

Development of a Perfusion Test Stand with Absolute Measurement Capabilities

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The capability to retrieve immediate and non-invasive measurements of perfusion would be an invaluable tool to the medical sciences. As research in techniques to acquire this information advances, the accepted values of reasonable perfusion in the human body continue to expand. Literature has presented results that range from 0.0002 to 3 g/s/mL. Consequently, the verification of experimental outcomes has been limited to a qualitative analysis of the experienced trends. For this reason, it would be of great interest to conduct perfusion experiments on a test stand with absolute measurement abilities in order to compare measured results with the expected values.

Upon reading various papers dealing with the topic of perfusion, it has become abundantly clear that there are no universal units. Both Baish and Benkeser used units of $\text{kg/m}^3\text{-s}$. Wissler's *Pennes Revisited* used units of $\text{ml}\cdot\text{min}^{-1}\cdot 100\text{ml}^{-1}$. Unfortunately, neither of these conventions specifies which is a measure of blood and which is a measure of tissue. Naturally, then, one may assume a measured *mass of tissue* and a measured *volume of blood*.

An inspection of these implications, however, proves otherwise. For any dynamic test stand with a variable flow an absolute value of perfusion is actually calculated as

$$w = V_{\text{blood}} / V_{\text{tissue}} / t_{\text{test}} = Q_{\text{blood}} / V_{\text{tissue}}$$

Now equipped with a method of calculating an absolute value for perfusion it becomes clear what mechanisms the test stand should have to achieve this state. Any value of perfusion may be created by selecting a flow rate of blood to pass through a static amount of tissue. The phantom tissue to be used within the test stand is an agar/saline combination. Sliced pieces of agar leave gaps for the saline to flow much like the intercellular spaces found in tissue. Figure 1 shows the implementation of concept.

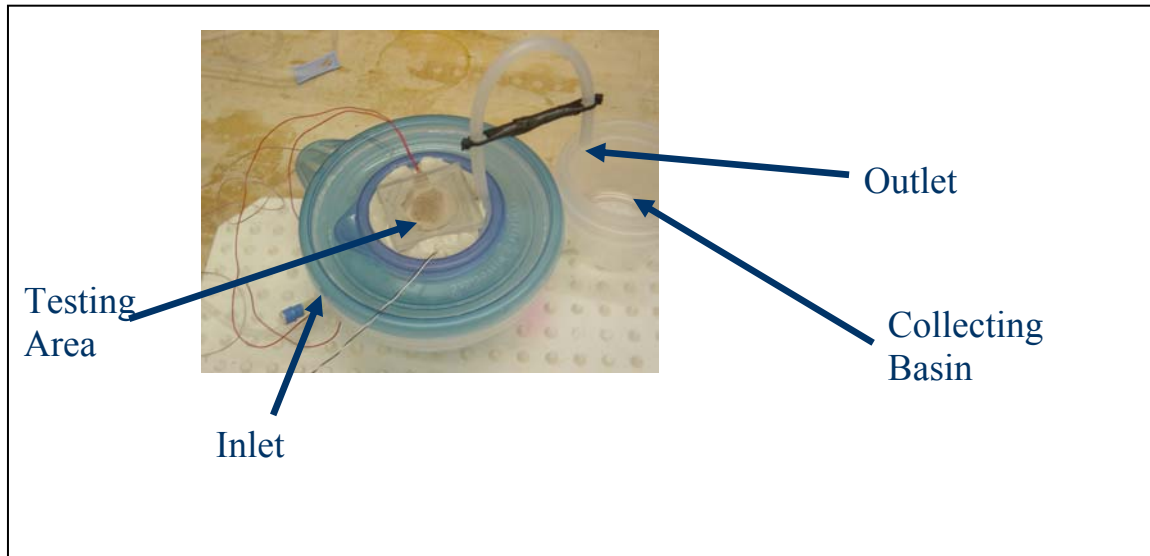


Figure 1: The major components identified for the perfusion test stand

Preliminary tests were performed to determine what range of flow rates would be needed to create a realistic perfused environment. From this analysis an IV drip was selected as the inlet device and a U-shaped tube as the outlet. Next, a relationship between IV-roller location (the mechanism that controls flow rate) and perfusion was determined.

Final tests showed that while this design can establish the perfused environment – the inconsistent flow from the IV required that perfusion values be calculated as an average over the testing period. The design concept, however, could be adapted to different phantom tissues that would require greater flow rates of blood – and thus a more consistent stream. This would ensure a static perfusion value over the duration of the test.