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SHORT COMMUNICATION

Evaluation of three portable blood lactate analysers: Lactate Pro, Lactate Scout and Lactate Plus

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Abstract Three portable blood lactate analysers, Lactate Pro (LP), Lactate Scout (LS) and Lactate Plus (L^+), were evaluated. Analyser reliability and accuracy was assessed. For reliability, intra- and inter-analyser comparisons demonstrated that the LP (intra-TE = 0.5 mM, inter-TE = 0.4 mM) and L^+ (intra-TE = 0.4, inter-TE = 0.4 mM) displayed greater overall reliability than the LS (intra-TE = 1.0, inter-TE = 0.8 mM). At BLa < 4.0 mM, the LP (intra-TE = 0.1 mM) demonstrated greater reliability than the LS (intra-TE = 0.5 mM) and L^+ (intra-TE = 0.4 mM). At BLa > 8.0 mM, the LP (intra-TE = 0.5 mM, inter-TE = 0.4 mM) and L^+ (intra- and inter-TE = 0.4 mM) displayed greater reliability than the LS (intra-TE = 1.1 mM, inter-TE = 0.9 mM). For accuracy, the L^+ (SEE = 0.6 mM) compared more favourably to the LP than the LS (SEE = 1.1 mM). At BLa ~1.0–18.0 mM, the LS produced values that were up to 0.9 mM higher than the LP; the L^+ produced BLa that were within ±0.1 mM. All portable analysers tended to under-read the ABL 700 analyser. The suitability of the LP and L^+ as accurate analysers is supported by strong correlations ($r = 0.91$ and $r = 0.94$) and limits of agreement ≤2.1 mM. This study showed that the LP and L^+, compared well to each other, displayed good reliability and accuracy when compared to a laboratory-based analyser. Although the LS also displayed relatively good reliability, it was not as reliable or accurate as the LP or L^+.

Keywords Portable lactate analysers · Lactate pro · Lactate scout · Lactate plus · Accuracy · Reliability · Linearity

Introduction

Measurement of the blood lactate response to exercise is a common inclusion in the physiological assessment of high-performance endurance athletes. Many exercise physiology laboratories measure blood lactate response to incremental exercise in conjunction with measures of intensity, heart rate (HR) and oxygen uptake $\dot{V}O_2$. Lactate analysis is commonly performed as it can serve as an indicator of training adaptation (Jacobs 1986; MacRae et al. 1992; Bourdon 2000), correlates well with endurance exercise (Sjodin and Jacobs 1981; Yoshisa et al. 1987; Bourdon 2000; Jones and Carter 2000; Bentley et al. 2001), and assists with the identification of optimal training stimuli and the prescription of training intensities (Jacobs 1986; Cohen et al. 1991; Bourdon 2000).

The use and applicability of lactate measurements is reliant upon reliable, accurate and linear instrumentation whether in laboratory or field settings. Over recent years, the application of physiological testing and monitoring in field settings has increased particularly with the emergence of portable hand-held blood lactate analysers. Many practitioners have moved away from large and timely laboratory-based analysers such as those manufactured by Radiometer Copenhagen (ABL series), Yellow Springs Instruments (YSI©), Kodak© Ektachem™, Analox© and Roche©

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Diagnostics. A number of portable, battery-operated blood lactate analysers are currently available for use. The Accusport Lactate Meter (Boehringer Mannheim, Germany), now released as the Accutrend® (Roche Diagnostics, Switzerland), was introduced in 1994 and employs reflectance photometry techniques. In 1997, the Lactate Pro™ (Arkray KDK, Japan) was released and uses an amperometric method. A number of additional portable lactate analysers have been released recently including the Lactate Scout (SensLab GmbH, Germany) and Lactate Plus (Nova Biomedical, USA).

One of the most common portable lactate analysers currently in use is the Lactate Pro analyser. To date, a number of papers have evaluated the Lactate Pro analyser in terms of its accuracy, reliability and linearity (Makita 1997; Pyne et al. 2000; McNaughton et al. 2002; Buckley et al. 2003; van Someren et al. 2005; Baldari et al. 2009). The aim of this investigation was to evaluate the suitability of the Lactate Scout and the Lactate Plus analysers for the testing of athletes and assess their reliability and accuracy against the Lactate Pro as well as the accuracy of all three portable blood lactate analysers against a laboratory-based Radiometer ABL 700 blood gas analyser.

Methods

Subjects

Both male and female athletes from a range of sports were recruited to participate in the study. All athletes were nationally competitive in their respective sports and were in regular training under the direct supervision of a full-time coach. Blood lactate samples were taken in the field from swimmers during and after a progressive incremental swimming test and after routine interval training. In the laboratory, samples were taken from cyclists during and after a progressive incremental cycle ergometer test, and from runners during and after a progressive incremental treadmill test. All subjects signed informed consent documents, in accordance with the policies of the Australian Institute of Sport. Experimental procedures were approved by the Ethics Committee of the Australian Institute of Sport.

