**BME 214L Carotid Artery Simulation Planning**

This document is to help you organize and plan your research, analysis, and writing your technical memorandum. There doesn’t need to be a lot of wordiness on this document – just enough to collect the ideas you need to write about. You may need to add some lines to each of the tables below to capture everything needed. You should use a reference manager like Mendeley for this document so that you already have your research ready for the tech memo. Under the Reference column in each table, you can include the citation – just use IEEE format[1] so it’s easy to read; at the bottom of the document, include your bibliography of all the sources you cited.

What are the medical concerns associated with carotid artery disease?

|  |  |
| --- | --- |
| **Concern** | **References** |
| Stroke | [1] |
| TIA / Limb Shaking | [1]–[3] |
| Cognitive Impairment | [4], [5] |
| Hypertension | <https://www.ahajournals.org/doi/abs/10.1161/01.STR.18.5.817> |

List each of the concerns from your table above in the table below. For each concern, describe how the fluid mechanics either play a part in causing the problem, or how the fluid flow might be affected by the problem. Some of the medical concerns listed may not have much to do with fluid mechanics, so you can state that.

|  |  |  |
| --- | --- | --- |
| **Concern** | **How fluid flow contributes or is impacted** | **References** |
| Stroke | Blood flow dislodges plaque build-up and brings plaque to smaller vessels in the brain | [6] |
| TIA/ Limb Shaking | Repeated reduced blood flow to brain |  |
| Cognitive Impairment | Blockages lower blood flow, lowering mass flow to the brain, restricting necessary macromolecules for proper functioning from reaching the brain. | [7] |
| Hypertension | Increased high blood pressure, increased higher local pressure, decreasing elasticity towards arteries | <https://www.ahajournals.org/doi/full/10.1161/01.STR.31.3.782> |

What are the specific fluid mechanics parameters that are associated with each concern you identified (velocity, pressure, mass flow rate, density, shear stress, etc)?

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| --- | --- | --- |
| **Concern** | **Fluid mechanics parameter** | **References** |
| Stroke | Sheer Stress | [8] |
| TIA |  |  |
| Cognitive Impairment | Mass Flow Rate | [7] |
| Hypertension | Pressure |  |

For each fluid mechanic parameter listed above, what is the cutoff value between “OK” and “bad, we need to intervene”

|  |  |  |
| --- | --- | --- |
| **Fluid mechanics parameter** | **Value or indication of a “bad” condition** | **References** |
| Sheer Stress | @Wall: Rupture: 56.2 +/- 30.6 Pa => below 55 Pa is concerning | [8] |
| Pressure | Pressure >/= 140 mmHg, 70-100 mmHg, 78.1 mmHg | <https://www.ahajournals.org/doi/full/10.1161/01.CIR.101.3.329> |
| Mass Flow Rate | ICA: 351 ± 109 ml/min is severe => below 375 ml/min is concerning | [9] |
|  |  |  |

For each fluid mechanic parameter listed above, what is the best way for you to evaluate or demonstrate how that parameter is impacted by the modeled blockages? Pick graphs, charts, tables, pictures, or something that best highlights those parameters for each of the different blood vessel geometries. Be very specific in your description (specific doesn’t mean wordy; specific means sufficient detail). Envision figures that visibly and convincingly communicate that a blockage of a certain amount requires immediate repair.

|  |  |
| --- | --- |
| **Fluid mechanics parameter** | **Chart, table, graph used to demonstrate** |
| Sheer Stress | Surface plot, shear stress at wall only important. |
| Pressure | Surface plot |
| Mass Flow Rate | Cut plot |
|  |  |

**Bibliography**

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[2] M. Knoflach *et al.*, “Prognostic relevance of limb shaking in symptomatic carotid artery occlusion,” *Cerebrovascular Diseases*, vol. 32, no. 1, pp. 35–40, Jul. 2011, doi: 10.1159/000326076.

[3] S. Mazzucco *et al.*, “Cerebral hemodynamic effects of early blood pressure lowering after TIA and stroke in patients with carotid stenosis,” *International Journal of Stroke*, 2022, doi: 10.1177/17474930211068655.

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[6] J. A. Madden, “Role of the vascular endothelium and plaque in acute ischemic stroke,” *Neurology*, vol. 79, no. Issue 13, Supplement 1, pp. S58–S62, Sep. 2012, doi: 10.1212/WNL.0b013e3182695836.

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[8] K. Kojima *et al.*, “High Wall Shear Stress Is Related to Atherosclerotic Plaque Rupture in the Aortic Arch of Patients with Cardiovascular Disease: A Study with Computational Fluid Dynamics Model and Non-Obstructive General Angioscopy,” *J Atheroscler Thromb*, vol. 28, no. 7, p. 742, Jul. 2021, doi: 10.5551/JAT.56598.

[9] N. Ackroyd, R. Gill, K. Griffiths, G. Kossoff, and M. Appleberg, “Quantitative common carotid artery blood flow: Prediction of internal carotid artery stenosis,” *J Vasc Surg*, vol. 3, no. 6, pp. 846–853, Jun. 1986, doi: 10.1016/0741-5214(86)90148-5.