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ORIGINAL ARTICLE

Comparative Evaluation of Blood Gas and Biochemistry Analyzers in Lactate Measurement in Pediatric Patient Groups

ABSTRACT

Objective

Lactate is an early biochemical marker of tissue hypoxia and hypoperfusion and plays an important role in clinical decision-making. This study aimed to compare lactate measurements obtained from blood gas and central laboratory biochemistry analyzers in pediatric patients and to evaluate the clinical agreement between the two methods.

Methods

Pediatric patients with simultaneous lactate measurements performed on blood gas and biochemistry analyzers at the Ankara Etlik City Hospital Medical Biochemistry Laboratory between January 2023 and August 2025 were retrospectively reviewed. A total of 914 paired lactate measurements were included. Method comparison was performed using Pearson correlation, Bland–Altman analysis, Passing–Bablok regression, and Cohen's kappa coefficient. A total allowable error (TEa) of ±0.20 mmol/L was used as the clinical acceptance criterion.

Results

A very strong positive correlation was observed between blood gas and biochemistry measurements ($r = 0.95$, $p < 0.0001$). Bland–Altman analysis showed a mean bias of −0.13 mmol/L (95% CI: −0.18 to −0.08), with limits of agreement (LoA) from −1.56 to 1.31 mmol/L; 95.1% of results fell within these limits. Passing–Bablok regression yielded $y = 0.211 + 0.975x$ (intercept 0.211, 95% CI: 0.168–0.251; slope 0.975, 95% CI: 0.954–0.996), with no deviation from linearity (CUSUM $p = 0.97$). Categorical agreement was substantial ($\kappa = 0.73$, 95% CI: 0.70–0.76), and misclassification remained below 10%.

Conclusion

Blood gas and biochemistry analyzers demonstrated a high level of agreement for lactate measurement in pediatric patients. The rapid turnaround time of blood gas analyzers may support timely clinical decision-making, particularly in emergency and intensive care settings. Although minor differences were observed at low and high concentrations, these were not large enough to meaningfully affect clinical interpretation.

Keywords: blood gas analysis; inter-device variability; lactate

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Introduction

Lactate is a key end product of cellular metabolism and increases particularly under anaerobic conditions. In clinical practice, lactate serves as an early indicator of tissue hypoxia and hypoperfusion and provides prognostic information in sepsis, septic shock, cardiac arrest, trauma, and other critical illnesses (1,2). In pediatric patients, lactate monitoring plays an important role not only in diagnosis but also in assessing response to treatment and predicting mortality risk (3). Children have distinct physiological characteristics—such as higher metabolic rates, age-dependent lactate clearance, and variable oxygen consumption—that may influence lactate kinetics compared with adults. Clinically used decision thresholds (<2 mmol/L, ≥2 mmol/L, and ≥4 mmol/L) are therefore highly relevant in pediatric emergency and intensive care settings due to their association with disease severity and outcomes (1–3).

In clinical laboratories, lactate is commonly measured in plasma using enzymatic methods on central laboratory biochemistry analyzers. These methods are generally regarded as reference approaches due to their accuracy and analytical reliability;

however, sample processing and transport may delay reporting (4). In contrast, point-of-care blood gas analyzers can provide lactate results within minutes from arterial or venous whole blood, which is particularly valuable in emergency and intensive care units where rapid decisions are required (5). Despite this advantage, methodological and matrix differences between whole-blood and plasma measurements necessitate method-comparison studies to ensure interchangeability and consistent clinical interpretation (6).

Several studies have compared blood gas analyzers with central laboratory analyzers, highlighting overall agreement but also potential systematic or proportional bias, especially around clinically important thresholds (7). However, most evidence has been generated in adult or mixed populations, while pediatric-specific data remain limited. Because lactate physiology and variability differ in children, this gap may introduce uncertainty in pediatric practice.

Accordingly, the aim of this study was to compare lactate measurements obtained using blood gas and biochemistry analyzers in pediatric patients and to evaluate clinical agreement between the two methods. By doing so, we sought to support the safe use of blood gas lactate in pediatric care and contribute to the literature on the clinical utility of point-of-care testing.

Methods

Study Design

This retrospective study evaluated data from the Medical Biochemistry Laboratory of Ankara Etlik City Hospital between January 1, 2023, and August 1, 2025. Pediatric cases in which lactate was measured simultaneously using a blood gas analyzer and a central laboratory biochemistry analyzer were included. Data were retrieved from the Laboratory Information System (LIS). A total of 914 paired lactate measurements were analyzed.