Lactate analysers

The Lactate Pro (LP, Arkray KDK, Japan) is a hand-held portable analyser measuring whole blood. A blood sample of 5 μL is required. Coded reagent strips fill by capillary action directly from the sample site. Lactate in the sample reacts with potassium ferricyanide and lactate oxidase to form potassium ferrocyanide and pyruvate. Upon application of a given voltage, ferrocyanide is oxidised, releasing electrons and creating a current. This current is measured amperometrically and is directly proportional to the lactate concentration of the sample. Sample analysis time is 60 s. The LP is supplied with a check strip to confirm that the analyser is operating correctly, and a calibration strip that provides a non-quantitative indication of analyser accuracy.

The Lactate Scout (LS, SensLab GmbH, Germany) uses an enzymatic–amperometric method for the detection of lactate in capillary blood. Lactate in the sample is oxidised by the enzyme lactate oxidase, and in the course of this redox reaction electrons are transferred via an additional mediator from the enzyme to a working electrode. The resulting current corresponds to the lactate concentration of the sample. The LS requires a blood sample of 0.5 μL, and has a sample analysis time of 15 s. Test strips fill by capillary action directly from the sample site, and each batch of test strips has a unique calibration code. The LS is supplied with a 1-level calibration solution (range 9.5–12.5 mM) that is used as a quality control to ensure that the analyser and test strips are functioning properly.

The Lactate Plus (L^+, Nova Biomedical, USA) uses an electrochemical lactate oxidase biosensor for the measurement of lactate in whole blood. A blood sample of 0.7 μL is required; sample analysis time is 13 s. Test strips used with the L^+ do not require calibration codes or specific calibration strips. The L^+ is supplied with two levels of a quality control solution (level 1: 1.0–1.6 mM; level 2: 4.0–5.4 mM) that are used prior to testing to ensure correct operation of the analyser.

All hand-held portable analysers were calibrated and operated in accordance with the manufacturer's instructions. Specifications for each hand-held analyser are detailed in Table 1.

The Radiometer ABL 700 (Radiometer Copenhagen, Denmark) is a laboratory blood gas analyser that incorporates co-oximetry, electrolyte and metabolite measurement. Lactate measurement by the ABL 700 requires a 75-μL capillary blood sample. Blood lactate passes across the outer layer of a multi-layered membrane and reacts with lactate oxidase to form pyruvate and H_2O_2. The H_2O_2 passes across the inner membrane, where it is subjected to a given potential and oxidised, creating a current that is measured amperometrically. The size of the current is directly proportional to the lactate concentration of the sample.

The ABL 700 automatically performs a 1- and 2-point calibration every 4 and 8 h, respectively. Further, the analyser was calibrated routinely according to manufacturer's recommendations, meeting all quality assurance performance standards during the study period. Three levels of quality control material (Bio-Rad Laboratories) were analysed during each day of operation. The laboratory

Table 1 Specifications for three hand-held portable analysers

	Lactate Pro	Lactate Scout	Lactate Plus
Manufacturer	Arkray KDK, Japan	SensLab GmbH, Germany	Nova Biomedical, USA
Method	Amperometric	Enzymatic–amperometric	Electrochemical Lactate Oxidase Biosensor
Sample volume (μL)	5.0	0.5	0.7
Analysis time (s)	60	15	13
Measurement range (mM)	0.8–23.3	0.5–25.0	0.3–25.0
Operating conditions	10–40°C	5–45°C	5–45°C
	20–80% RH	<85% RH	10–90% RH
Quality control (mM)	Calibration strip	1: 9.5–12.5	1: 1.0–1.6
			2: 4.0–5.4
Memory	20 readings	250 readings	130 readings
Data output port	No	Yes	Yes
Weight (g)	~50	~80	~75

participates in an external quality assurance programme (QAP; Australian RCPA-AACB Chemical Pathology Quality Assurance Program, Flinders Medical Centre, South Australia) for lactate measurement.

Experimental design

Capillary blood samples were drawn from either the earlobe or fingertip of participating athletes, with the site standardised for each athlete. Samples were collected into non-heparinised capillary tubes for ease of allocation to different analysers and to ensure that a blood sample of consistent lactate concentration was measured. Capillary tubes were capped and mixed thoroughly between repeat analyses. Immediately, each blood sample was analysed in duplicate, on two units of each brand of the portable analysers in random order (2× LP, 2× LS and 2× L^+). This allowed for intra-analyser (within-analyser) comparisons (LP I vs. LP I; LS I vs. LS I; L^+ I vs. L^+ I), inter-analyser (between-analyser) comparisons (LP I vs. LP II; LS I vs. LS II; L^+ I vs. L^+ II) as well as the analysis of accuracy of the LS and L^+ analysers against the LP analyser. The accuracy of all three portable analysers was also measured in relation to a Radiometer ABL 700 laboratory-based analyser. For the purpose of this investigation, the ABL 700 was considered to be the criterion measure. The total number of capillary blood samples used for this investigation is presented in Table 2.

