

# Comparison of the Lactate Pro Portable Lactate Analyzer to the YSI 1500

By

Ed McNeely, M.Sc.

Rowing Canada Sport Medicine and Science Committee

## **Introduction**

Blood lactate analysis has become an important part of the sport science program of many sports including rowing. Since 1992 Rowing Canada Aviron has used the YSI 1500 analyzer with the Canadian National team. While the YSI has proven to be a reliable analyzer the replacement cost of the analyzer and cost per sample is relatively high. While being a portable analyzer the YSI 1500 does not lend itself to easy use in on water testing protocols.

Over the past couple of years the Sport Medicine and Science Committee has been looking for a means of simplifying and expanding the testing program currently used by Rowing Canada. The Accusport portable lactate analyzer was evaluated a couple of years ago. The Accusport proved to be unreliable when compared to the YSI. The Accusport had several innate flaws that lent itself to inaccuracy. The volume of blood applied to the test strip was crucial to the accuracy of the measurement. However, the system had no means of controlling sample volume. This created a large amount of between tester error. While the Accusport had a high correlation to the YSI on grouped data the machine had an unacceptably high error on individual data. For the purposes of athlete monitoring the point by point comparison of the analyzers is more important than the grouped data.

The Lactate Pro was first brought to the attention of the committee in March of 2000. The analyzer seemed to have eliminated many of the problems that plagued the Accusport. The cost of the analyzer and the cost per sample for the test seemed attractive so arrangements were made to do an evaluation on the Lactate Pro.

## The Study

Several questions needed to be answered about the Lactate Pro these were

- Is the analyzer reliable (are the results reproducible)
- Does the analyzer produce the same result as the YSI
- Are there any innate flaws in the analyzer that may compromise it's use

### *Reliability*

The reliability of the machine was initially assessed by drawing a fingertip blood sample, storing it in a test tube that contained glycolytic inhibitor and analyzing it several times the results are presented in table 1.

**Table 1. Repeatability of the Lactate Pro at 4 levels of Lactate**

	<b>Sample A</b>	<b>Sample B</b>	<b>Sample C</b>	<b>Sample D</b>
Trial 1	1.0	2.1	4.3	3.3
Trial 2	1.2	2.1	4.6	3.1
Trial 3	1.0	2.0	4.4	3.2
Trial 4	1.2	2.1	4.4	3.3
Trial 5	1.0	2.1	4.6	3.2
Trial 6	1.1	2.2	4.4	3.3
Trial 7	1.0	2.0	4.6	3.3
Trial 8	0.9	2.1	4.5	3.3
Trial 9	1.2	2.2	4.4	3.4
Trial 10	1.2	2.0	4.4	3.4
<b>Average</b>	<b>1.1</b>	<b>2.1</b>	<b>4.5</b>	<b>3.3</b>
<b>S.D.</b>	<b>0.1135</b>	<b>0.0738</b>	<b>0.1075</b>	<b>0.919</b>
<b>C.V. (%)</b>	<b>10.5</b>	<b>2.4</b>	<b>2.4</b>	<b>2.8</b>

The data are repeatable the coefficient of variation for sample B is similar to that reported in the literature that accompanies the analyzer. Sample C and D have a lower variation than reported by the manufacturer. The acceptable variation in the YSI 1500, according to the operations manual is 5%. The same samples analyzed using the YSI 1500 can be seen in table 2.

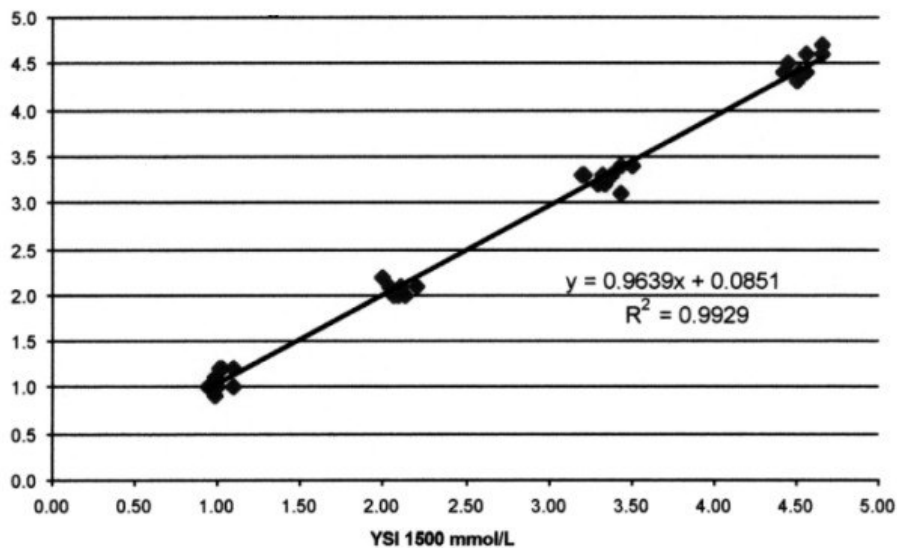
**Table 2. Repeatability of the YSI 1500 at 4 levels of Lactate**

