

## Experiment HC-5: Body Position, Exercise, and Cardiac Output

### Exercise 1: Cardiac Output While Reclining

Aim: To determine the cardiac output of a subject through the measurement of blood pressures and heart rate while the subject is reclining.

#### Procedure

1. Instruct the subject to rest in the supine position for at least five minutes before his or her blood pressure is taken.
2. While the subject is resting, place the blood pressure cuff of the BP-600 around the upper portion of the left arm, just above the elbow. Place the PT-104 pulse plethysmograph on the volar surface (where the fingerprints are located) of the distal segment of the left middle finger. Wrap the Velcro strap around the end of the finger to attach the unit in place.
3. At the end of the rest period, click on the Record button to begin recording the subject's pulse, blood pressure and heart rate.
4. Inflate the blood pressure cuff until the finger pulse wave on the Pulse channel disappears ([Figure HC-5-L1](#)).
5. Once the pulse wave disappears, release the cuff pressure at the rate of ~10 mmHg/second. Continue to release the pressure in the cuff until the aneuroid gauge reads 20 mmHg. Continue to record for an additional 30 seconds.

**Warning:** Remember that restricting circulation for a prolonged period can be dangerous. Do not release the pressure in the cuff at a rate any slower than 5 mm Hg per second.

6. Click the Stop button. Make sure the blood pressure cuff is completely deflated and is not putting any unnecessary pressure on the subject's arm.
7. The subject should rest in the sitting position between Exercises 1 and 2. To improve circulation in his or her arm, the subject should flex and extend their fingers to encourage blood circulation.
8. Select Save in the File menu.

#### Data Analysis

1. Scroll through the recording and find the section of data recorded before, during, and after the pressure in the cuff was occluding the pulse.
2. Use the Display Time icons to adjust the Display Time of the Main window to show the pulse and the pressure in the cuff of the BP-600 from the occlusion of the artery to the time 15 seconds after the time point when the diastolic pressure was recorded. This section of data can also be selected by:
  - Placing the cursors on either side of the section of data needed.

- Clicking the Zoom between Cursors button on the LabScribe toolbar to expand the segment of data to the width of the Main window.

