Experiment HE-8: Regulation of Body Temperature and the Respiratory Exchange Ratio (RER)

Note: Read the procedures for each exercise completely before beginning the experiment. Have a good understanding of how to perform these exercises before making recordings.

Warning: It is important that the subject is healthy and has no history of respiratory or cardiovascular problems.

Exercise 1: VCO_2, VO_2, and RER at Rest

Aim: To determine the effect of breathing at rest on VCO_2, VO_2, and RER.

Procedure

1. The subject should be comfortably dressed in t-shirt, shorts and socks.
2. Use surgical tape to tape the TM-100 temperature sensor to the inside of the subject's thigh where it will not come in contact with the electric blanket or ice packs.
3. Take the subject's core body temperature using his/her axillary temperature.
    - Place the thermometer underneath the subject's armpit.
    - Leave the thermometer in place for at least two minutes until you get an accurate temperature reading.
    - Record the subject's core temperature on Table HE-8-L1.
4. Instruct the subject to sit quietly, become accustomed to breathing through the mask and the flowhead, and breathe normally before any recordings are made.
5. Have the subject remove the mask from his or her face before the volume channels are zeroed.
6. Type <Subject's Name> Rest in the Mark box that is to the right of the Mark button.

Note: *The LabScribe software will zero the Lung Volume STPD channel during the first ten seconds of recording. No air should be moving through the flowhead during this time.*

7. Click on the Record button. After waiting ten seconds for the Lung Volume STPD channel to zero, the subject should put on the mask and check for leaks. Press the Enter key on the keyboard to mark the recording as the subject begins breathing through the mask and the flowhead.
8. Click the AutoScale buttons on all channels.
9. Notice that the CO_2 concentration increases with each exhalation and decreases with each inhalation as the O_2 concentration does the opposite.
10. On the Lung Volume STPD channel, the STPD Vol. Human function converts the data from the Air Flow channel to the tidal volumes at the standard temperature and pressure, dry.

11. On the Relative VCO2 channel, the VCO2-Breath function is programmed to determine the volume of carbon dioxide produced during the exercise. The volume of carbon dioxide produced in a minute is the parameter known as VCO_2.
12. On the Relative VO2 channel, the VO2-Breath function is programmed to determine the volume of oxygen consumed during the exercise. The volume of oxygen consumed in a minute is the parameter known as VO_2.
13. Record at least five minutes of data while the subject's respiration rate and volume are steady. Once the data is recorded, click Stop to halt the recording. Your data should be similar to Figure HE-8-L1.
14. Select Save in the File menu.

Note: *In this experiment, the weight of the subject is incorporated into the determination of VCO_2 and VO_2. These parameters are expressed as ml/min/kg body weight, and are commonly called Relative VCO_2 and Relative VO_2.*

