Point – of – care athletic testing a new approach in evaluating sport s performance

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Using POCT in a special area
HIGH PERFORMANCE SPORT TRAINING PROGRAMS and HIGH PERFORMANCE SPORT TESTINGS

Using mobile units

Testing, in daily changing conditions

- in different trainings
- in different meteo conditions : high / low temperatures (± excesive) humidity, etc…
- in altitude training camps (≥ 2000m)
- jet lag

Defining normal values, for high level athletes during trainings

Two physiological characteristics of HIGHLY TRAINED ATHLETES

- **High anaerobic power (producing METABOLIC ACIDOSIS)**

- **High capacity of ENDURANCE (capacity to SUSTAIN an effort for long time, capacity to promote RECOVERY).**

Two key factors for success in sport ! Two ways of monitoring !

Monitoring exercise metabolic acidosis

MONITORING TRAININGS:

- level of **training intensity** (blood lactate)

THE CAPACITY TO RESPOND EFFECTIVELY TO TRAINING

- **training zones** (defined levels of intensity used in trainings)
- control of **training "targeted" intensity** (blood lactate)

THE CAPACITY TO TOLERATE TRAININGS

The capacity to tolerate trainings

according to the CAPACITY OF ADAPTATION

according to the LEVEL OF FATIGUE

A restoration of previously impaired physiological capacities ;
TO BE USED NEXT DAY / TRAINING

Testing trainings - WHERE ?

Testing performance at or near the sites of training or competitions .

POCT in the SAME conditions likely to be really experienced .

Tests describe :

- **sport - specific energy sources used**
- **baseline conditions ("after last day" recovery)**
- **exercise intensity and functional costs**
- **reproducible exercise / functional capacity descriptors**

Testing ; WHAT ?
Specificity of trainings

Condition for HIGH PERFORMANCE SPORT ENHANCEMENT

The most specific training that can be done is the sport itself !

Sport specific trainings provide
METABOLIC SPORT SPECIFIC CONDITIONING !

Ability to monitor specific t raining becomes critical
(high intensity exercise training is particularly difficult).

POCT seems to be the best solution !

WHY
test in real conditions ?

Specific training stimulus - Specific physiological adaptations

Testing in sport specific conditions: POINT - OF - CARE TESTING

Final diagnosis is close related to the real conditions:

- **using sport specific skills**
- **using sport specific muscle groups**
- **using same energy systems mix, as required during competitions**

AIM -

USING POINT-OF-CARE TESTINGS, IN SPORT SPECIFIC ENVIRONMENT :

- to define and control trainings using ENERGY TRAINING ZONES

- to quantify METABOLIC ADAPTABILITY to trainings / races

- to appreciate POST-EXERCISE RECOVERY using a highly specific control: the dinamics of blood acid base status

- to create an INDIVIDUAL PERFORMANCE PROFILE

MATERIAL -

HIGH LEVEL ATHLETES

Our experience in field testing; 1994 – 2012; canoeing, kayaking, rowing; over 10000 tests in rest , trainings, races and post-exercise recovery.

METHOD -

1. BLOOD SAMPLING

Blood sampling should be easy and quick
Testing will spark interest and desire to continue
Testing should be easy to execute. It will be faster

The answer must be given the same day, until the next training so that we can make necessary corrections

Testings requires skills from the researcher and a micromethod

≈ 200 µl; rapid, simple, easy to do (mobile kit)
punctures in the fingertip; samples in heparinized capillary tubes

- A Micro Method for Determination of pH, Carbon Dioxide Tension, Base Excess and Standard Bicarbonate in Capillary Blood (on Radiometer, ABL 5)

O. Siggaard Andersen, K. Engel, K. Jørgensen, and P. Astrup - Scandinavian Journal of Clinical & Laboratory Investigation, 1960, Vol. 12, No. 2 : 172-176.