Inclusion criteria were: (i) age 0–18 years, (ii) simultaneous lactate measurements on both analyzers during the study period, and (iii) complete sample data. Exclusion criteria were: age >18 years, results available from only one analyzer, incomplete/incorrect records, a time interval ≥1 hour between paired measurements, and samples with hemolysis, clots, insufficient volume, analyzer error flags, or other rejection criteria. If multiple measurements were available for the same patient, only the first paired result was included.

Measurements

Central laboratory lactate was measured in plasma on two Roche Cobas c702 biochemistry analyzers (Roche Diagnostics, Mannheim, Germany) using the manufacturer's enzymatic colorimetric assay. Blood samples were collected into sodium fluoride (NaF) tubes (BD Vacutainer, Becton, Dickinson Company, Franklin Lakes, NJ, USA), transported on ice packs, and processed according to local protocols to minimize in vitro glycolysis.

Blood gas lactate was measured at the point of care using four Siemens RAPIDPoint 500 analyzers from heparinized arterial or venous whole blood, in accordance with the manufacturer's instructions. Internal quality control (two levels per run) and participation in external quality assessment were in place for the biochemistry analyzers. Blood gas analyzers underwent routine daily multi-point calibration and internal checks according to standard procedures.

Ethics

The study was conducted in accordance with the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee of Ankara Etlik City Hospital (Approval No: AEŞH-BADEK1-2025-492, Date: 03/09/2025). Informed consent was waived due to the retrospective design and the use of de-identified data.

Statistical Analysis

Method comparison followed CLSI EP09-A3 principles (8). The association between methods was evaluated using Pearson's correlation coefficient ($p < 0.05$ considered significant). Agreement was assessed using Bland–Altman analysis, calculating mean bias and 95% limits of agreement (LoA). Differences were defined as blood gas − biochemistry, and the proportion of paired results within the LoA was reported. Heteroscedasticity was visually assessed on the Bland–Altman plot.

Systematic and proportional differences were evaluated using Passing–Bablok regression, and deviation from linearity was assessed using the cumulative sum (CUSUM) test. The TEa for lactate published by the Wisconsin State Laboratory of Hygiene (WSLH) was used as the clinical acceptance criterion (±0.20 mmol/L) (9). Predicted differences at the 2 mmol/L and 4 mmol/L decision points were calculated from the regression equation and compared against this acceptance limit.

For categorical agreement, lactate values were grouped as <2 mmol/L, 2–4 mmol/L, and >4 mmol/L. Cohen's kappa (κ) with 95% CI was calculated. Misclassification rates at the >2 mmol/L and >4 mmol/L thresholds were also reported. A $\kappa \geq 0.70$ was interpreted as good agreement (10). All analyses were performed using MedCalc 23.3.5 (MedCalc Software Ltd, Ostend, Belgium).

Results

In the biochemistry analyzer dataset, the median lactate concentration was 1.84 mmol/L (IQR: 1.31–2.92), with 2.5th and 97.5th percentiles of 0.73 and 9.63 mmol/L, respectively. In the blood gas dataset, the median was 2.02 mmol/L (IQR: 1.49–2.99), with corresponding percentiles of 0.93 and 9.80 mmol/L. Most measurements clustered within the lower clinical range. In the biochemistry dataset, 14.6% (134/914) of results were ≥4 mmol/L, compared with 13.3% (122/914) in the blood gas dataset.

A very strong positive correlation was observed between methods ($r = 0.95$, $p < 0.0001$). Bland–Altman analysis showed a mean bias of −0.13 mmol/L (95% CI: −0.18 to −0.08), indicating that blood gas results were slightly lower on average. The LoA ranged from −1.56 mmol/L (95% CI: −1.64 to −1.48) to 1.31 mmol/L (95% CI: 1.23 to 1.39), and 869/914 (95.1%) paired results fell within these limits (Figure 1). No clear increase in dispersion at higher lactate concentrations was observed.

Passing–Bablok regression yielded $y = 0.211 + 0.975x$ (y: blood gas; x: biochemistry), with an intercept of 0.211 (95%

CI: 0.168–0.251) and a slope of 0.975 (95% CI: 0.954–0.996) (Table 1). The CUSUM test showed no deviation from linearity (p = 0.97) (Figure 2). According to the model, equal values were predicted at approximately 8.4 mmol/L, with blood gas results slightly higher below this point and biochemistry results slightly higher above it.

At the clinical decision thresholds, the regression-derived predicted bias was 0.164 mmol/L (95% CI: 0.076–0.243) at 2 mmol/L and 0.112 mmol/L (95% CI: −0.016–0.235) at 4 mmol/L; both were within the predefined TEa of ±0.20 mmol/L.

