

DAUGHERTY LAB  
Saha Cardiovascular Research Center  
University of Kentucky

# Protocols

## **Blood Pressure** (Kent Coda 8)

# Blood Pressure Measurement: Kent Coda 8 (Tail-Cuff)

## Things to Know

1. Many factors can affect blood pressure (BP) measurements: first-time measurements, temperature, stress, noise and inappropriate handling.
2. Measure a minimum of 3 days and a maximum of 5 consecutive days.
3. Measure at the same time each day because BP varies according to the time of day (circadian rhythm).

## Procedures

1. Turn on warming platforms. Warming platform has 3 levels of temperature control (Level 1  $\approx 32$  °C, Level 2  $\approx 35$  °C, and Level 3  $\approx 38$  °C). **Note:** temperature may vary. The suggested ideal temperature for the blood pressure analysis is 33 - 35 °C. Use the Infrared Thermometer to check the temperature of mouse tails. If the mouse tail is too cold, BP will not be read. Conversely, if the warming platform is too hot, mice will be stressed, and may lead to severe dehydration or even death.
2. Animal holders (three different sizes to accommodate mice): Small (10 to 25 g), Medium (25 to 50 g), and Large (50 to 100 g). Select appropriate holders for your mice.
3. Turn on the Coda 8 BP system and the computer. Open Coda 8 program on computer (Coda 8 v3 icon).
4. Test both the O-cuffs and VPR-cuffs: Run "TEST RUN" with **NO** mice. Select all channels with test ID # and run a couple cycles. As the machine is measuring, the red (O-cuffs) and blue (VPR-cuffs) lines on each graph should intersect. If they fail to intersect, the cuffs need to be replaced. Pause the machine, change the cuff, and test again.

5. Load mice:
  - A. Handle mice gently. Pick up mouse by the tail, place into the holder, and carefully attach the end piece as to not pinch the tail or any other body parts.



Animal Holders



VPR Cuffs



Occlusion Cuffs

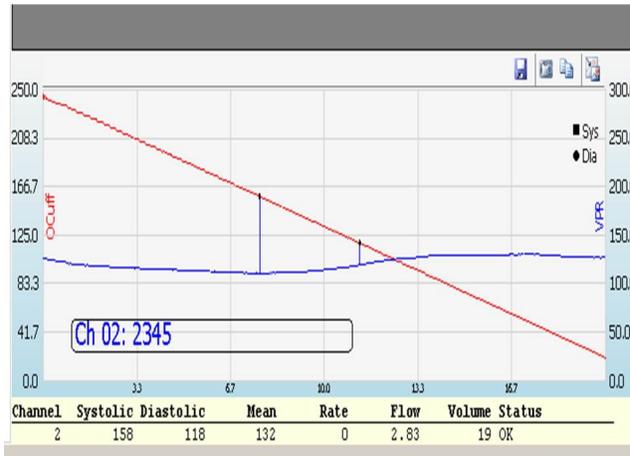
- B. Thread the tail through the O-Cuff first and then through the VPR-cuff. Secure the cuffs by sliding the hose into the notch on top of the mouse holder. **Adjust the position of O-Cuff on the tail to be neither too tight nor too loose.**

