CHAPTER 5

CONCLUSION & RECOMMENDATIONS

Recently three new skating tests to assess aerobic fitness have emerged (SMAT, Leone, Léger, & Comtois, 2002, unpublished; MS20MST, Kuisis, 2003; and FAST, Petrella, 2006). However the validity of the three new ice-skating field tests was not always obvious since the reported statistical indices (r and SEE) were quite different. This can be ascribed to them being developed using different age and gender groups, sometimes with small groups of subjects, wearing different equipment, and using different types of protocols, thus making comparisons between the tests difficult. Consequently it was deemed necessary to revalidate all three of the new tests using a homogenous group of subjects (who had the same skating ability for all tests), with standardised procedures for all tests.

The aim of this study was thus to:

1. compare the MS20MST, SMAT, and FAST ice-skating tests to determine how they relate to each other or to determine their common variance,

2. assess the external and relative validity of the three new practical ice-skating tests to predict maximal aerobic power ($\dot{V}O_2$ max) in adult male hockey players that have mastered their skating skills, using direct treadmill $\dot{V}O_2$ max ("gold standard") as the criterion variable, to determine which one is better suited for the evaluation of the maximal aerobic power of ice hockey players and to develop a regression to predict $\dot{V}O_2$ max from the MS20MST. To assess the external validity by comparing observed $\dot{V}O_2$ max to $\dot{V}O_2$ max predicted from original equations of the SMAT and FAST,

3. determine which test is rated by the players as being the best suited and most functional test, and

4. determine if these on-ice skating tests are in effect better than the over-ground 20 MST.

Summary

Testing players in their training environment more accurately reflects the muscular and metabolic demands of the sport, as well as specific adaptations from training (Daub *et al*, 1983). Of the three new tests, two of them, more accurately reproduce the "mechanics" or movement patterns (stop-and-go) of ice-hockey as seen in a game situation (MS20MST and SMAT) and duration of exertion (SMAT, one minute stages, followed by 30 seconds of rest) than others (FAST, continuous and curvilinear). Due to the differences in efficiency between running and skating (Léger, Seliger & Bassaerd, 1979), it is preferable to test ice-hockey players on-ice. Furthermore, these new tests allow testing many players simultaneously, in fact Petrella (2006) states that the FAST can comfortably test up to eight ice-hockey players simultaneously, and that a full roster hockey team can be completely evaluated within a typical one hour practice session. When using the SMAT, between 10 and 15 players can be tested on-ice at the same time, depending on their body size (Leone *et al.,* 2007); the same applies for the MS20MST. These tests also require less time than laboratory treadmill testing, less equipment, and are less expensive, as they can be easily administered during a training session, wearing either complete (SMAT and MS20MST) or partial ice-hockey equipment (FAST). Field tests such as the ones used in this study are valid and reliable [MS20MST r=0.87 (Kuisis, 2003); SMAT r= 0.92 (Leone *et al.,* 2007); FAST r=0.76 (Faught, Nystrom & Montelpare, 2003)].

The availability of the three new skating field tests of aerobic fitness provides the coach and sport scientist with the option of more specific on-ice field tests that are sometimes more time efficient. With regard to the three new on-ice aerobic tests, the MS20MST and the SMAT are very similar with regard to physiological demand (HR_{max} and $Lactate_{max}$), RPE, and subjective suitability ratings (Likert scale). The SMAT, however, might be more specific due to its intermittent nature, but that the MS20MST may be more specific with regards to distance, and more economical with regards to time (MS20MST test duration is approximately less than half of that of treadmill test duration, and approximately half of the SMAT duration). The FAST is not as specific to ice-hockey, because of its nature (continuous and curvilinear, with no stop-and-go), but because the modality is skating, it is more specific than running tests of aerobic fitness. In conclusion, the MS20MST or the SMAT should be the first option in assessing the aerobic fitness of adult male ice-hockey players, but if ice-time is a problem, the 20 MST can be used with confidence.