Table 2 Capillary blood sample numbers

Evaluation	Assessment	Analyser comparison	Samples
Reliability	Intra-analyser	LP I versus LP I	$n = 83$
		LS I versus LS I	$n = 116$
		L^+ I versus L^+ I	$n = 103$
	Inter-analyser	LP I versus LP II	$n = 203$
		LS I versus LS II	$n = 262$
		L^+ I versus L^+ II	$n = 232$
Accuracy	Portable analysers	LP versus LS	$n = 363$
		LP versus L^+	$n = 345$
Accuracy	Portable analysers versus laboratory analyser	ABL versus LP	$n = 58$
		ABL versus LS	$n = 77$
		ABL versus L^+	$n = 73$

Statistical analysis

Reliability

In addition to conventional descriptive statistics [mean ± standard deviation (SD)], intra- and inter-analyser reliability was determined by calculation of the typical error of measurement (TE) and coefficient of variation (CV), Pearson product–moment correlation analysis and standard linear regression with 95% CI. Overall intra- and inter-analyser reliability was calculated using all collected lactate samples. Further, intra- and inter-analyser reliability was determined for the three arbitrarily assigned lactate concentration zones: 0–4.0, 4.1–8.0 and >8.0 mM.

Accuracy

Between analyser accuracy was examined by calculation of the standard error of the estimate (SEE), CV, determination of the level of bias and Pearson product–moment correlation analysis. Between portable analyser accuracy was calculated overall as well as for the three lactate concentration zones.

Results

Intra-analyser reliability

Results for intra-analyser comparisons are presented in Table 3 and Fig. 1. The TE for the repeat measurement of the same blood sample by the same LP, LS and L^+ analyser was 0.5, 1.0 and 0.4 mM, respectively. CV values were 5.7, 10.2 and 8.5% for the LP, LS and L^+ analysers, respectively.

Correlation analysis shows the linear regression equation, correlation coefficient and 95% CI (Fig. 1). Correlations for repeat measurement of the same blood sample by the same LP, LS and L^+ analyser were $r = 0.98$, $r = 0.91$ and $r = 0.99$, respectively. The level of agreement between each pair of analysers is also reflected in the slope and intercept of the linear regression plots. The slope values were 0.934, 0.890 and 0.949 for the LP, LS and L^+ analysers, respectively.

Closer examination of the data highlighted greater intra-analyser reliability at the 0–4.0 mM range for the LP (TE = 0.1 mM, CV = 5.0%) compared to the LS (TE = 0.5 mM, CV = 19%) and L^+ (TE = 0.4 mM, CV = 27.7%). For the lactate range of 4.1–8.0 mM, all analysers demonstrated similar reliability (LP, LS and L^+ TE = 0.4, 0.3 and 0.3 mM and CV = 6.9, 3.8 and 5.2%, respectively). At higher lactate concentrations (>8.0 mM) the LP (TE = 0.5 mM, CV = 4.3%) and the L^+ (TE = 0.4 mM, CV = 3.7%) analysers displayed greater intra-analyser reliability than the LS (TE = 1.1 mM, CV = 9.8%).

Inter-analyser reliability

Results for the various inter-analyser comparisons are presented in Table 4 and Fig. 2. The TE for the repeat measurement of the same blood sample by different LP, LS and L^+ analysers was 0.4, 0.8 and 0.4 mM, respectively. CV values were 5.2, 8.8 and 7.5% for the LP, LS and L^+ analysers, respectively.

Table 3 Intra-analyser reliability data for Lactate Pro, Lactate Scout and Lactate Plus analysers

	LP I versus LP I	LS I versus LS I	L^+ I versus L^+ I
Sample number	83	116	103
Mean ± SD	8.6 ± 3.5	10.5 ± 3.2	9.9 ± 3.5
Range (mM)	1.9–15.6	2.5–17.6	1.0–15.4
Typical error, mM (±95% CI)	0.5 (0.41–0.55)	1.0 (0.87–1.12)	0.4 (0.35–0.46)
CV% (±95% CI)	5.7 (5.0–6.9)	10.2 (9.4–12.4)	8.5 (7.7–10.3)
Correlation *r*	0.984	0.910	0.988