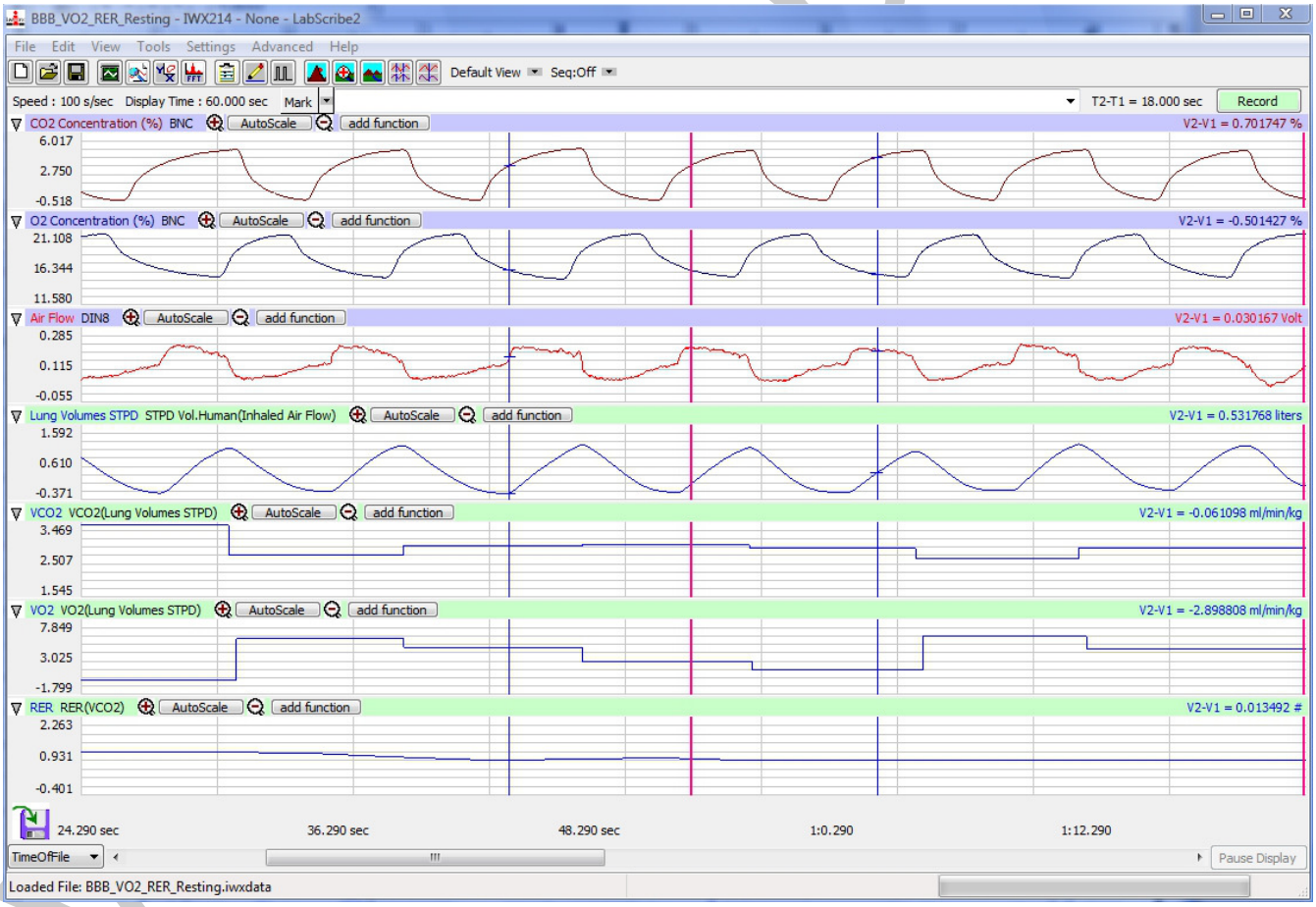

Figure HE-8-L1: Gas concentrations, lung volume (STPD), relative VCO2, relative VO2, and RER of a resting subject displayed on the Main window.

Data Analysis

1. Scroll to a section of the data where the subject's respiration rate and depth were consistent.
2. Use the Display Time icons to adjust the Display Time of the Main window to show at least a one-minute of the recording on the Main window. The required data can also be selected by:
    - Click the 2-Cursor icon (Figure HE-8-L2) on the LabScribe toolbar so that two blue cursors appear on the Main window.
    - Placing the cursors on either side of data required
    - Clicking the Zoom between Cursors button on the LabScribe toolbar to expand the calibration data to the width of the Main window.
3. Click on the Analysis window icon in the toolbar or select Analysis from the Windows menu to transfer the data displayed in the Main window to the Analysis window (Figure HE-8-L3).
4. Look at the Function Table that is above the uppermost channel displayed in the Analysis window. The mathematical function, Mean and T2-T1, should appear in this table. Values for each parameter on each channel are seen in the table across the top margin of each channel.