- C. Place mice in their designated positions on the warming platform.
  - D. Be sure to rotate mice each day in order to check the consistence of each channel. For example: On day 1, place mouse 1 on channel 1, mouse 2 on channel 2, mouse 3 on channel 3, mouse 4 on channel 4, and..... On day 2, place mouse 1 on channel 2, mouse 2 on channel 3, mouse 3 on channel 4, mouse 4 on channel 1, and.....Continue this pattern for all the mice. These rotations help to identify potential channel-specific issues.
6. Let mice stay in the holders with the tail cuffs on for **at least 5 minutes**. Not performing this step may lead to less successful rate of measurements. Recommend to cover mouse tails with a blanket if the environment is noisy or the temperature does not go up to certain level. **If a mouse has a wounded or short tail, severe dermatitis, is very sick, or is extremely irritated, do not measure BP on that mouse. An over-irritated mouse (e.g. screaming, moving) may also affect other simultaneously measured mice.**
7. Enter your specimen information:  
Under Device Manager
- A. Select Coda 8 - Channels 1-8
  - B. Select Use these devices
  - C. Select File and choose New
  - D. Under New select Experiment or Session
- The option of "Experiment": When you start a new experiment, enter the study name.
- The option of "Session": When you continue to run a same experiment, enter a session name.
- E. Type in Name of Experiment and select Researcher. Select Next.
  - F. Type in Session Name. Set cycles\*. Select Next.
  - G. Specimen pool. Use Manage specimens to add new mice. Move mouse numbers to active specimen area. Select Next.
  - H. Change cuff deflation time to 20 seconds. Select Next.
  - I. Session experiment. Select Next.
  - J. Experimental configuration. Select Next.
  - K. Press the "Finish" button. **This Finish button will begin blood pressure measurements immediately!**

\* Set cycles (F): Only measure each mouse for 20 cycles each run (acclimation cycle = 0). Same mice can only be run once (20 cycles) at the same day.

- 8. During measurements:
  - A. Do not touch the mice frequently. **Remember**, the more you handle the mouse, the more upset it may be! Never leave the room while mice are on the platform.
  - B. Do not touch the mouse during running. If a mouse pulls its tail free from the

cuffs, pause the machine analysis and then re-thread the mouse tail.



During measurements, the red line (O-cuff) is sloping downward while the blue line (VPR-cuff) line is slowly tilting up (See the Figure). These two lines should intersect. If the red line does not decline or the blue line does not incline, it indicate cuff leakage. Pause the machine, and change the leaking cuff.

- C. A run with 20 regular cycles takes approximately 15 min.
9. After finishing the run, **immediately release the mice and put them back to the cage before you do anything else.**
10. Clean mouse holders and warming platform between runs with baby wipes. Clean all areas that the mice have been in contact with. Blood, feces, and urine will upset the next group of mice. Do not use clidox, it degrades cuffs and any plastic items.

### After Measuring

1. Export the data as an EXCEL sheet to designed folders in the Daugherty Lab drive.
2. Clean warming platform and the cuffs with baby wipes. Use soap and water to wash mouse holders thoroughly with a soft brush. If you are measuring female mice, and the next groups being measured are males, please use soap and water to wash mouse holders thoroughly before you measure the male mice. Not washing the holders may lead to irritation of the male mice, and thus reducing successful measurements.

**\*DO NOT GET THE COMPUTERS WET.**

**\*DO NOT PLACE ANYTHING ON TOP OF THE COMPUTERS.**

**For data analysis, generally we only use systolic BP data.**

### Data to Include (only applies to Systolic BP measurements)

- A. At least 5 accepted systolic BP readings per mouse per day; and
- B. Standard Deviation  $\leq$  30 mmHg; and
- C. Systolic BP measurement must be  $>$  50 mmHg

Also recommend to check graphs of each accepted run to ensure the measurement is grossly reliable. Remove unreliable measurements (see Page 7) and note why the measurements were removed).

**Please also see the following website**

<http://www.jove.com/video/1291/measuring-blood-pressure-mice-using-volume-pressure-recording-tail?ID=1291>

The website contains the video prepared in our lab and the paper on it.

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**Updated** : Anju Balakrishnan and Deborah A. Howatt on 3/25/13  
**Verified** : Hong Lu on 4/13/2013

