**Laboratory Session 2: Wingate Testing**

***Introduction***

During the 1970’s, an Israeli pediatric physician named Oded Bar-Orr developed a 30 s test for the stationary cycle ergometer to quantify peak power generation as well as the power decrement during fatigue while cycling. Bar-Orr named the test after the Institute at which he worked, the Wingate Institute located in Netanya, Israel, and as such the test was called the Wingate Test. Over the ensuing years, research has been conducted to assess the muscle energetics of the Wingate test. Results have revealed that while the test is short and very intense, the consumption of oxygen (mitochondrial respiration) still accounts for up to 35% of the ATP turnover, yet with greatest contributions occurring from the phosphagen system.

The short duration of the Wingate Test is also its main limitation. The test is sufficient to tax the phosphagen system, but too short to fully tax the potential ATP turnover/replenishment from the glycolytic-lactate system. As such, the Wingate Test is not a test of a subject’s anaerobic capacity. Such a test needs to be between 2 to 3 min in duration, ending in fatigue.

What the Wingate Test is good for is to assess the decrement in muscle power generation during cycling, and to provide a measurement of a given subject’s peak power. As the mass of a subject influences power generation, comparing data between subjects requires power to be expressed relative to body mass (Watts/kg). Thus, the greater the peak Watts/kg for a given subject, the more powerful the subject. Based on this interpretation, the Wingate Test is widely used in elite athlete testing to assess progress in training for explosive and sustained muscular power.

We are currently preparing to do research on the Wingate Test to show that the start of the test is flawed. As the start requires near maximal cadence, such high leg turnover prevents optimal motor unit recruitment, causing near instantaneous reductions in power output over the initial 10 s. The rate of power output decline then dramatically decreases as now the neuromuscular system has the time per contraction to recruit more motor units (6). Thus, this lab will require you to perform the Wingate Test twice; once the traditional way, and the second time with a stationary start.

From an educational perspective, experiencing the Wingate Test is also beneficial for experiencing the systemic symptoms of a severe metabolic acidosis. We will study the biochemistry of metabolic acidosis in great detail this semester. Although lasting only 30 s, the high demand for ATP requires considerable involvement of ATP turnover from the phosphagen and glycolytic-lactate systems, causing proton release from glycolysis and ATP hydrolysis. Such extreme acidosis can take more than 30 min to recover from.

***Purpose***

To compare peak power, power decrement, and mean power output from the Wingate Test, when performed traditionally vs. a stationary start.

***Methods***

1. Come to the lab prepared to understand how to administer the Wingate Test.
2. Have the subject warm-up for 5 min at 50 Watts.
3. Decide on whether you want to use the Monark or Velotron bike. The following instructions are for the Velotron. Refer to each instruction document linked to the assignments page.
4. Randomly select which test (traditional vs. stationary) the subject will do first.
5. During the warm-up, double click on the desktop program icon “SMI POWER”.
6. Highlight “Test” header then click “New”.
7. Enter subject details into the software – Name, Gender, and body weight. The program will then calculate the weight needed to load the ergometer for the test. Make sure you have the correct weight discs to add to the carriage. Remember that the carriage weights 1 kg.
8. Click “OK” to load the actual test window.
9. After the warm-up, add the weights to the carriage. Make sure you have a trash bin handy just in case of severe nausea after the test!!!
10. When the subject is ready, click on “Start Test”. For the traditional version of the test, have the subject cycle as fast as they can with the weight carriage supported by a tester.
11. There is a 5 s countdown for this phase. At “zero”, gently apply the load and provide verbal motivation for the subject to keep pedaling as fast as possible through the 30 s test.
12. For the stationary start version, make sure the subject does not start the test until time zero (after the 5 s countdown).
13. THIS IS IMPORTANT. At the end of the test take off all the added weight and have the subject cycle at their preferred cadence for 5 min with the 1kg carriage load.
14. Click “OK” after the test is over to see the data graphed in a new window.
15. TO save the data as a text file, click File”, then “Save As”, and select the “Spreadsheet tab delimited” option. Save the file to the PEP478 folder I have developed.
16. The subject may want to keep riding longer, or need to get off the bike to walk around. Try to ensure that the subject does not lie down unless nausea or fainting (syncope) is imminent!!!!!!!
17. If the subject needs to walk around the lab, have someone walk with him or her until the subject looks and feels better!!
18. To get the data, you need to copy the text file to the 3.5 inch floppy disk, and then take it over to the VO2 computer to transfer it from the disk to a jump drive.
19. Repeat this for the alternate method of the test, where the subject starts the test from a stationary (0 rev/min) condition. I recommend waiting at least 30 min, preferably, 1 hour prior to a second test. This way you can test each other once each, and by the time this is done, depending on the size of your group, the second tests can be performed.

***Results***

1. Import your data from the text file into Excel.
2. Using Excel, clean the data by deleting all rows and columns other than time, corrected data, and corrected data expressed relative to body mass. Note that the corrected data adjusts for the initial inertia of the flywheel at the start of the test. NOTE: you only use the corrected data for the traditional method of the Wingate (not the stationary start method).
3. From the peak power (Watts) values (usually at 5 s), determine the peak Watts and absolute (Watts) and relative (% peak power) decrements by the end of the test.
4. Report the peak power and their corresponding times for each test.
5. Graph the data as Watts and also as Watts/kg vs. time (s). Label peak power on each graph.
6. Also fit a linear regression to the data from 10 s to 30 s. Use the slope (should be a negative number) to identify the rate of fatigue (Watts/min and Watts/kg/min). The easiest way to do this in Excel is to apply a trend line. I will show you how to do this in class.

***Discussion***

1. Describe the power decrement during the Wingate Test for each test.

2. Explain the bioenergetics of ATP production during short term intense exercise to exhaustion, and briefly comment on possible causes of fatigue.

3. Is the Wingate Test totally anaerobic. If not, try to find the estimated aerobic contribution to 30 s of maximal cycling.

4. Why is it recommended to express peak power relative to body mass or more correctly to LBM?

5. Explain the rationale for starting the test from stationary rather than the traditional high cadence method?

**References**

Find some research articles that allow you to extend and improve the Introduction and Discussion. It would also be good to get and read the research that has validated the correct weight to use for the Wingate Test for men and women of different body mass.

I have helped you out with the start of your reference list, as seen below.

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