Conclusion and Recommendations for Practice

1. When assessing the aerobic fitness of ice-hockey players, skating tests are better than running tests, simply because they are skating tests, and the modality is skating, which is more sport specific than any kind of running test (laboratory treadmill running, or running field tests),

2. The MS20MST and the SMAT are very similar with regard to physiological demand ($\dot{V}O_2$ max, HR, and lactate), RPE and subjective suitability ratings (Likert resemblance scale), are seen to more ice-hockey specific, and are preferable over the FAST,

3. FAST may be as specific to ice-hockey (because it is skating), but is less valid than the MS20MST and SMAT (obtaining the lowest correlations with the treadmill $\dot{V}O_2$ max, maximal lactate, maximal HR, PRE and lowest

Likert resemblance scores), and with its oval course is probably better suited to figure- and/ or speed skating. To date however, no research has examined that possibility,

4. MS20MST is the best test of overall fitness (aerobic and anaerobic, muscular and cardiovascular fatigue), and is the most time efficient, requiring approximately half of the time required by the SMAT or treadmill test. It also uses a hockey-specific, shorter distance, which may be more appropriate for players in certain positions than the SMAT,

5. SMAT is the most specific for testing aerobic fitness in adult ice-hockey players, due to it's stop-and-go, intermittent nature, and due to the fact that the distance skated is 45 m (as apposed to 20 m), there is less frequent stop-and-go, and along with the rest intervals, reduces the muscular fatigue in the legs and subjects stop the test prematurely; and

6. 20 MST has again been proven to be valid, and even suitable for aerobic assessment in adult ice-hockey players and is the best test to do if there is a lack of ice-time or financial restraint. Although the modality of the 20 MST (running) is not ideal for ice-hockey (running is not skating), the 20 MST is more specific than the treadmill or other field tests [due to the fact that its distance is short (20 m), and it has frequent stop-and-go, as in ice-hockey]. Furthermore, the 20 MST might, in certain circumstances still be more economical than the on-ice field tests of aerobic fitness, because ice time is expensive and the availability thereof is often limited. Interestingly, the 20 MST was better related to the SMAT or the MS20MST.

A possible modification to the MS20MST test would be to erase the audio voice indicating the beginning of a new level. It is speculated that many subjects stop the test the end of a stage, but the reasons for this are unclear, and it might be because they do not want to continue or because they push

themselves to try to complete the level. Furthermore, the counting of the shuttles could be consecutive starting at one and continuing to increase throughout the test (as in the FAST), and not restart at the beginning of each stage. The FAST test however, has different stages, but only counts the length numbers, so the researcher can see what stage the subject is on, but the subject only knows how many lengths they have done, and continues to aim for the next length, and is not tempted to aim for the end of a particular stage at which they think they will stop (as in MS20MST and SMAT). Doing the test with both of these "versions" might give some clarity as to which is better. Alternatively, the MS20MST test may further be modified to include rest intervals after each stage or shuttle (30 s after each stage as in the SMAT, or 10 s after each shuttle, as in the Yo-Yo test) making it intermittent, but very specific to ice-hockey because of the distance.

The SMAT seems to have an advantage over the other skating tests in that it includes rest periods after each stage, making it intermittent, much like ice-hockey. The distance however, may be too long, and subjects skate 45 m before they stop and turn, thus, a distance of 30 m might be more appropriate.

It is emphasised that any of the three of the skating tests can be used to evaluate the aerobic capacity of experienced hockey players who have mastered their skating skills (and who can perform rapid deceleration and abrupt stops, especially for the MS20MST and SMAT; cornering and cross-overs for the FAST). These tests should, however, be used with caution in beginners as the lower mechanical efficiency of beginners or unskilled players may affect the precision of the estimation of the oxygen uptake.

Future Research

The application of FAST to figure skating and speed skating needs to be researched, as it may be more appropriate for those disciplines, than for ice-hockey. It may also be interesting to study a more specific path for short track speed skating (using a standardized competitive course versus the symmetrical oval course). Also, an oval protocol with a linear increase in speed needs to be compared to the current FAST, in which speed increases exponentially. However the next most logical research step in determining the best and most valid skating test of aerobic capacity in ice-hockey players is to perform all three field tests with portable gas analysis throughout each test. Alternatively $\dot{V}O_2$ max can be obtained with the backward extrapolation of $\dot{V}O_2$ max at time zero of recovery using the exponential least squares regression (Di Pampero *et al.,* 1976; Léger, Seliger & Bassard, 1979), and to compare the results to those obtained from a skating treadmill protocol and/or a traditional running treadmill.