ROWING

Richard J. Godfrey, Craig A. Williams, Sarah Gilchrist and R.C. Richard Davison

Rowing is an Olympic sport in which athletes compete over a measured regatta course of 2,000 m and there are up to 22 boat classes in an international regatta. For the elite oarsman the competitive 2,000 m takes approximately 6 min. Two distinct disciplines exist within rowing; sweep rowing and sculling. In sweep rowing, boats require a crew of two (‘pair’), four (‘four’) or eight rowers each using a single oar and row on either one side (e.g. bowside or starboard) or the other (e.g. strokeside or port) of the boat. A sculling boat can seat one (‘single’), two (‘double’) or four (‘quad’) rowers each using two oars.

British Rowing formerly known as the Amateur Rowing Association, grassroots participation in rowing in the United Kingdom is estimated at more than 17,000 individuals. As a consequence of increasing media interest in rowing, resulting from long term and continuing Olympic and Paralympic success, there is greater awareness of the fact that elite rowers and their coaches view sport science as an essential component of their success. As a consequence more sports scientists, in a university setting, are being approached by club-level rowers seeking physiology support.

Physiologically, rowing is proposed to require a good balance between strength and endurance (Hagerman and Staron, 1983; Secher, 1983) so a contribution from both aerobic and anaerobic energy metabolism is required. The determinants of performance for elite heavyweight rowers have been assessed and five important physiological parameters identified (Ingham et al., 2002). These are reported to be: power at VO$_2${\text{peak}}, maximum power, maximal force ($r\ 0.95; \ P\ 0.001$), VO$_2${\text{peak}} ($r\ 88; \ P\ 0.001$) and oxygen consumption at the blood lactate threshold ($r\ 0.87; \ P\ 0.001$). All of these findings are derived from the use of a Concept IIc rowing ergometer (Concept, Nottingham, UK) with a force transducer at the handle such that force profiles and power measurements all result from the rowing action.

In prioritising which tests to implement in assessing the club level rower it could be argued that body composition, strength and power, and aerobic endurance are key. Body composition testing is important, particularly if the competitor being tested is a lightweight rower. DEXA (Dual Emission X-ray Absorptiometry) is currently considered the gold standard for assessing body composition Routinely, elite rowers continue to be tested using skinfold measurements (for further details see chapter 3.4). Rowing is often referred to as a power-endurance sport with an aerobic contribution of about 67-88% of the energy required and, hence, being able to sustain a high power output over a prolonged period is key. Accordingly, in assessing changes in physiology the discontinuous incremental protocol (colloquially referred to as a ‘step-test to max’) presented in Figure 4.4.1 is tried and tested.
Seven stroke power test

This test is designed to assess peak power. The athlete carries out a warm-up on the ergometer, performs some light stretching and then a specific warm-up using hard efforts of 2, 3 and 4 strokes. The athlete then carries out the test with the first two strokes not recorded to allow the rower to overcome the inertia of the flywheel and to achieve a rating of 30 strokes per minute (2 spm). From this test, work (J), mean force (N), mean power (W), stroke rate (spm) and stroke length (m) are reported from the five recorded strokes.

Step-test

This is a discontinuous incremental test, consisting of five 4-min efforts, each one requiring a 25 W increase in power output and followed by a sixth and final 4-min effort at race pace (see Figure 4.4.1). It was recently reported that stages of ≤7-min overestimated MLSS but that stages ≤4-min more accurately measure peak values. However, by using an appropriate regression equation both peak and MLSS levels could be accurately determined using a 4-min stage (Bourdon et al 2018). Gas exchange, heart rate and blood lactate are monitored in the second test only. Physiological variables measured are lactate threshold (LT), oxygen cost of ergometer rowing (economy), maximum oxygen consumption (VO2max) and power associated with VO2max (WVO2max). It is possible to combine this test with a 2000m time trial with a 15 minute recovery between the trials. This enables the determination of both physiological and performance parameters in one test (Bourdon et al 2009).