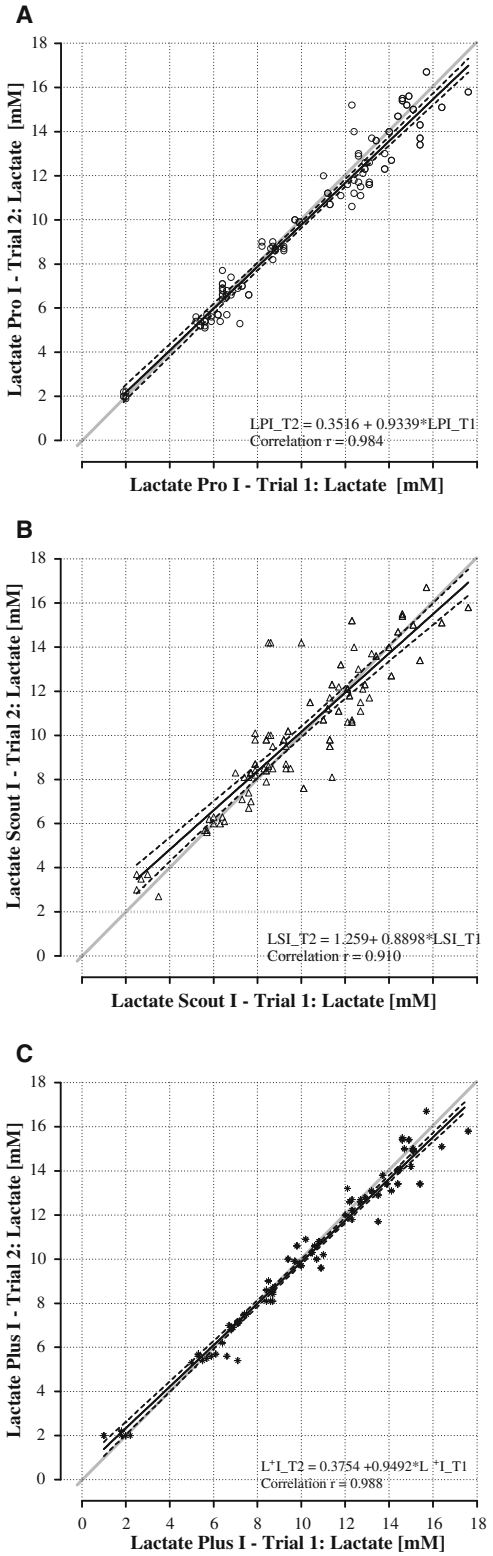

Fig. 1 Intra-analyser correlation plots for Lactate Pro (**a**, *circles*), Lactate Scout (**b**, *triangles*) and Lactate Plus (**c**, *asterisks*) analysers. Linear regression is represented by *solid black line*, ±95% CI by *dashed lines* and line of identity by *grey solid line*. Linear regression equation and correlation coefficients are presented on *bottom right of graph*

Table 4 Inter-analyser reliability data for Lactate Pro, Lactate Scout and Lactate Plus analysers

	LP I versus LP II	LS I versus LS II	L^+ I versus L^+ II
Sample number	203	262	232
Mean ± SD	8.8 ± 3.9	10.2 ± 3.6	9.7 ± 3.8
Range (mM)	1.2–15.6	2.2–17.6	1.0–15.4
Typical error, mM (±95% CI)	0.4 (0.39–0.48)	0.8 (0.76–0.90)	0.4 (0.33–0.39)
CV% (±95% CI)	5.2 (4.9–5.9)	8.8 (8.2–9.8)	7.5 (7.1–8.6)
Correlation *r*	0.989	0.951	0.991

Correlation analysis shows the linear regression equation, correlation coefficient and 95% CI (Fig. 2). The correlation between two different LP, LS and L^+ analysers in analysing the same blood sample was $r = 0.99$, $r = 0.95$ and $r = 0.99$, respectively. The slope values were 0.949, 0.897 and 0.999 for the LP, LS and L^+ analysers, respectively.

Noteworthy differences between the three analysers were only evident at the >8.0 mM range with inter-analyser reliability for LS (TE = 0.9 mM, CV = 8.0%) slightly poorer than for both LP (TE = 0.4 mM, CV = 3.7%) and L^+ (TE = 0.4 mM, CV = 3.1%) analysers.

Between portable analyser accuracy

Overall, the LS and L^+ produced lactate values that were 0.6 mM higher and 0.05 mM lower than the LP analyser. The SEE for measurement of the same blood sample by LS and L^+ analysers, in comparison to the LP, was 1.1 and 0.6 mM with CV values of 15.6 and 9.4%, respectively. These results are presented in Table 5 and Fig. 3. Correlation analysis shows the linear regression equation, correlation coefficient and 95% CI (Fig. 3). The correlation between LP and LS and L^+ analysers in analysing the same blood sample was $r = 0.97$ and $r = 0.99$, respectively.

For all of the three examined lactate concentration zones (0–4.0 mM, 4.1–8.0 mM and >8.0 mM), the LS tended to produce lactate values that were 0.9, 0.6 and 0.5 mM higher, respectively, than the LP. SEE values for each of these zones were 0.4, 0.7 and 1.2 mM. In comparison, the L^+ tended to produce lactate values that were 0.1 mM lower, 0.1 mM higher and 0.1 mM lower, respectively. SEE values were 0.3, 0.5 and 0.6 mM.

