HAPS 2002

Web-HUMAN Endurance Exercise Simulation

Below is an endurance exercise simulation session designed specifically for HAPS workshop participants. A much fuller step by step version of this simulation can be found at the *web*-HUMAN site (http://www.skidmore.edu/academics/human/) by clicking on Help and then looking under the section "How To Do It" examples.

Now that your familiarity with the operation of *web*-HUMAN has increased we undertake an endurance exercise simulation.

I. Initial Setup

Pick experiment number 1 & Run the subject for 1 hour [1H] with 1 hour between printouts. Use the **Change Table Columns** pulldown menus to set up Column headings as follows:

Time/Day	U N I T S
Arterial Oxygen Content (O2A)	_____
Cardiac output (COL)	_____
Oxygen debt (O2DEBT)	_____
Skeletal muscle blood flow(liters) (MFLOL)	_____
Ventilation (VENT)	_____
Exercise (EXER)	_____

II. Running a simulated exercise session (at moderate levels)

We will now have the subject exercise at a moderate level for as long as s/he is able. Exercise sessions require the user to set both the duration and the level (intensity) of the exercise bout.

- Set the exercise duration (**XERMIN**) parameter for some very large time (such as 100 minutes) This will allow exercise to proceed until some critical, limiting physiological value has been exceeded. (e.g. oxygen debts of > 10L will terminate exercise)

- The level of exercise is controlled by the variable **EXER**, which specifies the level of exercise in O2 usage above the basal level (i.e. rate of O2 used by exercise). Set EXER = to 2.0 L/M (moderate exercise).

- Run your exercise session for 1 hour with 5 min. between printouts. From the output table determine how long the subject was able to exercise for. Try Your 'Patient's Chart' under **Obtain Help, Extra Data or Charts** for an exact report of the exercise time.

III. Consider the physiological response

1) At what time did the exercise terminate and why?
2) Of the 2 parts of the O2 delivery system, the respiratory and cardiovascular, which showed the larger increase and what implications might this have for O2 delivery during exercise?
3) Eyeball cardiac output and muscle blood flow and find evidence for muscle vasodilation during exercise.
4) Why, despite the large increase in lung ventilation, does the blood O2 content not rise appreciably?

IV. Factors limiting exercise endurance time (if workshop time allows)

Question- Which part of the cardiopulmonary system is the limiting factor in supplying oxygen to the exercising muscles (that is, why does the model run up an O2DEBT)? Is it due to an insufficient respiratory O_2 intake rate or to an insufficient circulatory O_2 transport rate?

Design- To answer this question, try to increase the subject's tolerance (time to 10 L debt) during moderate exercise (EXER=2.0) in *two* ways. First, have him/her breathe 100% oxygen while exercising. This removes as much as possible any respiratory restraint. Then, restoring the O2 to its normal value, instead increase the model's basic heart strength (i.e. simulate a cardiac muscle training effect). This 'conditions' the CV system & tends to remove the circulatory restraint. Whichever of these maneuvers works best (gives the longer increase in exercise time) indicates that that particular system was the most limiting one originally.

Implementation/ Experiment #1* - To breathe 100% O2, set the fractional concentration of O2 in the atmosphere (**FO2AT**) to 1.0 (this may be varied between 0.0 <-> 1.0; it is, of course, normally 0.21). Remember to initialize ('Start Over')and reset the Table Columns, substituting **O2V** for EXER (you already know how EXER will behave, when it will turn off, etc.) before you start. Record data as before.

Implementation/ Experiement #2 - To increase basic heart strength (normally = 1.0) you must set the values of right heart strength (**RHSB**) *and* left heart strength (**LHSB**) to higher (yet equal) values. A recommended value is 1.25. (What would happen if you raise the strength of only one side of the heart?!) Use the same Table Columns as in the 100% O2 section above.

Evaluation- Which maneuver, the 100% O2 or the heart conditioning, increased endurance time more? Which system is then normally the limiting one?

*Note: One way to set up an experiment that requires changing 3 variables is to first change two (e.g. EXER & XERMIN) then Run for 0 min. with 0 min. between printouts, then change the third and finally run the experiment itself.