For an individual who has not been tested before, a 2,000 m time trial on the Concept IIc should be performed first. This should be a maximal effort and the time for 2,000 m should be converted into a 500 m split time. For heavyweight men and women add 15 s to this time and you have the split for the third stage of the step-test. Subtract 25 W from this to get the power output (and split time) for stage 2 and subtract 50 W for stage 1. For stage 4 add 25 W and for stage 5 add 50 W. For lightweight men and women also add 15 s to the calculated 500 m split time to find the split for the third stage. However, it may be more appropriate to use a 15–20 W increment (rather than a 25 W increment) for lightweights. The data collected and calculated from the step test includes, VO2peak, power at VO2peak, the percentage of maximum that can be sustained (i.e. VO2 at lactate threshold as a percentage of VO2peak), power at LT, maximum power, maximum force. The heart rate associated with LT can be used to determine a number of heart rate zones which can be used for training.
Blood lactate

For a number of years now the EBIO plus (Eppendorf, Colone, Germany) laboratory-based analyser and the Biosen C_line (EKF Diagnostics, Germany) portable analyser have been used with elite rowers. These have superseded the long-term use of the Analox GM-7 (or portable PGM-7) (Analox Instruments Ltd, Hammersmith, UK). Generally, lab-based systems have been preferred as their validity and reliability have been tested. Although it is possible to use new ‘palm top’ lactate analysers they are currently questioned with respect to validity and reliability, but such research work is on-going. Hence, in the future, once their reliability and validity have been more fully demonstrated, they will prove to be the more practical equipment to use. With the EBIO plus and Biosen C_line it is possible to collect the capillary sample (earlobe is preferred as it limits pain of sampling, contamination of samples and is more consistent with health and safety). Blood is collected into a capillary tube which is immediately placed in an Eppendorf tube (containing a lysing agent) which can then be kept for 24 h without the need for refrigeration.

Ergometry

The preferred ergometer used in the United Kingdom is the Concept IIc (Concept, Nottingham, UK). When lab testing takes place with elite athletes a Concept IIc with force transducer at the handle is used, the Avicon system. This is an on-line system and force profiles for each stroke of the seven stroke power test and averages for each stage of the step test is recorded. This provides further feedback to the coach on technique. If testing sub-elite rowers a standard Concept IIc, without Avicon system, can be used and sufficient information provided to aid training of the individual. Despite the widespread use of the Concept II ergometer it is recognised that the movement dynamics do not exactly replicate the on-water experience and thus potential physiological demand. In an attempt to better replicate the on-water dynamics Concept developed the slide which allows the ergometer to move in the opposite direction of the rower as happens on the water. The addition of the slide has been shown to impact on the physiological responses with lower VO2peak and a better correlation between on water performance and the VO2 power relationship derived from testing using the slide. Thus this may better replicate on water physiological responses (Mello et al 2014).

Field-testing

Coaches in many sports are increasingly demanding that field-based testing replace laboratory-based testing. Generally, physiologists do not oppose a reduction in the frequency of lab-based testing and an increase in field-testing. However, it is very difficult to justify the elimination of lab-based testing altogether as it is simply impossible to collect data more objectively. Hence, only in the lab can conditions be appropriately standardised uninfluenced by the vagaries of changing gym, weather or water conditions. Indeed, GB elite rowers are still lab-tested two to three times per year with four to five field-based (step-test) sessions. In addition, the coach administers some tests such as an 18 km, 30 min, 2 km and 250 m rows on the water. Regularly blood
samples are taken (by a physiologist) at the end of such rows or the 18 km row can be broken into 3 x 6 km rows with a 30–60 s rest interval for blood samples to be taken. In the 30 min row the athlete must complete the greatest possible distance at a fixed rate of 20 spm. This provides power output, heart rate and lactate data. The standard for elite women for this test is 7–8,000 m and for men 8.5–9,000 m.

The competitive environment for rowing is heavily influenced by environmental conditions and thus despite its ecological validity presents significant problems in using performance times of boat speed to assess improvements in fitness. In terms of on-water performance measures in comparison to Concept II performances the calculated standard error of measurement is relatively large and ranges 2.6–7.2% (Smith and Hopkins 2018). Recent advances in GPS measurement technology does allow reasonably accurate measurement of boat speed, with standard error of estimate ~0.2%.

At field camps overseas, early morning monitoring also occurs, prior to daily training. This involves the use of urine osmolality to monitor hydration status, blood urea as an index of the additional stress superimposed on training by an, often, extreme environment and morning body mass and supine resting heart rate. Data here are viewed in combination with a psychological inventory and if necessary, discussion with the coach and athlete. The coach takes decisions on the necessity of modifying training with certain individuals as a consequence of all of this plus on-water and gym-based data. Further, decisions are taken ‘weighing’ the mass of data in the light of extensive coaching experience and the coach’s personal knowledge of the individual.

REFERENCES