Portable analyser versus laboratory analyser accuracy

Results for the comparison of the LP, LS and L^+ analysers to the ABL 700 analyser are presented in Table 6 and Fig. 4. The SEE for measurement of the same blood sample

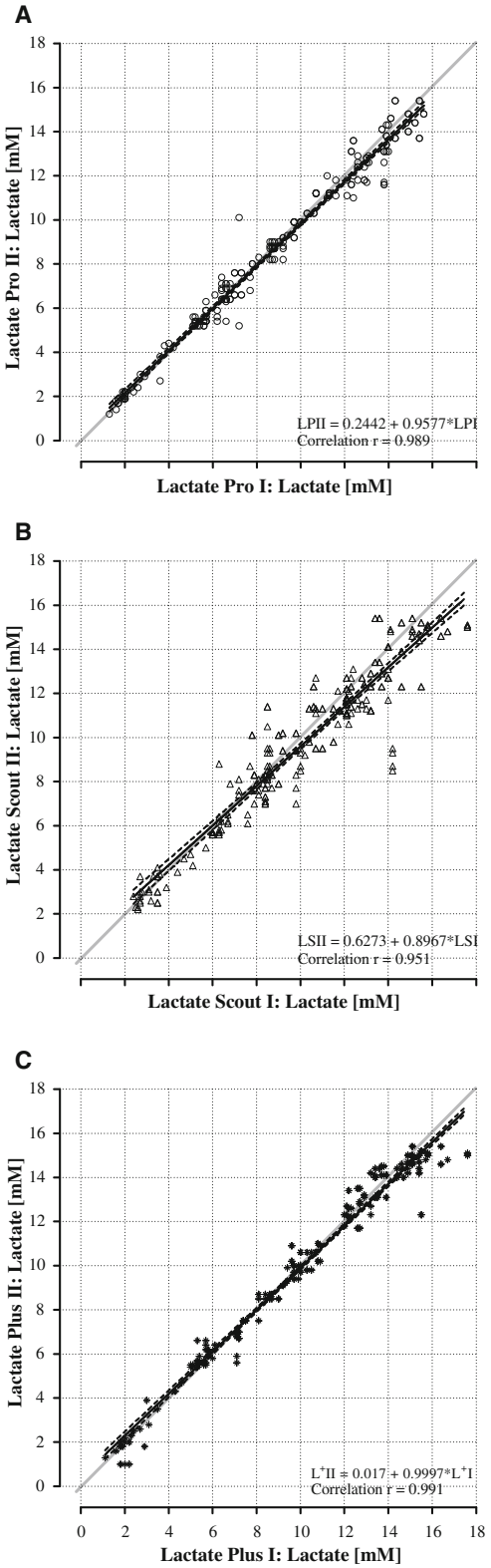

Fig. 2 Inter-analyser correlation plots for Lactate Pro (**a**, *circles*), Lactate Scout (**b**, *triangles*) and Lactate Plus (**c**, *asterisks*) analysers. Linear regression is represented by *solid black line*, ±95% CI by *dashed lines* and line of identity by *grey solid line*. Linear regression equation and correlation coefficients are presented on *bottom right of graph*

Table 5 Accuracy data for Lactate Scout and Lactate Plus analysers versus Lactate Pro analyser

	LS versus LP	L^+ versus LP
Sample number	363	345
Mean ± SD	9.4 ± 4.2	9.0 ± 4.3
Range (mM)	1.2–17.6	1.0–15.4
Mean bias, mM (±95% CI)	0.6 (0.5–0.8)	−0.05 (−0.1 to 0.02)
SEE, mM (±95% CI)	1.1 (1.0–1.2)	0.6 (0.6–0.7)
CV% (±95% CI)	15.6 (14.4–16.9)	9.4 (8.7–10.2)
Correlation *r*	0.967	0.990

by LP, LS and L^+ analysers, in comparison to the ABL 700, was 1.1, 1.4 and 0.9 mM, respectively. A consistent bias was observed between the ABL 700 analyser and all portable analysers. On average, the LP, LS and L^+ analysers produced lactate values that were 0.7, 0.4 and 0.8 mM lower than the ABL 700, respectively. Absolute errors for blood lactate concentrations >8.0 mM (Fig. 5) ranged from 3.3 mM low to 1.8 mM high for the LP (range of 5.1 mM), 3.5 mM low to 2.4 mM high for the LS (range of 5.9 mM) and 2.3 mM low to 1.5 mM high for the L^+ (range of 3.8 mM).

Coefficient of variation values were 8.9, 11.9 and 7.4%, respectively. Correlation analysis shows the linear regression equation, correlation coefficient and 95% CI (Fig. 4). The correlation between LP, LS, L^+ analysers and the ABL 700 in analysing the same blood sample was $r = 0.91$, $r = 0.84$ and $r = 0.94$, respectively.

Discussion

Reliability

Employing reliable lactate analysers is vital for successful longitudinal monitoring and progression of athletes. Blood lactate data, in combination with other physiological measurements such as workload and heart rate, are used to derive training threshold values and prescribe accurate training intensities for specific sports. Due to the logistics associated with testing multiple athletes at one time, scientists commonly interchange multiple units of the same brand analyser between repeat tests. As such, it is important that the brand of analyser employed demonstrates good intra and inter-analyser reliability. This way, measurement errors are minimised, and a greater level of confidence achieved when comparing and interpreting repeat blood lactate samples on the same athlete. It is worth noting that despite differences in reliability between LP, LS and L^+ analysers, intra- and inter-analyser reliability data within each brand was similar. This supports the practice of interchanging multiple units of the same brand analyser between repeat tests.