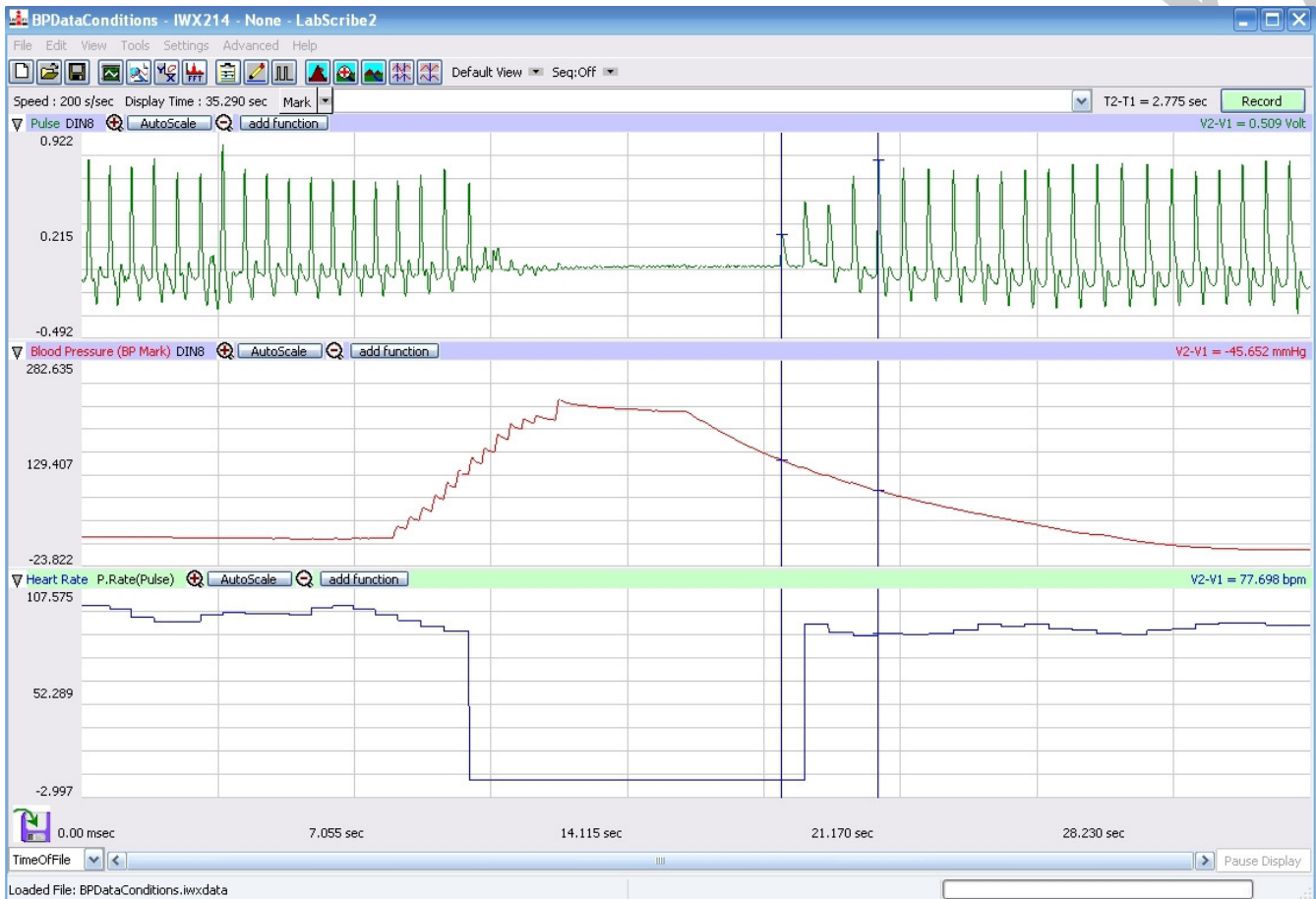


Figure HC-5-L1: The pulse, pressure in the cuff of the BP-600, and heart rate recorded before, during, and after the occlusion of the brachial artery.

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 HC-5-L2).
4. Look at the Function Table that is above the uppermost channel displayed in the Analysis window. The mathematical functions that are listed should include Value1, Value2, T2-T1, and Mean. The values for these parameters from each channel are seen in the table across the top margin of each channel.
5. Once the cursors are placed in the correct positions for determining the blood pressures, the values for the blood pressures can be recorded in the on-line notebook of LabScribe by typing the names and values directly into the Journal.
6. The functions in the channel pull-down menus of the Analysis window can also be used to enter the names and values of the parameters from the recording to the Journal. To use these functions:
  - Place the cursors at the locations used to measure the cuff pressures from the Blood Pressure channel.

- Transfer the name of the mathematical function used to determine the blood pressure to the Journal using the Add Title to Journal function in the ECG Channel pull-down menu.
  - Transfer the value for the blood pressure to the Journal using the Add Ch. Data to Journal function in the ECG Channel pull-down menu.
7. Once the cursors are placed in the correct positions for determining the systolic, diastolic, and pulse pressures, record the values for these pressures in the Journal using the one of the techniques described in Steps 5 or 6.
  8. Use the mouse to click on and drag the cursors to specific points on the pulse, blood pressure, and heart rate recording to measure the following:
    - Systolic blood pressure. To determine the subject's systolic blood pressure, place a cursor on the first of the smallest pulse waves that reappear after the pressure from the cuff of the BP-600 is released. Value1 on the Blood Pressure channel is the subject's systolic blood pressure. Enter this pressure in [Table HC-5-L1](#).
    - Diastolic blood pressure. To determine the subject's diastolic blood pressure, place the other cursor on the first of the largest pulse waves that reappear as the pressure from the cuff of the BP-600 is released. Value2 on the Blood Pressure channel is the subject's diastolic blood pressure. Enter this pressure in the data table.
    - Heart Rate. To determine the subject's heart rate, place a cursor on the recording just after the point used to determine the diastolic pressure. Place the other cursor on the recording about 10 seconds after the first cursor ([Figure HC-5-L3](#)). Mean on the Heart Rate channel is the subject's average heart rate after the blood pressure determination. Enter this rate in the data table.
  9. Determine the stroke volume of the subject while he or she was reclining by using the following equation:
 
$$\text{Stroke Volume (ml/beat)} = 101 + (0.50 \times \text{Systolic Pressure}) - (1.09 \times \text{Diastolic Pressure}) - (0.61 \times \text{Age})$$
  10. Enter the value for the stroke volume of the subject in the Journal and on the data table.
  11. Determine the cardiac output of the subject while he or she was reclining using the following equation:
 
$$\text{Cardiac Output (ml/min)} = \text{Stroke Volume (ml/beat)} \times \text{Heart Rate (beats/minute)}$$
  12. Enter the value for the cardiac output of the subject in the Journal and on the data table.

