**Comparing Healthy and Diseased Vascular Networks to Better Understand Pathologies**

***Abstract***

***Introduction***

By recognizing the self-similarity in vascular systems, relationships can be recognized between vessel characteristics at different levels of the network's hierarchy. These relationships are significant in analyzing vascular systems as a whole and recognizing differences between the diseased state of a system versus the healthy state of a system. Observations about vascular networks are also important in research pertaining to drug delivery, tumor growth, and stroke recovery.

The WBE model suggests that metabolic rate is a function of body mass with a scaling exponent of 3/4. The model rests on eight assumptions, and is useful in determining relationships between radii of a vascular network and length of a vascular network. The framework assumes that vessels within the same level of hierarchy are equivalent, meaning they share the same radius, length, and flow rate. The model also assumes that the vascular network is space filling, meaning every capillary feeds a group of cells. This relationship can be useful in calculating scale-free ratios, by recognizing that total blood volume is proportional to the sum of the service volumes at each level of the vascular network. These assumptions lead to the conclusion that scaling exponents for radius and length at different hierarchies of a vascular network can be used to find information about an averaged network. By analyzing real data, we recognize that many of the assumptions made in the WBE model neglect some characteristics of real vascular systems, for example, loopy veins and asymmetry. Four current methods, based on the assumptions of the WBE model, can be used to determine the scaling exponents for radius and length. Scaling exponents can be calculated using the conservation-based method, the ratio-based, the distribution-based method, and the regression-based method.

Prior methods of vascular extraction are inefficient and time consuming. By utilizing image processing, we are able to generate data about the radius and length of the vessels in a vascular system. This paper first attempts to validate the methods for vessel extraction from 3D vascular images. We compare data from two versions of software, which use different methods to process the images, to see which software is preferable.

Using software to extract data from 3D vascular images, we can compare the characteristics of diseased systems to healthy systems. The original framework fails to recognize loopy veins, which are prevalent in subjects who are undergoing stroke recovery. By acknowledging the gaps in the original model, we can improve the assumptions of the model and better understand real vascular networks. Using methods to calculate scaling exponents and comparing data from healthy systems to that of diseased systems, we recognize relationships that can lead to further knowledge on how to treat these conditions.

***Methods***

***Results***

***Discussion***