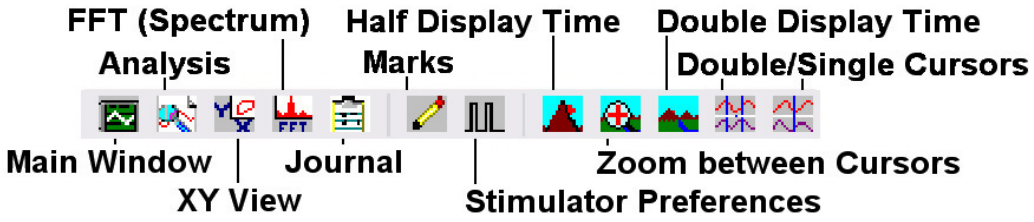

Figure HE-8-L2: The LabScribe Toolbar

5. Once the cursors are placed in the correct positions for determining the mean VCO2 and VO2 values for a one-minute section of data as indicated by the value for T2-T1, the mean VCO2 and VO2 values can be recorded in the on-line notebook of LabScribe by typing the name and values directly into the Journal.The functions in the channel pull-down menus of the Analysis window can also be used to enter the name and values of the parameter from the recording to the Journal. To use these functions:
    - Place the cursors at the locations used to measure the means of the VCO2, VO2, and skin temperature over one minute.
    - Transfer the name of the mathematical function used to determine these mean values to the Journal using the Add Title to Journal function in the Relative VCO2 Channel pull-down menu.
    - Transfer the values for the means of the VCO2, VO2, RER, and skin temperature to the Journal using the Add All Data to Journal function in the Relative VCO2 Channel pull-down menu.