**File name:** K:\Protocols and forms\Mouse Procedures - Invasive & Noninvasive\Blood Pressure - Kent Coda 8.wpd

## An example of BP readings and analysis

Run #	Specimen Name	Specimen Description	Channel	Regular Cycle	Accepted	Diastolic	Systolic	Mean	Rate	Flow	Volume
1	A25	Mouse	1	TRUE	TRUE	115	136	122	670	12.54	39.75
2	A25	Mouse	1	TRUE	TRUE	114	142	123	676	12.46	54.25
3	A25	Mouse	1	TRUE	TRUE	121	143	128	685	11.63	54.82
4	A25	Mouse	1	TRUE	TRUE	117	144	126	617	11.26	46.54
5	A25	Mouse	1	TRUE	TRUE	122	145	129	583	16.07	53.19
6	A25	Mouse	1	TRUE	TRUE	103	132	112	603	13.91	56.07
7	A25	Mouse	1	TRUE	FALSE	118	212	149	0	5.34	55.15
8	A25	Mouse	1	TRUE	TRUE	102	145	116	697	14.11	71.83
9	A25	Mouse	1	TRUE	TRUE	109	138	118	548	17.75	71.43
10	A25	Mouse	1	TRUE	TRUE	111	143	121	471	15.38	72.83
11	A25	Mouse	1	TRUE	TRUE	124	168	138	518	16.08	96.64
12	A25	Mouse	1	TRUE	FALSE	114	124	117	0	52.11	56.81
13	A25	Mouse	1	TRUE	TRUE	111	156	126	539	16.57	87.63
14	A25	Mouse	1	TRUE	TRUE	110	143	121	530	16.06	74.85
15	A25	Mouse	1	TRUE	TRUE	113	143	123	471	19.1	85.26
16	A25	Mouse	1	TRUE	TRUE	113	147	124	613	16.96	83.12
17	A25	Mouse	1	TRUE	TRUE	98	137	111	701	17.77	64.14
18	A25	Mouse	1	TRUE	TRUE	108	139	118	558	19.29	90.84
19	A25	Mouse	1	TRUE	FALSE	115	160	130	0	16.16	94.46
20	A25	Mouse	1	TRUE	TRUE	114	129	119	666	27.82	65.51

**Run #1-20:** total of 20 run cycles

**Specimen name:** the mouse number you give, e.g. A25, here.

**Channel:** used channel #1 of the Coda 8 machine for this mouse BP measurements.

**Regular cycles:** TRUE measurements (no acclimation cycles)

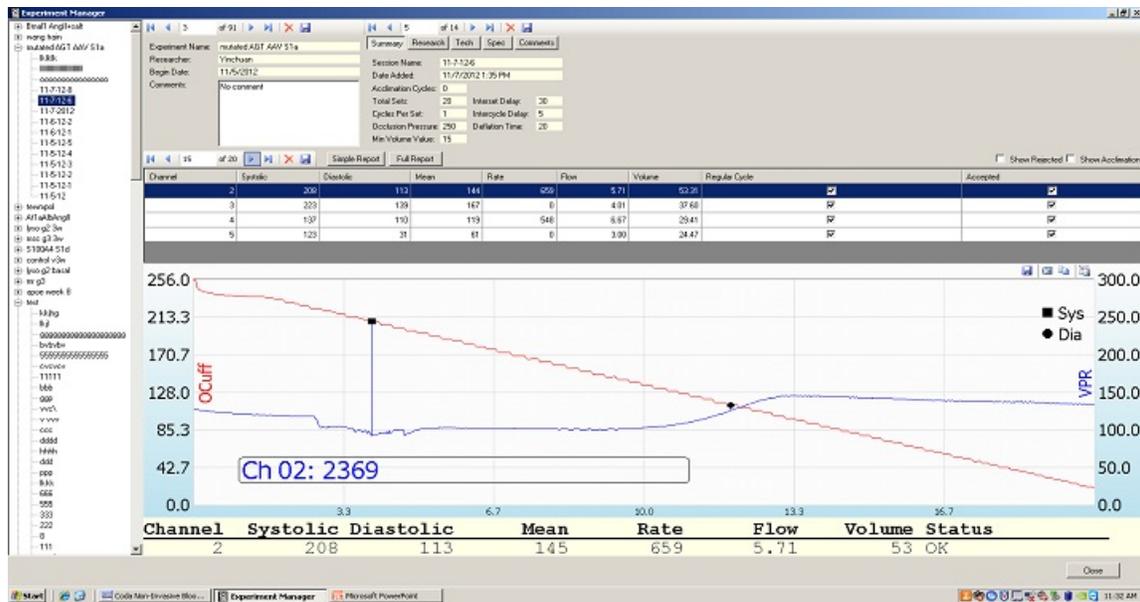
**Accepted:** TRUE - use the measurement; FALSE - DO NOT use the measurement.

