Jang, L S, and W H Kan. “Peristaltic Piezoelectric Micropump System for Biomedical Applications.” www.ncbi.nlm.nih.gov/pubmed/17505886.

Summary:

A piezoelectric peristaltic micropump was developed. The pump was designed to be portable, and was tested using deionized water and blood. The pump works through the use of the piezoelectric effect to create a peristaltic-style diaphragm that can move liquids both forwards and backwards. When electricity is run through PZT (piezoelectric) chips, they actuate and serve to open the channel in this design. By putting three of these chips in a row along a channel, the authors can actuate them in a specific sequence to push or pull liquids through the channel. The rest of the body of the pump was fabricated from Pyrex glass and silicon. The pump is powered by a single 12V battery, and its electronic components are controlled by an Atmega8535 microcontroller. It is entirely self-contained, having its own LCD display and keyboard, and thus not necessitating the use of a computer during its operation. The pump was first tested by pumping deionized water through it. The authors tested different phases of peristaltic motion and recorded the flow rate of the water through the device and the displacement of the middle diaphragm against the frequency of the motion. They found that the frequency of operation of the diaphragm was affected by the different actuation sequences, and that the flow rate for all sequences peaks a particular frequency and then decreases at any higher frequency (meaning that a single optimal frequency would exist). Next, the pump’s performance was compared when pumping blood and water. It was found that the PEOU coating applied to the pump had a very beneficial effect in preventing the coagulation of the blood. Their pump with the coating ran for 30 minutes straight pumping blood with no problems, while a control pump without the coating jammed up in seconds due to blood coagulation. It was also found that the pump operated with a much faster flow rate when pumping water instead of blood. The higher viscosity of blood was identified by the authors as a cause of this, but they also pointed out that their pump design was heavily affected by the type of liquid used in it. Lastly, the authors tested their pump with a living rat to see if any adverse physiological effects would result from its use in living organisms. They found that neither the rats mean arterial pressure nor its heart rate were significantly affected by the use of the pump.

Questions:

1. How did the authors of the paper control for the potential effect of the anesthetic on the rat’s heart rate?

2. Could the pump’s performance be affected by increasing the number of PZT actuators in the channel?