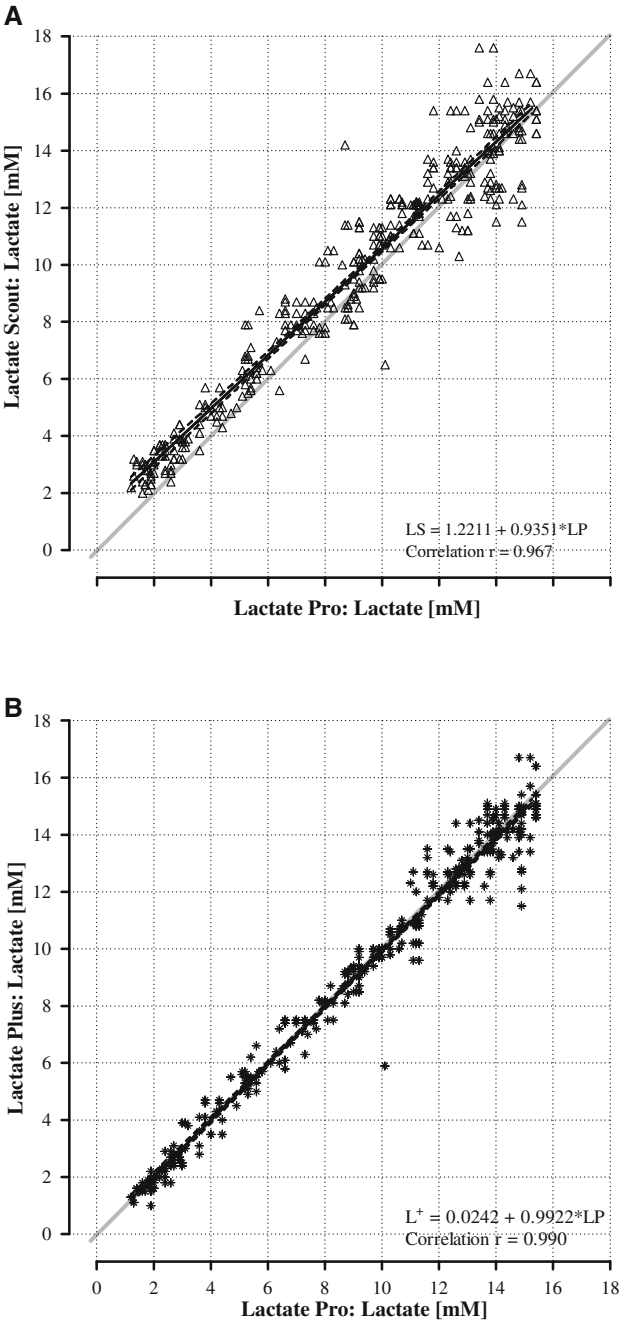

Fig. 3 Portable analyser correlation plots for Lactate Scout (**a**, *triangles*) and Lactate Plus (**b**, *asterisks*) analysers versus Lactate Pro analyser. Linear regression is represented by *solid black line*, ±95% CI by *dashed lines* and line of identity by *grey solid line*. Linear regression equation and correlation coefficients are presented on *bottom right of graph*

Results of the current study showed that the LP and L^+ demonstrated better intra- and inter-analyser reliability than the LS. Overall intra- and inter-analyser TE values for the LS were approximately double those for the LP and L^+. Closer examination of the data highlighted that at low lactate concentrations (0–4.0 mM) the LP displayed greater

Table 6 Accuracy data for Lactate Pro, Lactate Scout and Lactate Plus analysers versus Radiometer ABL 700

	ABL versus LP	ABL versus LS	ABL versus L^+
Sample number	58	77	73
Mean ± SD	12.2 ± 2.5	12.5 ± 2.5	12.3 ± 2.3
Range (mM)	6.6–17.0	7.6–17.6	7.4–17.0
Mean bias, mM (±95% CI)	−0.7 (−1.0 to −0.4)	−0.4 (−0.7 to −0.1)	−0.8 (−1.1 to −0.6)
SEE, mM (±95% CI)	1.1 (0.9–1.3)	1.4 (1.2–1.6)	0.9 (0.7–1.0)
CV% (±95% CI)	8.9 (7.4–11.0)	11.9 (10.2–14.3)	7.4 (6.3–8.9)
Correlation *r*	0.913	0.837	0.936

intra- and inter-analyser reliability than both the LS and L^+. This was indicated by lower CV and TE values, suggesting better agreement between blood lactate concentrations measured using the same individual analyser or between two different LP analysers. Pyne et al. (2000), McNaughton et al. (2002) and Baldari et al. (2009) reported similar inter-analyser correlations for the LP analyser ($r = 0.99$, $r = 0.98$, $r = 0.99$, respectively). The LS and L^+ measured intra-analyser TE values for 0–4.0 mM lactate concentrations of 0.5 and 0.4 mM, respectively, and an inter-analyser TE value of 0.3 mM for both brands. Lactate concentrations at this low range are used in the derivation of blood lactate thresholds and associated training intensities. Furthermore, some laboratories employ athlete testing protocols using a fixed absolute lactate concentration (such as 2.0 or 4.0 mM). As such, the poorer reliability of the LS and L^+ at low lactate concentrations is a factor to consider for monitoring blood lactate data longitudinally.

