120–130.