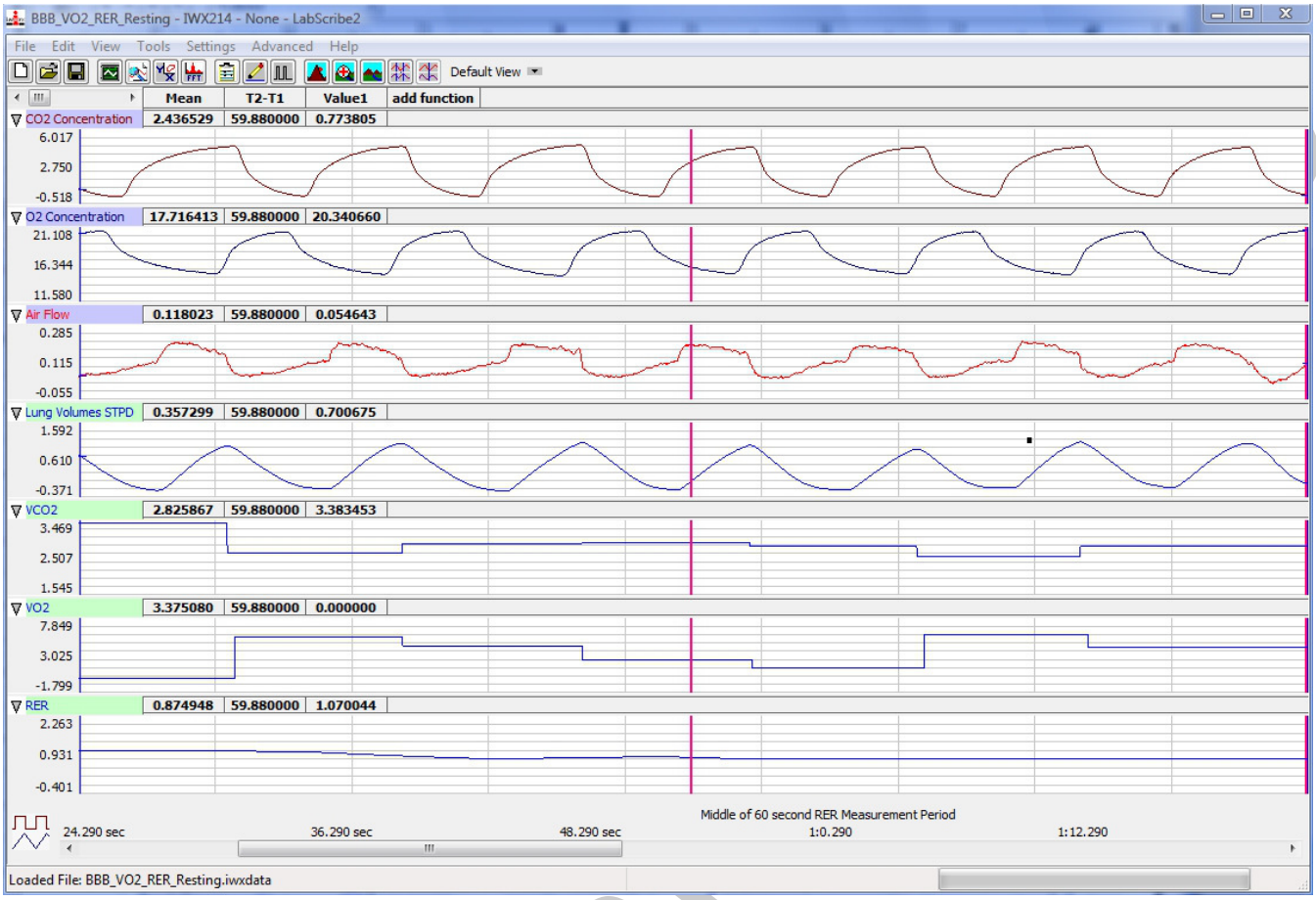

Figure HE-8-L3: Gas concentrations, lung volume (STPD), relative VCO2, relative VO2, and RER of a resting subject displayed on the Analysis window.

6. Use the mouse to click on and drag the cursors to positions on the Relative VCO2 channel that are one minute apart (Figure HE-8-L3). The values for the following parameters are determined when the cursors are positioned as directed:
    - The value for Mean on the Relative VCO2 channel is the average volume of carbon dioxide produced in one minute per kg body weight.
    - The value for Mean on the Relative VO2 channel is the average volume of oxygen consumed in one minute per kg body weight.
    - The value for Mean on the RER channel is the average respiratory exchange ratio (RER) over the time between the cursors on the Analysis window.
    - The value for Mean on the Skin Temp channel is the average skin temperature over the time between the cursors on the Analysis window.
7. Record the values for the Means in the Journal using one of the techniques described in Steps 5 or 6, and on Table HE-8-L1.

Exercise 2: Effect of High Body Temperature on VCO_2, VO_2, and RER

Aim: To measure the effect of higher than normal body temperature on VCO_2, VO_2, and RER.

Procedure

1. Ask the subject to put on sweat pants, a sweatshirt and socks over his/her shorts and t-shirt.
2. Wrap the subject in the electric blanket and turn the setting up so the subject can feel the warmth from the blanket. Do not make the temperature too high.
3. Let the subject sit wrapped in the electric blanket for at least 15 minutes, but no longer than 25 minutes.
4. Turn off and remove the electric blanket.
5. Immediately take the subject's body temperature using the method described in Exercise 1. Record the temperature on Table HE-8-L1.
6. Use the same procedures used in Exercise 1 to record the lung volumes and skin temperature from the subject while the gas concentrations are reaching a steady state immediately after the 15 minute warming period and removal of the blanket, 5 minutes after removal of the blanket, and 15 minutes after removal of the blanket.

Note: *The subject will have his/her breathing recorded for a minimum of 20 minutes without stopping the recording. Stop the recording only after you have recorded data for five minutes after the 15 minutes after removal of the blanket.*

7. Mark the recording with a comments that indicate the name of the subject and the beginning of the three periods being recorded.