- Blood lactate tester (Accusport, Lactat Pro, Nova)

- Dry chemistry automated analyser (Spotchem). Features: Analysis capacity: 1-9 parameters. 23 parameters available

2. TYPES OF TESTINGS:

"Spot" testings: like taking a picture !

Continous (over a period of time) and targeted testings:

-continous, in basal conditions or testing post - exercise recovery

-targeted testings, in training sessions: *ATTENTION TO TIMING !*

assessing a targeted intensity
assessing adaptations in races
assessing specific effort intensity during race

Succesive results can create a *personal athlete profile*

3. WHAT TEST :

BLOOD LACTATE : baseline; peak exercise; post-exercise 1, 3, 5, 10, 30 min

BLOOD ACID – BASE : baseline; peak exercise; post-exercise 1, 3, 5, 10, 30 min

CK + LDH : baseline; post-exercise 30 min, 6 h, 24 h, 48 h, 72 h.

SGOT, SGPT, PROTEINS , ELECTROLYTES : baseline

DETERMINE NORMAL VALUES
ADAPTED FOR HIGH LEVEL ATHLETES !

The choice of testings will depend on the specific goals of performance evaluation, namely exercise tolerance and training-induced adaptations.

Correlating a set of testing parameters, complex diagnosis :

Time ; distance
HR monitoring
Blood acid-base status
Muscular damage markers

Blood acid – base status

-Energy sources involved in efforts, costs arising and quality of compensation reactions.
-Acid-base status - an index of metabolic fittness.
-Early prediction for overtraining (overtraining MUST be prevented)

“Muscular” biochemistry

La, GOT / GPT, CK, LDH

PARAMETERS USED IN DEFINING "THE MOMENT"

- pH
- pCO_2 (mm Hg)
- HCO_3 (mmol/L), SBC (mmol/L)
- La (mmol/L)
- Electrolytes

Metabolic cost during testing

- HCO3
- SBC

R = SBC / HCO3 – value of R, *metabolic cost* in rest, exercise and recovery

IM = La / V (m / sec) – metabolic index, mmol / m · sec^{-1}

Reasons for HCO3 monitoring

HCO3 – muscular endurance index

- ↑ plasma HCO3, improving exercise endurance capacity
- ↑ HCO3

  good extracellular buffer capacity
  ↑ extracellular pH
  ↑ H+ gradient across sarcolema , enhanced H+ handling !

Index of metabolic cost

R = SBC / HCO3

SBC – the bicarbonate concentration in the blood, at pCO2=40 mm Hg, fully oxygenated saturation, at 37°C. Represent only metabolic component of buffering.

HCO3 – the actual blood bicarbonate, calculated at pCO2 measured in the blood sample! Result of a mix of metabolic and respiratory components

Normal value: 1
< 1, > 1, metabolic cost

R CLASSIFICATIONS

BASAL / REST :

0.98 – 1.02 ***Excellent***
0.96-0,98 *or* **1.02-1.04** ***Well***
< 0.96 *or* **>1.04** ***Poor***

EXERCISE

(*corellated with results, ventilation, costs – indications !*)

1. (R<1.10) + (ΔR = 0.05) + (*good results*)
Ideal !

2. (R > 1.10) + (ΔR = 0.15) + (pCO2↓) + (*good results*)
Attention ! Recovery !

3. (R > 1.20) + (pCO2 ↓↓) - *Dificult ! Rest and recovery*

ΔR = R exercise - R basal

TESTING RESULTS

BASELINE CONDITIONS

pH - normal or lasting metabolic acidosis

pCO2, HCO3, Lactate (post-exercise recovery), with medium - high metabolic costs in certain cases

