HONG KONG SPORTS INSTITUTE
香港體育學院

RESEARCH HIGHLIGHTS

Determination of the Validity and Reliability of a Portable Lactate Analyser

K.K. Lo, Y.Y. Chan, Y.H. Tang, W.H. Yu, Patrick Fox, Raymond C.H. So
Scientific Conditioning Centre, Hong Kong Sports Institute

MARCH 2019

Introduction

Monitoring of blood lactate (BLa) concentration during exercise is one of the most consistent indicators of exercise intensity, and commonplace in sports physiology laboratories and in the field [1-3]. Lactate analysis is performed for prescription of training intensities, and to evaluate individual responses to specific training sessions [4]. A portable lactate analyser allows real-time data feedback during on-field testing and training monitoring. In this study, we assessed the validity and reliability of the portable lactate analyser Nova (Lactate Plus, Nova Biomedical, USA) against two valid and reliable laboratory-based lactate analysers, the EKF (Biosen C-line Sport, EKF Diagnostics, Germany) and the YSI (YSI 1500, Yellow Springs Instrument Company, USA). In addition, we also compared the performance of the Nova analyser with that of three portable lactate analysers, Lactate Scout (LS, EKF Diagnostics, Germany), Lactate Pro I (LP, Arkray KDK, Japan) and Lactate Pro II (LP2, Arkray KDK, Japan). Thus, we determined the reproducibility and validity of the Nova analyser results for BLa, and the quantitative agreement between the Nova analyser and laboratory analysers for lactate monitoring of subjects during exercise of difference intensity.

Methodology

Subject

Fifty-one trained and healthy individuals from the Hong Kong Sports Institute (HKSI) were recruited to participate in this study. All participants gave written informed consent and the protocol was reviewed and approved by the HKSI.

Experimental design

Blood samples were taken during a VO_2 max test and an incremental step-test across a range of exercise intensities from rest to exhaustion (0.5 mM to 22 mM lactate) [5-7]. 300 µL Capillary blood samples were drawn from the fingertips of the subjects and collected in a large capillary tube (300 µL) [3,6,8]. Samples were randomly allocated to different lactate analysers and used for inter-analyser comparison using both laboratory analysers (EKF and YSI) and all portable analysers (LP, LP2 and LS) against the Nova portable analyser.

Statistical analysis

A comparison of the results of analysers was performed using a Pearson product-moment correlation analysis and a paired t-test. Least-product regression analysis was used rather than least-squares regression, to minimise the deviation of both the dependent variable and the independent variable from linear regression with a 95% confidence interval (CI). The inter-reliability of EKF, YSI and Nova analysers was tested, while the validity of the Nova analyser was tested against the two laboratory analysers and the three portable lactate analysers.

Results

Reliability

Two samples of blood were collected from each subject for intra-comparison of EKF, YSI and Nova. Results for the three pairs of lactate analyser tests were highly correlated ($r > 0.99$), and paired t-tests showed that no significant difference ($p > 0.05$) existed in the results generated by the three analysers.

Validity

The results showed that a very strong relationship ($r > 0.97$) existed between the results generated by Nova and those generated by the other five analysers (EKF, YSI, LS, LP1 and LP2). A paired t-test showed that the results from Nova were not significantly different from those obtained from EKF and LS ($p = 0.42$ and 0.92 respectively), while there was a significant difference between the results from Nova and those from YSI, LP1 and LP2 ($p < 0.001$). Least-product regression (Table 1) indicated that proportional biases existed between the results of Nova and LP (slope = 0.85, 95% CI = 0.8 to 0.9) and between the results of Nova and LP2 (slope = 1.16, 95% CI = 1.12 to 1.21). Small fixed biases were observed between the results of Nova and LS (y-intercept = -0.55, 95% CI = -1.05 to -0.05), and also in the results from LP (y-intercept = 0.7, 95% CI = 0.35 to 1.05) and LP2 (y-intercept = -0.78, 95% CI = -1.21 to -0.35) in comparison with the results from Nova.