For mid-range lactate concentrations (4.1–8.0 mM), intra- and inter-analyser reliability results were similar for all three analysers tested. However, at high lactate concentrations (>8.0 mM), the LS demonstrated poorer reliability than the other analysers, with TE values (intra- and inter-analyser) almost double those observed for both the LP and L^+. At values >8.0 mM, the LS exhibited a degree of heteroscedasticity, where repeat measurements showed greater inconsistency than those at lower values. Accordingly, the poorer reliability of the LS at high blood lactate concentrations is an important limitation considering these concentrations are routinely measured in athletic testing.

Accuracy

The accuracy of the LS and L^+ against the LP was assessed. A strong linear relationship was observed between lactate concentrations measured by L^+ and LP analysers. The measured mean bias of the L^+ across the different lactate concentration zones was small (less than the measured L^+ intra- and inter-analyser TE), and strong correlations across these different concentration zones were observed. These results suggest that the L^+ compares favourably to the LP across the measured lactate concentration range (0–15.0 mM). The LS, however, showed a trend of larger mean bias values for low- and mid-range lactate concentration zones (greater than the measured LS intra- and inter-analyser TE). Furthermore, the limits of agreement, as proposed by Altman and Bland (1983), suggest that the degree of variation between LS and LP analysers was greater than between L^+ and LP analysers.

On average, there was a tendency for all portable blood lactate analysers to under-read blood lactate concentrations compared to the ABL 700. This may simply reflect the different methods for measurement of blood lactate within the blood sample. Relatively strong correlations for LP and L^+ compared to the ABL 700 were observed. The correlation between LP and the ABL 700 is similar, although slightly lower than the $r = 0.98$ reported by Pyne et al. (2000). The suitability of the LP and L^+ as accurate portable analysers is supported by correlation data and a low degree of variability compared to the ABL 700 with limits of agreement ≤2.1 mM. The correlation observed between the LS and the ABL 700 was not as strong as for the LP and L^+, and the limits of agreement for the LS were higher. These results suggest that the LS does not give the same result as the ABL 700 despite being moderately or highly correlated. It is important to note, however, a limitation of the current study that only blood lactate concentrations >8.0 mM were collected for comparison to the ABL 700 and as such the aforementioned results pertain to these high lactate concentrations only.

To summarise, (1) The overall reliability (intra- and inter-analyser) of the LP and L^+ was greater than the LS. (2) The LP demonstrated greater intra-analyser reliability at low lactate concentrations (0–4.0 mM) than both the LS and L^+. Poorer reliability at low lactate concentrations is a factor to consider for monitoring blood lactate data longitudinally. (3) The LS demonstrated poorer reliability (intra- and inter-analyser) at lactate concentrations >8.0 mM. This may have implications for longitudinal

