# Summary Report for Research Allocation wd_vdmf01: Modeling Vascular Damage Caused by Radiation

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## 1 PI Information

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## 2 Allocation Summary

Vasculature is critical to supporting all the members of the animal kingdom. Without this network of blood vessels, the cells that make up the body would be deprived critical oxygen and nutrients necessary for survival. While much is known about the physical processes involved in blood transport through these vessels, we typically limit the studies to small regions of the body. This work looked to model the blood flow through each vessel of the 20 billion vessels in the human body.

This allocation supported the development of the algorithms necessary to complete this daunting task. We successfully developed a two-step approach to calculating the blood flow in the vessels. We also demonstrated that the computations are feasible for up to 8 billion vessels. The results from this work will be used as preliminary results for future grants and computation resource proposals for future improvements to the algorithm, increasing the physical accuracy of the algorithm.

## 3 Potential Applications

This work has many potential applications. These applications include medical applications including: drug delivery or discovery, radiation therapy simulations, traumatic brain injury, cardiovascular disease simulation, and stroke modeling. This model enables future researchers to better understand the systemics of changes in vasculature. Additionally, this may be of interest to individuals study physiological outcomes of drugs, such as war fighter performance.

## 4 Education Impact

This allocation has enabled the education of a doctoral student (William Donahue). During this allocation, time was spent learning distributed software design, scientific computing, and high-performance computing.

Additionally, the student learned about multiple computer science topics such as data structures, algorithm design, and project and data management.

## 5 Publications and Presentations

There were 2 poster presentations based upon the work outlined here. Citation information was:

Donahue W. & Newhauser W. "Towards a Multiscale Model of Vascular Dose for the Whole Brain"

It was presented at:

- American Association of Physicists in Medicine Annual Meeting. 2017. Denver, CO
- 63$^{rd}$ Annual Meeting of the Radiation Research Society. 2017. Cancun, Mexico.

Additionally, this allocation provided data to support 3 manuscripts that are currently in preparation:

Donahue W. & Newhauser W. "Toward a Complete Computational Model of the Vasculature of the Whole Human Brain"

Donahue W. & Newhauser W. "First Computation of Blood Flow Through Entire Body"

Donahue W. & Newhauser W. "Validation of First Computation of Blood Flow Through Entire Body"