Table 1. Least-product regression equation, 95% CI for y-intercept and slope for the Nova lactate analyser results compared with those of five other lactate analysers

Lactate analyser comparison	Equation	95% CI for y-intercept	95% CI for slope
Nova VS EKF	y = -0.18 + 1.04x	(-0.51, 0.15)	(0.96, 1.11)
Nova VS YSI	y = -0.3 + 1.01x	(-0.72, 0.13)	(0.92, 1.11)
Nova VS LS	y = -0.55 + 1.06x	(-1.05, -0.05) †	(0.99, 1.13)
Nova VS LP	y = 0.7 + 0.85x	(0.35, 1.05) †	(0.8, 0.9)*
Nova VS LP2	y = -0.78 + 1.16x	(-1.21, -0.35) †	(1.12, 1.21)*

† 95% CI for y-intercept not including the value of 0 means that fixed bias existed
* 95% CI for slope not including the value of 1 means that proportional bias existed

Discussion

The findings of this study indicated that BLa measurements from the Nova analyser were highly comparable to those from two laboratory standard BLa analysers (EKF and YSI). A linear relationship existed between the lactate values obtained using Nova, EKF and YSI, which substantiates the reliability and validity of Nova. Therefore, the Nova lactate analyser is recommended for BLa monitoring of athletes during on-field training.

An interesting finding is that results from the Nova and LS analysers are somewhat interchangeable, as indicated by regression transformation. There was also a small fixed bias between measurements made with these two analysers, but there was no evidence of a proportional bias (Table 1). This may imply that the lactate values measured by Nova and LS were closer than the values measured by Nova and LP, and by Nova and LP2. The existence of a high fixed and proportional bias must therefore be considered when determining the suitability of LP or LP2 analysers to replace Nova during physiological assessments.

Both Nova and LS appear suitable for use out of the laboratory. These devices required blood volumes of 0.7 µL (Nova) and 0.5 µL (LS) [1], and had analysis times of 13 s (Nova) and 10 s (LS). However, each batch of LS analyser test-strips requires a unique calibration, whilst no calibration is needed when using the Nova analyser [8]. Thus, use of Nova eliminates a time-consuming step that is also a source of real error, and is thus preferable.

To conclude, the Nova portable lactate analyser is accurate and reliable, with performance comparable to that of EKF or YSI laboratory analysers across a full range of lactate concentrations. In addition, only a short time is required for BLa measurement by the Nova analyser. Thus, the authors recommend the use of the Nova analyser for BLa monitoring during on-field training.

Acknowledgement

We are grateful to all participants in our study for providing us with test data and donating blood samples for lactate analysis. Also, we thank the Scientific Assessment Team of the Scientific Conditioning Centre, Hong Kong Sports Institute.

Reference

1. Bonaventura JM, Sharpe K, Knight E, Fuller KL, Tanner RK, Gore CJ. (2015). Reliability and accuracy of six hand-held blood lactate analysers.
2. Mc Naughton LR, Thompson D, Philips G, Backx K, Crickmore L. (2002). A comparison of the Lactate Pro, Accusport, Analox GM7 and Kodak Ektachem lactate analysers in normal, hot and humid conditions. Int J Sports Med. 23 (2):130-135.
3. Medbø JI, Mamen A, Holt Olsen O, Evertsen F. (2000). Examination of four different instruments for measuring blood lactate concentration. Scand J Clin Lab Invest. 60 (5):367-380.
4. Pyne DB, Boston T, Martin DT, Logan A. (2000). Evaluation of the Lactate Pro blood lactate analyser. Eur J Appl Physiol. 82(1-2):112-116.
5. Hart S, Drevets K, Alford M, Salacinski A, Hunt BE. (2013). A method-comparison study regarding the validity and reliability of the Lactate Plus analyzer. BMJ Open. 3 (2).
6. McLean SR, Smith DJ. (2004). Comparison of the Lactate Pro and the YSI 1500 Sport blood lactate analyzers. Int J Appl Sports Sci. 2004 (2):22-30.
7. White R, Yaeger D, Stavrianeas S. Determination of blood lactate concentration: reliability and validity of a lactate oxidase-based method. In: International Journal of Exercise Science. University of Chicago Press: 83-93.
8. Tanner RK, Fuller KL, Ross MLR. (2010). Evaluation of three portable blood lactate analysers: Lactate Pro, Lactate Scout and Lactate Plus. Eur J Appl Physiol. 109 (3):551-559.