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Biopac Student Lab® Lesson 16
BLOOD PRESSURE
Data Report
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BLOOD PRESSURE

- *Indirect measurement*
- *Ventricular Systole & Diastole*
- *Korotkoff sounds*
- *Mean Arterial pressure*

DATA REPORT
Student's Name: Thisari Amarasekara
Lab Section: Blood Pressure
Date: 11/29/2022

I. Data and Calculations

Subject Profile
Name: Fonseka K. W.T. S____________________________________ Height: 167cm_____________
Age: 22_______ Time: 10.30 am____ Gender: Male / ~~Female~~ Weight: 60kg______________

A. **Systolic Measurements**

Complete Table 16.2 with the systolic measurements for all data recordings. Note the pressure measurement at the event marker insertion point (where Director audibly detected and marked systolic) and where the first Korotkoff sound was detected with the stethoscope microphone. Calculate the Delta difference (Δ) between the trials for each condition, the trial average pressure, and the Delta difference between the event marker and stethoscope microphone average pressure measurements.

Table 16.2 Systolic Data

Systolic Pressure mmHg 1 Value						
Condition	**Trial**	**Audibly Detected Pressure (Event marker)**	**Average Pressure (Calculate) A**	**Microphone Detected Pressure (In data, unmarked)**	**Average Pressure (Calculate) B**	**Δ Average Pressure B minus Average Pressure A**
Left arm, seated	1	129.45094	**126.32038**	122.14951	**123.27651**	-3.04387
	2	123.18982		124.40351		
	Δ	6.26112		2.254		
Right arm, seated	1	126.97539	**132.57882**	134.70064	**136.36706**	3.78824
	2	135.18226		138.03348		
	Δ	5.20686		3.33284		
Right arm, lying down	1	134.32497	**138.544**	141.22183	**145.81171**	7.267771
	2	142.76303		150.40159		
	Δ	8.43806				
Right arm, after exercise*	1	131.95538		142.90751		10.95213

*For 'Right arm, after exercise' recording, calculate the Delta difference between the 'Audibly Detected Pressure' and the 'Microphone Detected Pressure' values, and record the result in the right column.

B. Diastolic Measurements

Complete Table 16.3 with the diastolic measurements for all data recordings. Note the pressure measurement at the event marker insertion point (where Director audibly detected and marked diastolic) and where the sound disappeared from the stethoscope microphone. Calculate the Delta difference (Δ) between the trials for each condition, the trial average pressure, and the Delta difference between the event marker and stethoscope microphone average pressure measurements.

Table 16.3 Diastolic Data

Diastolic Pressure mmHg 1 Value						
Condition	**Trial**	**Audibly Detected Pressure (Event marker)**	**Average Pressure (Calculate) A**	**Microphone Detected Pressure (In data, unmarked)**	**Average Pressure (Calculate) B**	**Δ Average Pressure B minus Average Pressure A**
Left arm, seated	1	63.04460	**55.77951**	67.64892	**58.237985**	2.458475
	2	40.51422		48.82705		
	Δ	22.53018		18.82187		
Right arm, seated	1	79.69916	**73.59698**	65.71279	**62.69783**	-10.89915
	2	67.49480		59.68286		
	Δ	12.20436		6.02993		
Right arm, lying down	1	65.26970	**69.27199**	59.97183	**65.39011**	-3.88188
	2	73.27429		70.80838		
	Δ	8.00459		10.83655		
Right arm, after exercise*	1	62.28731		71.92575		9.63844

*For 'Right arm, after exercise' recording, calculate the Delta difference between the 'Audibly Detected Pressure' and the 'Microphone Detected Pressure' values, and record the result in the right column.

C. BPM Measurements

Complete Table 16.4 with the BPM measurements from three cycles of each data recording and calculate the mean BPM for each.

* **Cycle** measurements: If ECG was recorded, use 3 BPM; if ECG was not recorded, use 1 BPM.