When analyze the BP data, delete all the FALSE measurements, and only use the TRUE Regular cycles, Accepted TRUE for the analysis (17 cycles in the example).

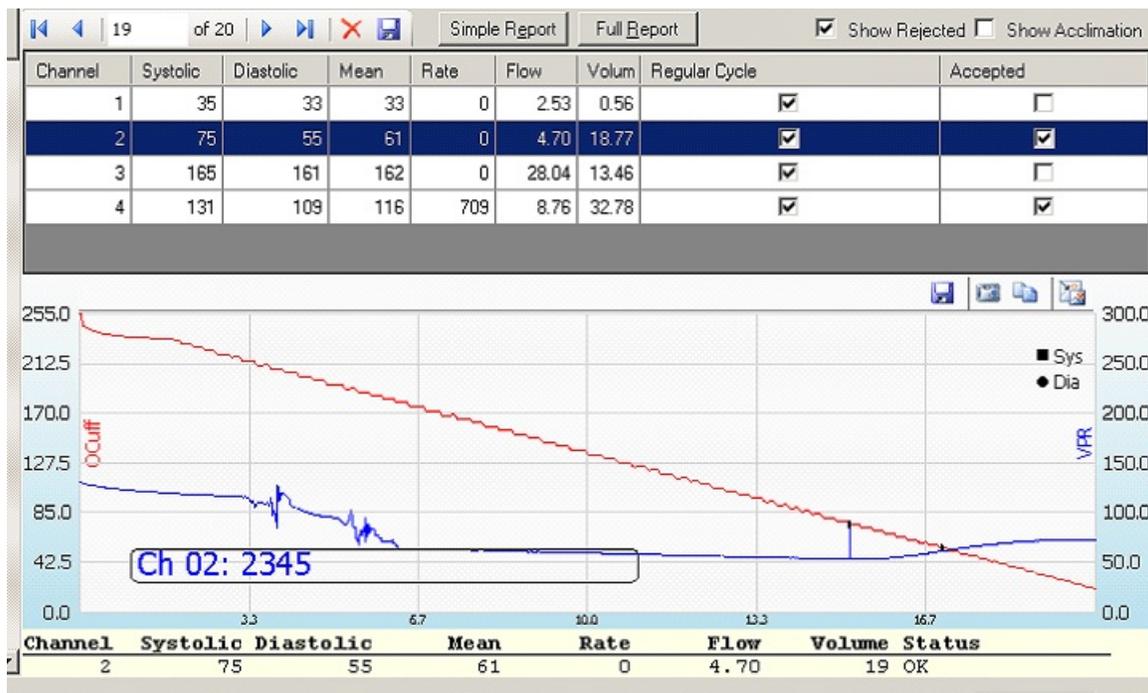
Run #	Specimen Name	Systolic
1	A25	136
2	A25	142
3	A25	143
4	A25	144
5	A25	145
6	A25	132
8	A25	145
9	A25	138
10	A25	143
11	A25	168
13	A25	156
14	A25	143
15	A25	143
16	A25	147
17	A25	137
18	A25	139
20	A25	129
	<b>Mean</b>	143
	SD	9

The mean value of the accepted cycles of systolic BP (143 mmHg) represents mean of the SBP at this specific day. The Standard deviation of the mean value is 9 mmHg. Therefore, 143 mmHg is acceptable as a valid measurement.

## Software Issues Recognized During Measurements



Systolic blood pressure (208 mmHg) is false. The software falsely recognizes a tail movement as the start of volume increase, i.e. systolic blood pressure. This value can't be used, although it was accepted as "TRUE".



The software recognizes the right point for systolic blood pressure. However, due to the tail movement, this value may not reflect the real pressure. In this case, look at the measurements from other cycles before include/exclude this value.