When assessed against TEa (±0.20 mmol/L), 38.8% (355/914) of paired measurements fell within this analytical performance criterion. In categorical analysis, agreement was substantial (κ = 0.73, 95% CI: 0.70–0.76). Misclassification at the >2 mmol/L and >4 mmol/L thresholds remained below 10%, indicating good clinical concordance.

Discussion

This study compared lactate measurements obtained using blood gas and central laboratory biochemistry analyzers in pediatric patients. Overall, the methods showed strong correlation and clinically acceptable agreement. Bland–Altman analysis demonstrated a small negative mean bias (−0.13 mmol/L), and Passing–Bablok regression supported a linear relationship without clinically meaningful constant or proportional bias.

Previous studies comparing point-of-care analyzers with central laboratory methods have generally reported high correlation but have also noted that analyzer-specific biases may be more evident at very low or very high lactate concentrations (11–14). Our findings are consistent with this literature and extend it by providing pediatric-specific evidence using simultaneous measurements across Roche Cobas c702 and Siemens RAPIDPoint platforms.

Minor differences between analyzers may reflect methodological and matrix differences. Central laboratory analyzers typically measure lactate in plasma using enzymatic colorimetric methods, whereas blood gas analyzers measure lactate in whole blood using electrochemical methods. Preanalytical factors (e.g., sampling, processing time, and in vitro glycolysis) may further contribute to observed differences. Despite these sources of variability, the key clinical advantage of blood gas analyzers is their rapid turnaround time, which can support urgent clinical decisions in emergency and intensive care settings.

Although TEa was set narrowly at ±0.20 mmol/L, predicted biases at the clinically relevant 2 mmol/L and 4 mmol/L thresholds remained within this acceptance limit. Moreover, categorical agreement was substantial, and misclassification rates were low, suggesting that method-related differences are unlikely to meaningfully alter clinical classification at these decision points. The intersection predicted near 8.4 mmol/L appears to be an analytical feature of the regression model rather than a clinically meaningful threshold, particularly because pediatric decision-making is often concentrated in the lower lactate range.

Strengths of this study include the pediatric-only population, large sample size, and simultaneous paired measurements. Limitations include the retrospective design, limited control over preanalytical variables, potential inter-device variability due to multiple analyzers, and the use of different sample matrices (whole blood vs plasma). In addition, the single-center design may limit generalizability. Nevertheless, the findings provide clinically useful evidence supporting the use of blood gas lactate in pediatric practice.

Conclusıon

Blood gas and central laboratory biochemistry analyzers showed a high degree of agreement in lactate measurements in pediatric patients. The rapid availability of results from blood gas analyzers represents an important advantage in emergency and intensive care settings. Although small methodological differences may occur, particularly at extreme concentrations, agreement at clinically relevant decision thresholds was acceptable. Further prospective and multi-center studies may support standardization and strengthen evidence for pediatric clinical decision-making.

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None.

Author Contributions

All authors approved the final manuscript. The manuscript has not been published in whole or in part and is not under consideration elsewhere.

Conflict of Interest

The authors declare no conflicts of interest.

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Tables

Table 1. Passing-Bablok regression analysis

Parameter	Passing-Bablok Regression	Intercept (95% CI)	Slope (95% CI)	Cusum test for linearity
Lactate	y = 0.211 + 0.974. x	0.168 – 0.251	0.954 – 0.996	No significant deviation from linearity (P=0,97)

The regression equation describes the relationship between blood gas (y) and biochemistry (x) lactate measurements. CI = confidence interval; Cusum = cumulative sum test.

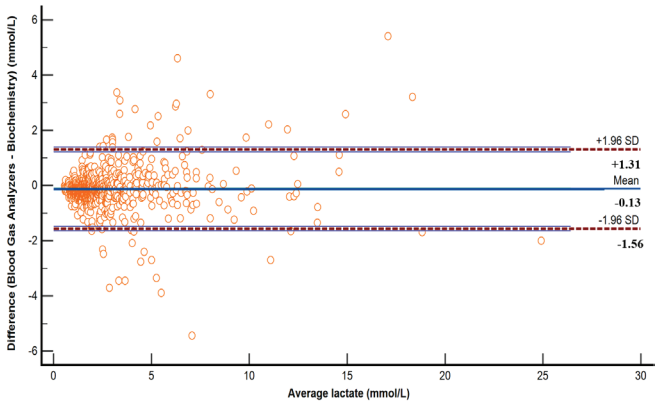

Figure 1. Bland–Altman plot comparing lactate measurements obtained from the blood gas and the biochemistry analyzers. The solid line indicates the mean bias (−0.13 mmol/L; 95% CI: −0.18 to −0.08), while the dashed lines represent the 95% LoA (−1.56 to +1.31 mmol/L; 95% CI: −1.64 to −1.48 and 1.23 to 1.39, respectively). The blue lines surrounding each LoA represent the 95% CI of the LoA estimates. A total of 869 out of 914 paired results (95.1%) were within the LoA.