Table 16.4 BPM

Condition	**Trial**	**Cycle* 1**	**2**	**3**	**Calculate the Mean of Cycles 1 – 3**	**of Trial 1 – 2 means**
Left arm, seated	1	89.82025	90.36144	94.33962	91.50613	89.40059
	2	82.87292	84.74576	94.26347	87.29405	
Right arm, seated	1	79.57559	75.56675	81.96721	79.03651	80.021565
	2	77.12082	80.42895	85.47008	81.00662	
Right arm, lying down	1	76.14213	76.92307	78.53403	77.19974	82.18978
	2	96.15384	87.46355	77.92207	87.17982	
Right arm, after exercise	1	117.64705	118.11023	115.83011	117.1958	

D. Summary of Mean Blood Pressure Data

Complete Table 16.5 with the average from sound data from tables 16.2 and 16.3 and then calculate the pulse pressure and the mean Arterial Pressure (MAP). Note the pressure measurements at the event marker insertion points (where Director audibly detected and marked systolic and diastolic).

Pulse pressure = Systolic pressure – Diastolic pressure

$$\text{MAP} = \frac{\text{pulse pressure}}{3} + \text{diastolic pressure} \quad OR \quad \text{MAP} = \frac{(\text{systolic pressure} + 2\,\text{diastolic pressure})}{3}$$

Table 16.5 Average Systolic Pressure/Average Diastolic Pressure

CONDITION	SYSTOLE Table 16.2 Sound Average	DIASTOLE Table 16.3 Sound Average	BPM Table 16.4	Calculations: Pulse pressure	MAP
Left arm, seated	126.32038	55.77951	89.40059	70.54087	79.29313
Right arm, seated	132.57882	73.59698	80.021565	58.98184	93.25759
Right arm, lying down	138.544	69.27199	82.18978	69.27201	92.36266
Right arm, after exercise	131.95538	62.18731	117.1958	69.76807	85.44333

E. **Timing of Korotkoff Sounds** NOTE: This table requires ECG data, which is not recorded on MP46/45 systems.

Complete Table 16.6 with the Delta T for each condition, and calculate the means.

Table 16.6

Condition	Trial	Timing of Sounds: 1 Delta T	Mean (calc)
Left arm, seated	1	0.22000	0.23300
	2	0.24600	
Right arm, seated	1	0.20200	0.19300
	2	0.18400	
Right arm, lying down	1	0.18600	0.18400
	2	0.18200	
Right arm, after exercise	1	0.18000	0.18000

F. **Calculation of Pulse Speed**

Complete the calculation in Table 16.7 using "Right arm, seated" data.

Table 16.7

Distance	Distance between Subject's sternum and right shoulder	22 cm
	Distance between Subject's right shoulder and antecubital fossa	27 cm
	Total distance	49 cm
Time	Time between R-wave and first Korotkoff sound	0.193 secs
Speed	Speed = distance/time = 49 cm / 0.283 sec	253.886 cm/sec

II. Questions:

1. Note the difference in systolic pressure value between when (a) the sound actually began, (b) was detected by the stethoscope transducer, and (c) was recorded, and the time when the observer first heard the sound and pressed the event marker keystroke. (Example: 141 mmHg – 135 mmHg = 6 mmHg.) What factors could account for this difference? Would the observed difference be the same if measured by another observer? Explain your answer.

   When a person detects the first sound, there will be a time delay of about one or more cardiac cycles since it'll most probably take another sound to be heard until the marker is placed. The delays accounting for the above difference could be due to sound detection delay of the observer, delay to place the marker and the software recording the marker.
   These delays could vary between individuals since the response times different individuals varies and hence the same difference will not be observed if measured by another observer.

2. a) Does your systolic and/or diastolic arterial pressure change as your heart rate increases?

According to the observations in the Table 16.5, comparing the data of the condition Right arm, seated, lying down and after exercise,
With the increase of heart rate from positions seated to lying down the systolic pressure increases while the diastolic pressure decreases.
Comparing with the increase of heart rate from lying down to after exercise, both the systolic and diastolic pressures decreases.
Theses irregular changes could be either due to the subject’s health condition or the human errors in the moment of observation.

b) How does this change affect your pulse pressure?

The pulse pressure of the subject has increased from conditions sitting down to lying down and after exercise. However, the pulse pressure when lying down and after exercise are almost equal. This could be due to the subject’s physical conditions or the errors in measuring the pressure measurements.

c) How would you expect the systolic, diastolic and pulse pressures to change in a normal healthy individual as the heart rate increases?

