Douglas Bag Validation of the aeroman professional

Executive summary

Introduction:

The aeroman professional metabolic analyser (AM) is according to the home page of aerolution in first hand aimed to be used for measurements in the fitness area (fitness studios, trainers and rehab practices). This report is an update and focuses on the 2nd part of the validation done in February 2012. The 1st part in August 2011 already showed extraordinary sensor accuracy for O_2 and CO_2 measurements within 2 % compared to the Douglas bag (DB) reference method as well as all submaximal values showed great validity. The reason to enhance the study was due to significant differences only in the highest VO_2 range, possibly related to a reduced drying capacity of the nafion sample line used for equilibrating exhaled air humidity to the environment humidity. Therefore this device was updated with new nafion tubing and a humidity controlling routine in the firmware able to compensate humidity changes.

Methods:

Eight (4 each day during 2 consecutive days) well trained male endurance athletes (cyclists) took part in the validation study, with an age, weight and length of 35 ±5 yrs., 80.4 ±6.6 kg and 185.5 ±4.9 cm, respectively. The validation protocol included cycling on 2 submaximal workloads for 8 minutes at each work load (160 and 240 watts, with 80 RPM, controlled steady state). Then, an incremental part (+22.5 w/min) to maximal exhaustion followed (similar to the protocol of Rosdahl et al. 2010), pedaling at 90 RPM. The athletes performed one test am and one pm with a light meal and at least 4 h of rest in between. The 1st submaximal level (160 w) was 4 min work to reach steady state and then a 90 s collection/registration period was performed for one of the methods, followed by a 60 s cycling period for changing to the other method and a new 90 s. sampling period. At 8 minutes the 240 w work rate was started with the same device still connected. After 4 min to reach steady state, a 60 s collection sequence was performed followed by a 60 s changing phase to the other device again and a new 60 s sampling phase. The stepwise increasing part started and ended with the same method as in the previous sampling. 30 s. samplings were performed during the final 3 minutes of the sequence leading to exhaustion. Each day before the lunch break, 2 of the 4 athletes ended the test with the DB method and 2 with the AM Professional device. After lunch the order was changed. During the end of the incremental sequence leading to exhaustion, three to six 30 second bags of air were collected from each participant (see Gore, 2000).

Results:

Reliability: Coefficient of variance (CV) for the Aeroman VO_2, VE and RER at the 2 submaximal work rates was 2.9, 5.4 and 3.5 % respectively and for the Douglas bag method 2.2, 3.5 and 2.3 %. CV of the expired fractions of O_2 and CO_2 were 2.3 and 2.4 % and 0.9 and 2.0 % for AM and DB respectively.

Validity:

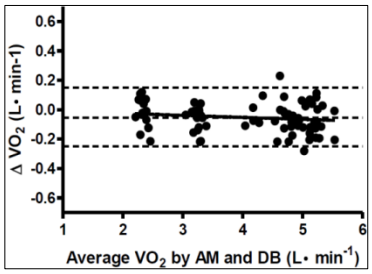

Fig. 1: Average VO_2 by AM and DB (L · min^{-1})

According to the t-test for the two submaximal workloads low but significant differences between DB and AM were detected in several variables. However, only the VE diff was high with 7.0 and 5.5 % on the 160 and 240 workloads respectively. During the maximal part the VO_2 mean values showed no significant differences and all data together (sub levels and incremental to max) had a 1.2 % difference. The general differences expressed in percent were between 0 and 2.2 (Table 1). Figure 1 makes at a glance clear that the AM and DB VO2 are even distributed around the mean value between 2 - 5.5 L · min^{-1}.

Device		VO_2 (L· min^{-1})		VE (L·min^{-1})		RER		FE O_2 (%)		FE CO_2 (%)	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
DB	All data	4.01	1.12	124.2	58.4	1.023	0.119	16.70	0.91	4.27	0.60
AM	All data	4.06	1.13	118.3	55.8	1.004	0.106	16.53	1.03	4.29	0.60
Δ	All data	***		***		**		***		n.s.	
Δ %	All data	1.2		5.0		1.9		1.0		0.4	

Tab. 1: DB vs. AM means (±SD), Students' paired t-test results (Δ) and percent difference (Δ %) for 8 athletes.

Conclusion:

Reliability: The very low test-retest coefficient of variance (CV) for the Aeroman variables in the 2 submaximal work rates demonstrate that the evaluated unit must be *regarded as reliable* in this measuring range (see Gore, 2000).
Validity: The Aeroman is at the 2 submaximal workloads valid in VO_2, RER and FE CO_2 compared to the Douglas bag method. FE O_2 precision in the low workloads exceeds the own specified AE range of ± 0.1 Vol. %. VE differ exceed the 3 % vs. DB. At the incremental test *values of VE are regarded as not valid* as the mean value difference exceed 3 % and some values, according to the t-test, are also significantly different. The fractions of expired O_2 and CO_2 are however most valid. Despite the systematic differences in VE, and some other differences to DB, the overall good validation results and the number of new measurement principles make this device most interesting from many aspects.

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