- pH (N) + pCO2 + La ↑ : *systemic recovery ; muscular non-recovery*

- pCO2 ↓ + pH ↓ + La ↑ : *systemic and muscular non-recovery*

Acid-base status, lactate and R in basal conditions

Average pH values are normal in most cases; minimal values reveals lasting metabolic acidosis

pCO2, HCO3, ABE, Lactate - mean values confirm the diminished post-exercise recovery, with medium - high metabolic costs in certain cases

	pH	pCO2	HCO3	ABE	SBC	Lactate	R
A	7.40±0.01	35.6±2.8	21.5±1.5	-2.1±1	22.5±0.8	2.03±0.95	1.05±0.04
	7.38-7.40	29-41	18-24	-5 to 0	21-24	0.0-4.35	1-1.17
B	7.36±0.02	40.3±3.2	22.1±1.4	-2.3±1.33	22.4±1.06	2.4±0.8	1.01±0.03
	7.32-7.42	33-45	20-27	-5 to 2	20-26	1.2±4.35	0.96-1.10
C	7.40±0.02	38±3.4	23.1±1.8	-0.86±1.6	23.7±1.4	1.2±1.1	1.03±0.04
	7.35-7.45	32-45	19-27	-4 to 2	21-26	0-3.6	0.96±1.11

A – at the beginning; B – after 6 months; C – in competition

Acid-base status, lactate and R after warm-up

Warming-up has to be done before every training session

"Heating effect" cause a minor acid-base imbalance, putting body buffering systems in action being ready to compensate future imbalances

	pH	pCO2	HCO3	ABE	SBC	Lactate	R
Basal	7.39±0.01	41.9±2.9	25.1±1.9	-0.7±1.8	24.9±1.5	2.18±1	1±0.02
Warm-up	7.33±0.03	38±5	19.7±2	-5.7±1.8	20.1±2.4	4.6±2.1	1.02±0.02

Blood ABS parameters evolution in a W2 team

	Nume	Tip	pH	pCO2	pO2	ABE	HCO3	SBC	La	R
29.06.12	SV	BAZ	7.4	39.9	88.3	-0.2	24.4	24.1	0.77	0.99
29.06.12	SV	R2	7.15	26.9	93.2	-18.2	9.1	10.9	14.21	1.20
29.06.12	AG	BAZ	7.41	37.9	96.8	-0.5	23.7	23.9	2.09	1.01
29.06.12	AG	R2	7.30	31.4	92.5	-9.6	15.3	16.8	9.45	1.10

	Nume	Tip	pH	pCO2	pO2	ABE	HCO3	SBC	La	R
27.06.12	AG	BAZ	7.4	41.6	89.8	0.5	25.3	24.6	0.7	0.97
27.06.12	AG	R1	7.34	35.8	86.8	-5.9	18.9	19.6	6.43	1.04
27.06.12	SV	BAZ	7.4	40.1	110.2	-0.2	24.5	24.2	1.89	0.99
27.06.12	SV	R1	7.24	25.4	98.5	-14.9	10.7	12.9	13.05	1.21

Blood lactate clearence curve

- blood samples in minute 1, 3, 5, 7 , 10, 20, 30.

- creating a “clearence” curve;

- the highest value is considered blood lactate peak value

- the time to reach blood lactate peak value - index of clearence , index of fatigue.

Rates of lactate clearence

20 minute post - effort recovery (blood sampling at min. 3, 13 and 23)

- REC 1-10 min = 100 - [(La min.13 / La min.3) x 100%]
- REC 11-20 min = 100 - [(La min.23 / La min.13) x 100%].
-REC 20 min = 100 - [(La min.23 / La min.3) x 100%].

US Swimming, Sokolovats, 2001

Test results - suggestive if analyzed combinated with time results

↑ time performance + ↓ blood lactate values + ↑ clearence rates (significant aerobic endurance capacity)

–blood lactate values + ↓ clearence rates - reduced performance / overtraining

CONCLUSIONS

- Testing in real conditions is a powerful tool in taking training decisions.

- Acid-base status, as a metabolic fittness index can monitor basal and resting condition, trainings and races.
- developing levels of training : energy zones
- describing recovery.

- Data bank and personal profile.

Test results - suggestive if analyzed combinated with time results.