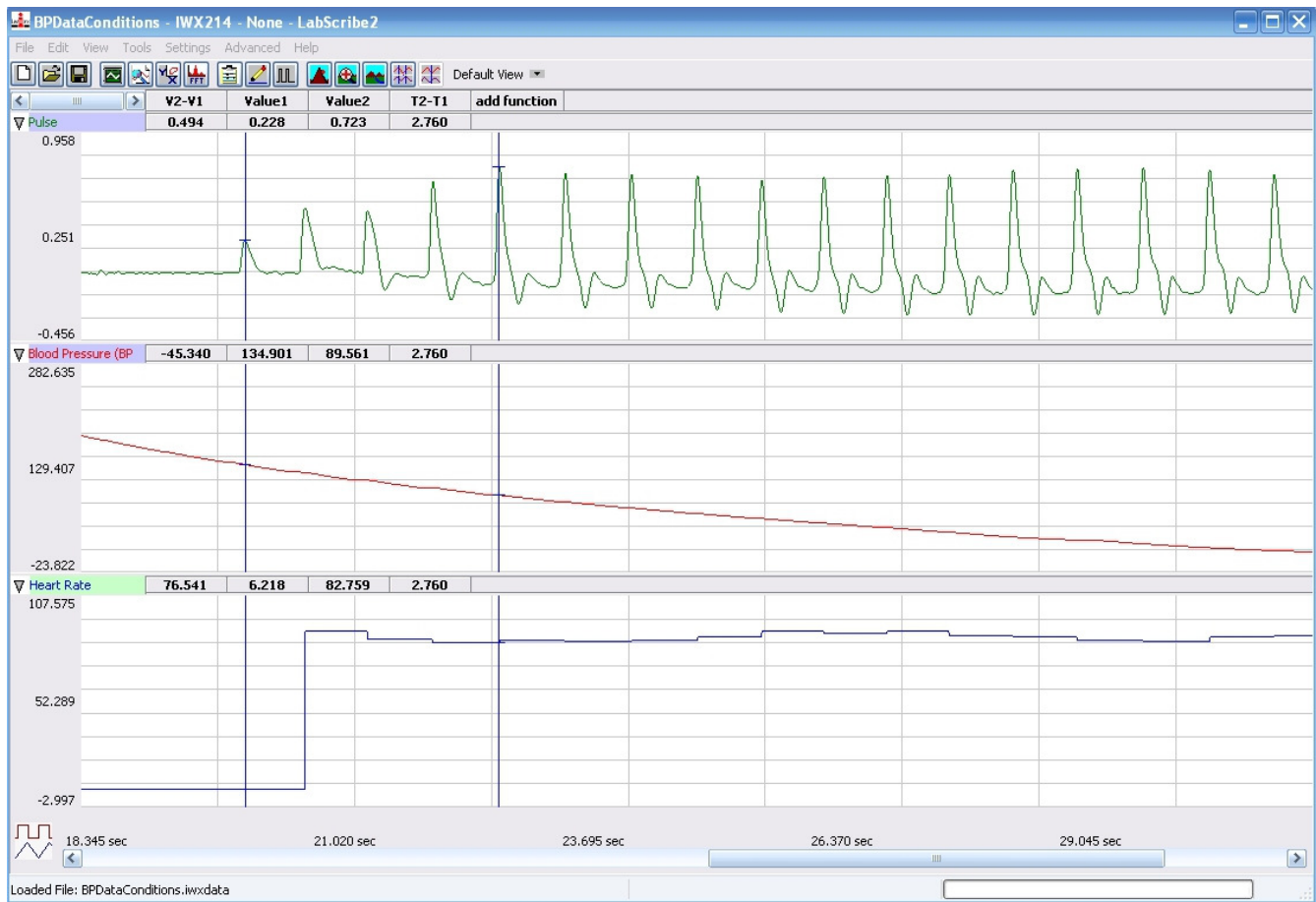


Figure HC-5-L2: The pulse, pressure in the cuff of the BP-600, and heart rate recorded before, during, and after the occlusion of the brachial artery displayed in the Analysis window. Cursors are placed for measuring the systolic and diastolic pressures, which are 134.9 mmHg and 89.6 mmHg, respectively.

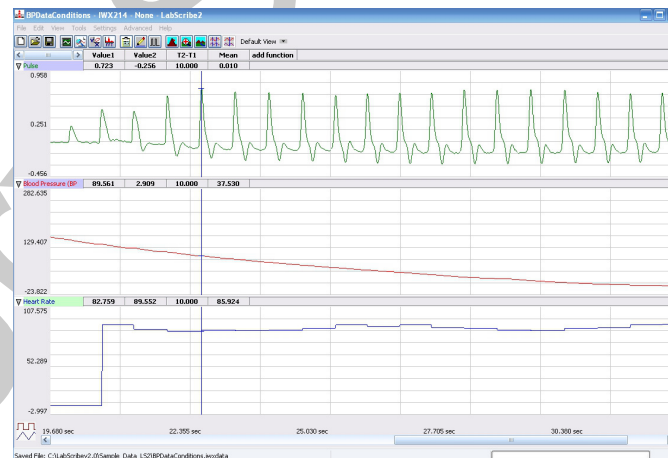


Figure HC-5-L3: The pulse, pressure in the cuff of the BP-600, and heart rate recorded before, during, and after the occlusion of the brachial artery displayed in the Analysis window. Cursors are placed for measuring the mean heart rate in the 10 seconds after the diastolic pressure is measured. The mean heart rate is 85.9 BPM.