For a normal healthy individual,

Systolic pressure: As the heart rate increases the time between contractions of the heart decreases meaning the heart has less time to fill with blood before the next contraction and this decreases the stroke volume. And the force of each contraction increases to maintain the same cardiac output. Hence, the systolic pressure increases.

Diastolic pressure: As the heart rate increases, the diastolic pressure will slightly increase, but the increase is smaller compared to that of the systolic blood pressure.

Pulse pressure: Since pulse pressure is the difference between systolic and diastolic pressures, as the heart rate increases according to the above explanations the pulse pressure will increase.

3. Give three sources of error in the indirect method of determining systemic arterial blood pressure.

Random errors caused by the observer when determining the Korotkoff sounds.
Incorrect placement of the pressure cuff (or cuff being too tight or loose).
Instrumental errors in the pressure gauge used.

4. Use an equation that relates flow, pressure, and resistance to define mean arterial pressure:

Mean Atrial Pressure = (Cardiac Output) x (Total Peripheral Resistance)

5. Blood flow (liters per min). through the pulmonary circuit equals blood flow through the systemic circuit, but pulmonary resistance to flow is 5 times less than the systemic resistance to flow. Using the equation in Question 4, show that mean pulmonary pressure is 5 times less than mean systemic pressure.

Left Ventricular Cardiac Output = (Mean Systemic Pressure) / (Total Systemic Resistance)

Right Ventricular Cardiac Output = (Mean Pulmonary Pressure) / (Total Pulmonary Resistance)

By equating the two cardiac outputs,

(Mean Systemic Pressure) / (Total Systemic Resistance) = (Mean Pulmonary Pressure) / (Total Pulmonary Resistance)

(Mean Systemic Pressure) / (Mean Pulmonary Pressure) = (Total Systemic Resistance) / (Total Pulmonary Resistance)

(Total Systemic Resistance) / (Total Pulmonary Resistance) = 5

(Mean Systemic Pressure) / (Mean Pulmonary Pressure) = 5

Therefore, Mean Systemic Pressure = 5 x Mean Pulmonary Pressure

6. Define the first and second sounds of **Korotkoff**. Which sound is used to approximate systolic pressure and which sound is used to approximate diastolic pressure?

The first sound of Korotkoff is the strong tapping sound heard when the pressure in the cuff is slightly less than the systolic pressure of the cuff-occluded artery. The pressure in the cuff at that moment is approximated to the systolic pressure.

The second sound of Korotkoff is the more soft, swishing sound heard when the pressure in the cuff is reduced to nearly the diastolic pressure of the cuff-occluded artery. The sound disappears after this second sound and the pressure in the cuff at that moment is approximated to the diastolic pressure.

7. Why is mean arterial pressure not equal to (systolic pressure – diastolic pressure)/2?

   The pressure in arteries does not remain constant throughout the cardiac cycle. During systole, the pressure increases while during diastole, the pressure decreases, meaning the average pressure during the cardiac cycle is not the average of the systolic and diastolic pressure.

   Also, the duration of systole is shorter than the diastole meaning the impact of the pressure during systole has a greater impact on the average pressure during the cardiac cycle.

   Therefore, a weighted average should be taken for the Mean Atrial Pressure rather than simply the average of systolic and diastolic pressures.

8. Define **pulse pressure**. Explain, in terms of changes in systolic and diastolic pressures, why pulse pressure increases during exercise.

   Pulse pressure = Systolic pressure – Diastolic pressure

   i.e. Pulse pressure is the difference between the Systolic pressure and the Diastolic pressure.

   During exercise, both the systolic and diastolic pressure increases. However, the increase in systolic pressure is greater than that of the diastolic pressure. This results in the increase of Pulse pressure during exercise.

9. Give one reason why blood pressure in the left arm may be different than blood pressure in the right arm of a Subject at rest.

   Asymmetry of the arterial blood vessels coming off from the aorta which can affect the blood flow and hence the blood pressure measurements.

10. Name an artery other than the brachial that could be used for an indirect measurement of blood pressure and explain your choice.

    Radial Artery.

    This is the next most common alternative to the brachial artery for blood pressure measurements and is located in the wrist. This method is sometimes used for patients with obesity or arm abnormalities where it is difficult to obtain the BP measurement from the brachial artery.

End of Lesson 16 Data Report