	Sample A	Sample B	Sample C	Sample D
Trial 1	0.95	2.11	4.50	3.22
Trial 2	1.01	2.20	4.72	3.44
Trial 3	1.00	2.13	4.42	3.34
Trial 4	1.10	2.20	4.43	3.38
Trial 5	1.10	2.03	4.50	3.29
Trial 6	0.99	2.00	4.56	3.20
Trial 7	0.94	2.07	4.65	3.21
Trial 8	0.98	2.11	4.44	3.33
Trial 9	1.03	2.00	4.51	3.44
Trial 10	1.10	2.09	4.56	3.50
<b>Average</b>	<b>1.0</b>	<b>2.1</b>	<b>4.5</b>	<b>3.3</b>
<b>S.D.</b>	<b>0.0611</b>	<b>0.0720</b>	<b>0.0970</b>	<b>0.1056</b>
<b>C.V. (%)</b>	<b>6.0</b>	<b>3.4</b>	<b>2.1</b>	<b>3.2</b>

As the data indicates the Lactate pro portable analyzer yields results that are as repeatable as those of the YSI 1500. Only the A sample is significantly different ( $p < 0.05$ ) between the two analyzers. This is probably because the Lactate pro is designed to work within a range of 0.8-23.3 mmol/L. The lowest value is close to the limit of this operational range and probably contributes to some innacuracy.

When these data are plotted (figure 1.) There is a significant correlation of  $r = 0.9964$  ( $p < 0.01$ ) that is slightly lower than the  $r = 0.9988$  mentioned in the literature that accompanies the analyzer.

**Figure 1. Lactate Pro vs. YSI 1500**



Similar data have been reported in the literature for other portable lactate analyzers (Accusport). However, for the practitioner group data is of little value. The true test of the analyzer is how accurately the results from individual athletes compare.

## **Individual Comparisons**

The second part of this study involved the comparison of lactate measures performed on Canadian National team rowers during a normal physiological monitoring session.

## **Protocol**

### **Pre-Test procedure**

The training and nutritional regimens in the two days immediately prior to the testing session can have an impact on your results. Please follow the following suggestions

- Maintain a high carbohydrate diet

Try to emphasize such things as pasta, rice, bread, and potatoes in your meals. You should consume some type of carbohydrate drink (gatorade, power ade, exceed, etc.) immediately (within 30 minutes) following your workouts. Fat and protein will have no effect on lactate levels but may detract from the amount of carbs you can consume. Avoid all alcohol.

- Caffeine raises both lactate and heart rate levels

Do not consume caffeinated beverages in the 90 minute period before your test. If you have a morning test and need a cup of coffee make sure you are awake early enough to have it.

- Avoid higher intensity training

Strength training and categories V, IV, and III all use carbohydrates as their major fuel source. Carbohydrate depletion will result in false results. If you are training in the two days prior to testing try to do only category VI, and technical sessions. Please use some form of carbohydrate drink during these sessions and try to keep them to 90 minutes or less. Only one training session should be done the day before the test.

### **The Test**

This is a progressive incremental submaximal test. Each stage is three minutes long with a one minute break between stages. Wattage is increased each stage. The wattage used is determined by your category and gender (i.e. lightweight or heavyweight, male or female). Lactate samples are taken from the finger tip after each stage. The wattages are as follows:

<u>Stage</u>	<u>LW Men</u>	<u>LW women</u>	<u>HW men</u>	<u>HW women</u>
1	190	140	265	160
2	230	170	295	190
3	270	200	330	220
4	310	230	365	250
5	350	260	400	280

### *Warm up*

The warm up consists of 10 minutes rowing at a pre assigned wattage.

Lightweight Men 200 watts

Lightweight Women 160 watts

Heavyweight Men 260 watts

Heavyweight Women 170 watts

These values are subject to change following discussion with the coaches.

### *Stroke rate*

Stroke rate is held constant through out the test and should fall between 22 and 26 strokes per minute.

### *Test performance*

Since the average watt reading is used for this test you need to be as consistent as possible during each stage.

## **Technical Note**

Blood samples were drawn from the fingertip within 60 seconds of finishing the stage. A sample was analyzed using the Lactate pro immediately, a second sample was drawn into a test tube(Terumo corporation) containing a glycolytic inhibitor for later analysis on the YSI. The test tubes had previously been evaluated and found to maintain the lactate concentration in the sample constant for 7 days.