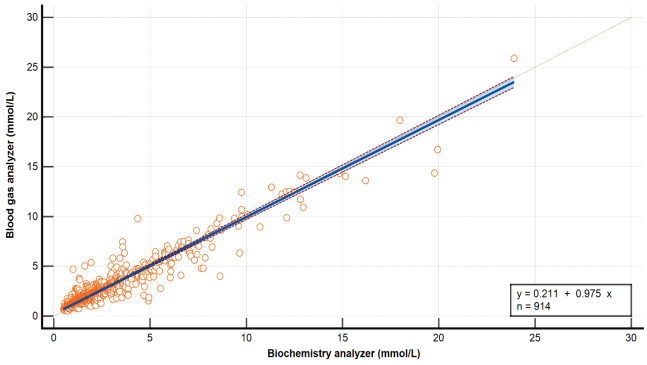

Figure 2. Passing–Bablok regression analysis comparing lactate measurements obtained from the blood gas analyzers (y-axis) and the biochemistry analyzers (x-axis).

7. References

1. Ramanathan R, Parrish DW, Hartwich JE, Haynes JH. Utility of admission serum lactate in pediatric trauma. J Pediatr Surg. 2015 Apr;50(4):598-603.

2. Vincent JL, Quintairos E Silva A, Couto L Jr, Taccone FS. The value of blood lactate kinetics in critically ill patients: a systematic review. Crit Care. 2016 Aug 13;20(1):257.

3. Scott HF, Donoghue AJ, Gaieski DF, Marchese RF, Mistry RD. The utility of early lactate testing in undifferentiated pediatric systemic inflammatory response syndrome. Acad Emerg Med. 2012 Nov;19(11):1276-80.

4. Kraut JA, Madias NE. Lactic acidosis. N Engl J Med. 2014 Dec 11;371(24):2309-19.

5. Bakker J, Nijsten MW, Jansen TC. Clinical use of lactate monitoring in critically ill patients. Ann Intensive Care. 2013 May 10;3(1):12.

6. Ismail F, Mackay WG, Kerry A, Staines H, Rooney KD. The accuracy and timeliness of a Point Of Care lactate measurement in patients with Sepsis. Scand J Trauma Resusc Emerg Med. 2015 Sep 17;23:68. doi: 10.1186/s13049-015-0151-x. Erratum in: Scand J Trauma Resusc Emerg Med. 2016 Mar 31;24:41.

7. Jansen TC, van Bommel J, Bakker J. Blood lactate monitoring in critically ill patients: a systematic health technology assessment. Crit Care Med. 2009 Oct;37(10):2827-39.

8. Measurement Procedure Comparison and Bias Estimation Using Patient Samples; Approved Guideline. 3rd ed. CLSI document EP09-A3. Wayne (PA): Clinical and Laboratory Standards Institute; 2013.

9. Data Innovations. Total Allowable Error Table [Internet]. Eau Claire, WI: Data Innovations; 2025 Jun 30 [cited 2025-Sep-20]. Analyte: Lactate, Serum ±0.2 mmol/L (WSLH). Available from: https://www.datainnovations.com/allowable-total-error-table/

10. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977 Mar;33(1):159-74. PMID: 843571.

11. Karon BS, Scott R, Burritt MF, Santrach PJ. Comparison of lactate values between point-of-care and central laboratory analyzers. Am J Clin Pathol. 2007 Jul;128(1):168-71.

12. Marija K, Bernhard KF, Beatrice LK. Blood-gas vs. Central-Laboratory analyzers: interchangeability and reference intervals for sodium, potassium, glucose, lactate and hemoglobin. Heliyon. 2021 Oct 30;7(11):e08302.

13. Jeong TD, Kim SK. Performance of the New RAPIDPoint 500e Blood Gas Analyzer and its Comparison with Central Laboratory Biochemistry Analyzer. Clin Lab. 2022 Sep 1;68(9).

14. Mohammed-Ali Z, Bagherpoor S, Diker P, Hoang T, Vidovic I, Cursio C, et al. Performance evaluation of all analytes on the epoc® Blood Analysis System for use in hospital surgical and intensive care units. Pract Lab Med. 2020 Nov 25;22:e00190.