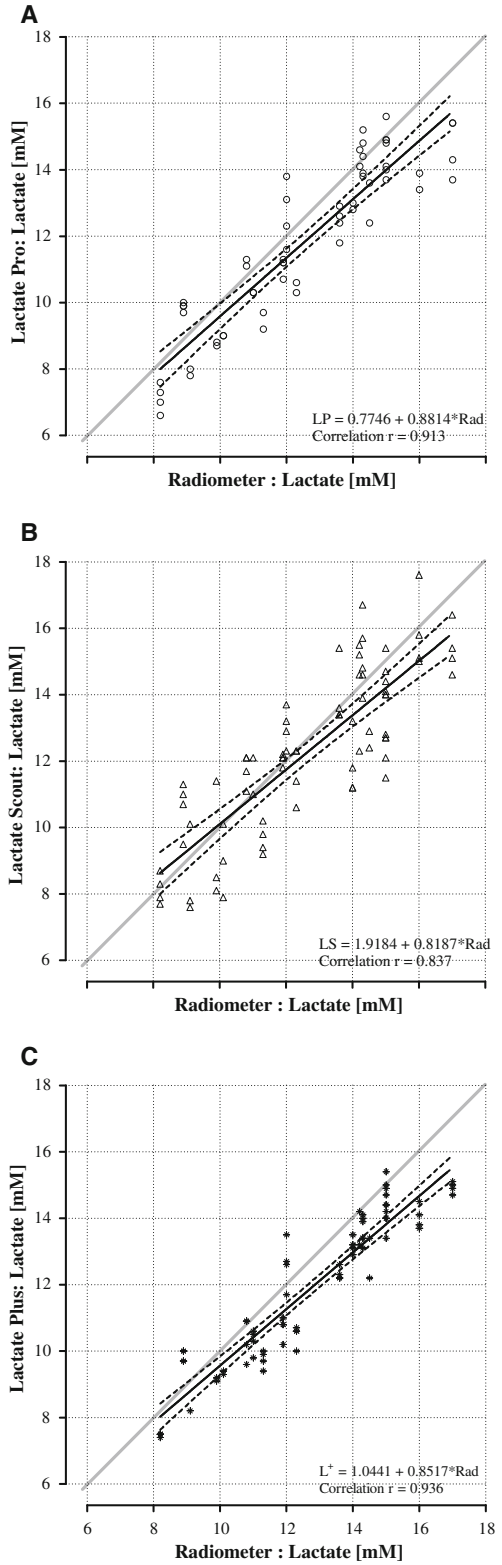

Fig. 4 Portable analyser correlation plots for Lactate Pro (**a**, *circles*), Lactate Scout (**b**, *triangles*) and Lactate Plus (**c**, *asterisks*) analysers versus Radiometer ABL 700 analyser. Linear regression is represented by *solid black line*, ±95% CI by *dashed lines* and line of identity by *grey solid line*. Linear regression equation and correlation coefficients are presented on *bottom right of graph*

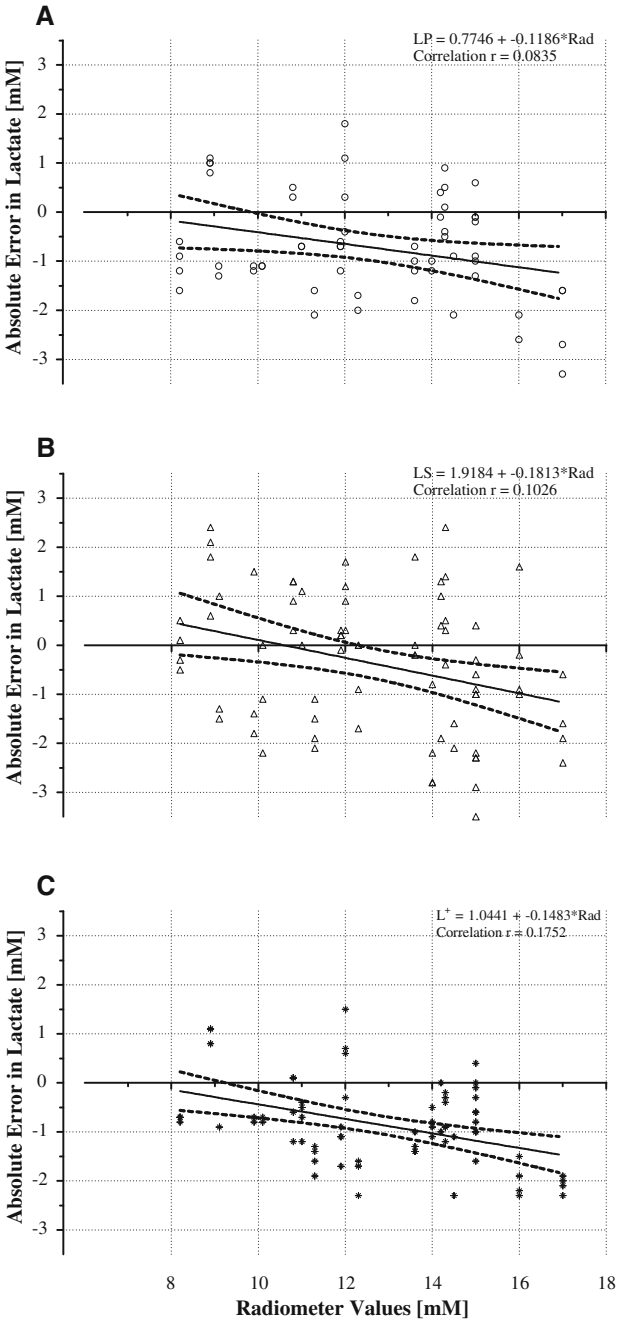

Fig. 5 Portable analyser Bland–Altman plots for Lactate Pro (**a**, *circles*), Lactate Scout (**b**, *triangles*) and Lactate Plus (**c**, *asterisks*) analysers versus Radiometer ABL 700 analyser. Linear regression is represented by *solid black line* and ±95% CI by *dashed lines*. Linear regression equation and correlation coefficients are presented on *top right of graph*

monitoring of blood lactate data for an athletic population, where high lactate concentrations are routinely measured. (4) Authors recommend that only one brand of portable lactate analyser be employed and that scientists exercise caution if comparing blood lactate data measured by different brands. This is particularly true if comparing data

measured by LS to that measured by LP or L^+. (5) Within each brand of analyser, intra- and inter-analyser reliability was similar. This supports the practice of interchanging multiple units between repeat tests rather than the exclusive use of one individual analyser for every test. (6) The L^+ compared more favourably to the LP than the LS. (7) All portable analysers tended to under-read the ABL700 and as such results should not be directly compared. However, both the LP and L^+ appear suitable for use in laboratory settings in place of laboratory-based analysers. (8) The LS was not as accurate as the LP and L^+ when compared to the ABL 700 at high blood lactate concentrations. However, more research is needed to compare all portable analysers to the ABL 700 at low- and mid-range lactate concentrations. (9) Operating requirements such as sample volume, measurement range and analysis time should be considered when selecting the most suitable portable blood lactate analyser for use in laboratory and field settings.

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