# Results

**Table 3. Individual results**

<u>Subject</u>	<u>Analyzer</u>	<u>Lactate</u>					<u>Wattage</u>				
1	YSI	0.92	1.13	1.91	3.36	5.81	190	230	270	310	350
	<b>LacPro</b>	<b>1.1</b>	<b>1.1</b>	<b>2.0</b>	<b>3.3</b>	<b>5.8</b>	<b>190</b>	<b>230</b>	<b>270</b>	<b>310</b>	<b>350</b>
2	YSI	1.70	1.33	1.67	2.87	5.21	190	230	270	310	350
	<b>LacPro</b>	<b>1.7</b>	<b>1.4</b>	<b>1.5</b>	<b>2.9</b>	<b>5.1</b>	<b>190</b>	<b>230</b>	<b>270</b>	<b>310</b>	<b>350</b>
3	YSI	1.12	1.44	2.25	3.42	5.55	190	230	270	310	350
	<b>LacPro</b>	<b>1.2</b>	<b>1.5</b>	<b>2.2</b>	<b>3.5</b>	<b>5.6</b>	<b>190</b>	<b>230</b>	<b>270</b>	<b>310</b>	<b>350</b>
4	YSI	0.88	0.88	1.51	3.11	6.01	190	230	270	310	350
	<b>LacPro</b>	<b>1.0</b>	<b>1.2</b>	<b>1.6</b>	<b>3.0</b>	<b>6.0</b>	<b>190</b>	<b>230</b>	<b>270</b>	<b>310</b>	<b>350</b>
5	YSI	1.32	1.60	2.12	3.18	5.43	190	230	270	310	350
	<b>LacPro</b>	<b>1.1</b>	<b>1.6</b>	<b>2.2</b>	<b>3.3</b>	<b>5.4</b>	<b>190</b>	<b>230</b>	<b>270</b>	<b>310</b>	<b>350</b>
6	YSI	0.84	1.11	1.74	3.30	6.43	190	230	270	310	350
	<b>LacPro</b>	<b>1.0</b>	<b>1.0</b>	<b>1.8</b>	<b>3.5</b>	<b>6.6</b>	<b>190</b>	<b>230</b>	<b>270</b>	<b>310</b>	<b>350</b>
7	YSI	0.90	1.65	1.96	3.40	5.27	160	190	220	250	280
	<b>LacPro</b>	<b>1.1</b>	<b>1.5</b>	<b>2.0</b>	<b>3.5</b>	<b>5.4</b>	<b>160</b>	<b>190</b>	<b>220</b>	<b>250</b>	<b>280</b>
8	YSI	1.22	1.35	2.13	3.56	7.33	141	170	200	230	260
	<b>LacPro</b>	<b>1.2</b>	<b>1.4</b>	<b>1.9</b>	<b>3.4</b>	<b>7.1</b>	<b>141</b>	<b>170</b>	<b>200</b>	<b>230</b>	<b>260</b>

The lactate curves generated by the Lactate Pro and the YSI are essentially the same. The greatest differences in the curves exist towards the low end of the operating range of the Lactate Pro.

The training recommendations (wattage for various intensities of exercise) are the similar for both the YSI and Lactate Pro. Table 4 shows these comparisons.

**Table 4. Wattage Comparison for 2 and 4 mMol points using YSI and Lactate Pro**

<u>Subject</u>	<u>YSI</u>		<u>Lactate Pro</u>		<u>Change (YSI-LP)</u>	
	<u>2mMol watts</u>	<u>4mMol watts</u>	<u>2mMol watts</u>	<u>4mMol watts</u>	<u>2mMol watts</u>	<u>4mMol watts</u>
1	272	321	270	322	2	-1
2	285	330	288	330	-3	0
3	260	322	261	321	-1	1
4	285	323	285	325	0	-2
5	263	327	253	325	10	2
6	274	320	276	318	-2	2
7	222	260	220	257	2	3
8	196	234	203	236	-7	-2

Only subjects 5 and 8 would have different training recommendations as a result of using the Lactate Pro test meter. However, the total difference is within the error of the YSI analyzer and cannot be attributed solely to the error in the Lactate Pro.

## **Problems**

The only problem encountered to date with the Lactate Pro is the small sample size. The Lactate Pro uses only 5  $\mu$ l of blood. This is a positive in that there is less blood needed for each sample but there is a greater risk of contamination with sweat in such a small sample. This means that greater care and strict adherence to the recommended testing procedure must be followed.

## **Recommendations and Future Applications**

The data support the use of the Lactate Pro analyzer with the National Rowing team. The accuracy and repeatability of measures is as good as that of the YSI analyzer that has been used in the past. In addition, the lower unit price and cost per sample makes it possible to increase the number of participants in the lactate testing program without increasing the overall cost of the program.

The Lactate Pro appears to be the answer to our on water testing problems. The quick turn around time (60 seconds per sample) and ease of use make it ideal for on water testing. In the past it was not possible to provide immediate feedback on lactate levels because all samples had to be placed in test tubes since the YSI analyzer was not practical to transport in a boat.

The low price of the analyzer makes it affordable for clubs and Provincial associations to purchase this machine. If protocols can be standardized through out the country. We can start gathering information on younger athletes and improve the accuracy of training program design in the under 23 and development athletes.