Data Analysis

1. Use the same procedures used in Exercise 1 to determine the oxygen consumed (VO_2), carbon dioxide produced (VCO_2), and respiratory exchange ratio (RER), and skin temperature during high body temperature, and at both 5 minutes and 15 minutes after removal of the electric blanket.
2. If the concentrations of oxygen and carbon dioxide were at a steady level for less than a minute, prorate volumes to minute volumes. For example, if the oxygen and carbon dioxide concentrations reached a steady level for 30 seconds during the different time periods, the measured volumes are converted to minute volumes by multiplying the 30-second values by 2.
3. Record the values for the means of the VCO_2, VO_2, RER, and skin temperature, and the core temperature, in the Journal and on the data table.

Table HE-8-5: VCO2, VO_2, the Respiratory Exchange Ratio (RER), and Temperatures of a Subject at Rest, During High Body Temperature, and During Low Body Temperature.

Environmental Conditions	Experimental Periods	Core Body Temp. (^oC)	Skin Temp. (^oC)	Mean VCO_2 (ml/min/kg)	Mean VO_2 (ml/min/kg)	RER
Room Temperature (^oC)	Resting					
	High Body Temperature (Immediate)					
Barometric Pressure (mmHg)	5 Minutes After High Temperature					
	15 Minutes After High Temperature					
	Cold Body Temperature (Immediate)					
Relative Humidity (%)	5 Minutes After Cold Temperature					
	15 Minutes After Cold Temperature					

Exercise 3: Effect of Cold Temperature on VCO_2, VO_2, and RER

Aim: To measure the effects of colder than normal body on VCO_2, VO_2, and RER.

Warning: If using a different subject for the Cold Temperature exercise, you MUST repeat Exercise 1 for the subject at Rest. If using the same subject, let the subject remain at room temperature for 15 minutes while he/she cools back down to normal body temperature prior to starting Exercise 3.

Procedure

1. Ask the subject to sit comfortably in only his/her t-shirt and shorts. Bare feet are suggested.
2. Place cold packs on the subject's core body area, and on the hands and feet if possible.
3. Let the subject sit with the cold packs on for at least 15 minutes, but no longer than 25 minutes.

4. Turn off and remove the cold packs.
5. Immediately take the subject's body temperature using the method described in Exercise 1. Record the temperature on the data table.
6. Use the same procedures used in Exercise 1 to record the lung volumes and skin temperature from the subject while the gas concentrations are reaching a steady state immediately after the 15 minute cooling period and removal of the cold packs, 5 minutes after removal of the cold packs, and 15 minutes after removal of the cold packs.
7. Mark the recording with a comments that indicate the name of the subject and the beginning of the three periods being recorded.

Data Analysis

1. Use the same procedures used in Exercise 1 to determine the oxygen consumed (VO_2), carbon dioxide produced (VCO_2), and respiratory exchange ratio (RER), and skin temperature during low body temperature, and at both 5 minutes and 15 minutes after removal of the cold packs.
2. If the concentrations of oxygen and carbon dioxide were at a steady level for less than a minute, prorate volumes to minute volumes. For example, if the oxygen and carbon dioxide concentrations reached a steady level for 30 seconds during the different time periods, the measured volumes are converted to minute volumes by multiplying the 30-second values by 2.
3. Record the values for the means of the VCO_2, VO_2, RER, and skin temperature, and the core temperature, in the Journal and on the data table.

Note: *The subject will have his/her breathing recorded for a minimum of 20 minutes without stopping the recording. Stop the recording only after you have recorded data for five minutes after the 15 minutes after removal of the cold packs.*

Questions

1. During which experimental period was the subject's VCO_2 the highest? In which period was it the lowest?
2. During which period was the subject's VO_2 the highest? In which period was it the lowest?
3. During which period did the subject have the highest RER? In which period was the RER the lowest?
4. What is the direct correlation between maintaining body temperature, RER, and metabolism?
5. Is it easier to maintain body temperature when and individual is hot or cold? Explain your answer. You may need to use additional sources other than your textbook.

Appendix: Optional Spirometer Flow Head Calibration

For increased accuracy of measurements, User's may want to perform an optional calibration porcedure on their flow head. This procedure uses an optional 3 liter calibration syringe. Directions are included with the syringe.