**Table HC-5-L1: Blood Pressures, Stroke Volumes, and Cardiac Outputs of Subject in Different Body Positions.**

Subject's Age _____ years	Systolic Pressure (mmHg)	Diastolic Pressure (mmHg)	Stroke Volume (ml/beat)	Heart Rate (BPM)	Cardiac Output (ml/min)
Body Position					
Reclining					
Sitting					
Standing					
Sitting, After Exercise					
Sitting, 30 Secs After Exercise					
Sitting, 60 Secs After Exercise					
Sitting, 90 Secs After Exercise					
Sitting, 120 Secs After Exercise					

**Exercise 2: Cardiac Output While Sitting**

Aim: To determine the cardiac output of the same subject through the measurement of blood pressures and heart rate while the subject is sitting.

**Procedure**

1. Repeat the procedures outlined in Exercise 1 on the same subject while the subject is sitting.
2. The subject should continue to rest in the standing position between Exercises 2 and 3.

**Data Analysis**

1. Use the same techniques used in Exercise 1 to determine the systolic and diastolic blood pressures, heart rate, stroke volume, and cardiac output of the sitting subject.
2. Record the values for each parameter in the Journal and on the data table.

### **Exercise 3: Cardiac Output While Standing**

**Aim:** To determine the cardiac output of the same subject through the measurement of blood pressures and heart rate while the subject is standing.

#### ***Procedure***

1. Repeat the procedures outlined in Exercise 1 on the same subject while the subject is standing.
2. The subject should continue to rest in the standing position between Exercises 3 and 4.

#### ***Data Analysis***

1. Use the same techniques used in Exercise 1 to determine the systolic and diastolic blood pressures, heart rate, stroke volume, and cardiac output of the standing subject.
2. Record the values for each parameter in the Journal and on the data table.

### **Exercise 4: Cardiac Output After Exercise**

**Aim:** To determine the cardiac output of the same subject through the measurement of blood pressures and heart rate while the subject is recovering from exercise.

#### ***Procedure***

1. Remove the blood pressure cuff and pulse plethysmograph from the subject. Leave these devices connected to the IWX/214.
2. Instruct the subject to exercise vigorously enough to elevate his or her heart rate. Walking up and down stairs or doing jumping jacks are suitable exercises.
3. While the subject is exercising, type Recovery, Time = 0 in the Mark box to the right of the Mark button.
4. Immediately after exercising, the subject should sit. Other members of the group should attach the pulse plethysmograph and blood pressure cuff to the subject as done in Exercise 1 as quickly as possible, and click on the Record button.
5. Inflate the cuff and record the data needed to determine the subject's blood pressure immediately after exercise. Press the Enter key on the keyboard as the subject's blood pressure is recorded.
6. After the data needed to determine the subject's blood pressure is recorded:
  - Deflate the blood pressure completely.
  - Monitor the subject's heart rate by continuing to record.
7. Every thirty seconds after the beginning of the recovery period, repeat Steps 5 and 6. Mark each determination with the time of the recovery period. Continue to record the subject's blood pressure until the pressures are similar to the resting pressures.
8. Click Stop to halt recording.
9. Select Save from the File menu.

### ***Data Analysis***

1. Use the same techniques used in Exercise 1 to determine the systolic and diastolic blood pressures, heart rate, stroke volume, and cardiac output of the subject at the five intervals after the end of exercise.
2. Record the values for each parameter in the Journal and on the data table.

### **Questions**

1. How do the systolic and diastolic pressures of the subject in the reclining, sitting, and standing positions compare?
2. How do the heart rates of the subject in the reclining, sitting, and standing positions compare?
3. How do the cardiac outputs of the subject in the reclining, sitting, and standing positions compare?
4. How do the systolic and diastolic pressures from the subject at the various times after exercise compare to each other? And, the heart rates and cardiac outputs?
5. How do the systolic and diastolic pressures, heart rates, and cardiac outputs immediately after exercise compare to those recorded while the subject is sitting?
6. How do the systolic and diastolic pressures, heart rates, and cardiac outputs 2 minutes after exercise compare to those recorded while the subject is sitting?
7. From the data recorded, determine which factor, stroke volume or heart rate, has the greatest impact on cardiac output.