A model for predicting stroke outcome based on circulating lymphocyte profiles

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# Background

Globally stroke has the second largest mortality rate and is a leading cause of physical and mental debilitation. It is the third most common cause of death in China with approximately 1.57 million deaths in 2018 [(Wang et al., 2020)](#1), over 700,000 cases are observed every year in the United States of America with 165,000 of those cases leading to death (Ingall, 2004), and 1 in 5 people in Ireland will suffer a stroke in their lifetime (Stroke - Irish Heart, n.d.). The statistics back the idea that more research is required, because the human race is living longer as medicine improves and with stroke victims typically being over the age of 65 years old, the probability that one will suffer a stroke increases. Bushnell et al. in 2014 published a paper that claims that every 10 years over the age of 55 years old, the probability that one will suffer a stroke doubles. However, age is not the only factor that has an effect on the chances of a stroke occuring. Currently, obesity is a leading factor that causes stroke in young people. Some papers found that children as young as 15 years old have suffered a stroke (George, Tong, Kuklina and Labarthe, 2011) due to conditions obtained from obesity such as hypertension, diabetes, and atherosclerosis.

Stroke is a very prominant and fatal condition in modern society. With the population living longer and child obesity becoming a considerable threat, it is vital for medicine to be equipped with tools such as Machine Learning (otherwise known as Artifical Intelligence, or AI) algorithms to predict the outcomes of stroke based on a set of features, such as lymphocyte profiles, which may help alleviate pressures on healthcare systems, and fortify the medical professional’s opinion which, ultimately, would provide a better and more accurate healthcare service.

## What is stroke?

Like every other organ in the human body, the brain requires a specific supply of oxygen to maintain optimal function. If the brain has an insufficient supply of oxygen, brain cells such as neurons, oligodendrocytes, and astrocytes begin to die (infarction). These cells are vital for the function of the brain, as they send signals to other organs to activate their respective function. There are two main causes of stroke:

1. Ischemia – This is defined as “the inhibition of blood supply to the brain”. This is typically caused by a blood clot. A blood clot, or thrombosis, occurs when the inflammatory system reacts normally to a bleed. Platelets in the blood aggregate when haemorrhaging is detected, and the aggregate acts like a “plug” to inhibit the bleed. However, in certain conditions a false-activation of this system occurs leading to a blood clot within the artery, in the absence of haemmorhaging. This causes an occlusion of the vessel which denies vital organs blood supply, and if the carotid artery, which is connected to the brain, is blocked, then the patient will have a stroke.
2. Haemorrhaging – This is also know as a bleed. When the integrity of a blood vessel is compromised and the blood flows out of the circulatory system into other tissues, the blood cannot reach its intended destination. This leads to a lack of oxygen reaching vital organs, such as the brain i.e the carotid artery cannot transport blood to the brain as there was a haemorrhage earlier in the circulatory loop.

There are certain conditions that increase the likelihood that the two different kinds of stroke occur. These include; high blood pressure (clinically known as hypertension), high cholesterol, irregular heart beats (clinically known as atrial fibrillation), and diabetes, all of which are associated with obesity (National Health Service UK, 2019).

### Hypertension and Vascular Disease

There is a strong link between hypertension/high blood pressure and cardiovascular diseases. The cardiovascular system is also known as the circulatory system, this system is made up of arteries that deliver oxygenated blood to the organs, veins that deliver deoxygenated blood from the organs and returns is to the lungs, and capillaries, small vessels usually organised in a network with this cell walls that allow the passage of oxygen in-and-out of the organ. A study as early as 1948 found that 65% of death from cardiovascular disease, like myocardial infarction (also known as heart attack) were in the untreated hypertensive cohort. This link has been well documented and further diseases and conditions now stem from high blood pressure (Doyle, 1991). The reason hypertension is linked will be elaborated below.

### High fats diet

High blood pressure occurs due to the narrowing of blood vessels. The formula for pressure is as follows:

P: Pressure

F: Force

A: Area

As the area of the lumen within the vessel narrows (Area gets smaller) the value for P (Pressure) increases as there is the same force over a smaller area. But how does a lumen narrow?

Lipids are one of the core components found in biological entities. Lipids are vital in normal cell process and are required for energy, building cell structures, and insulation. However, too much of a lipid known as cholesterol can have detrimental effects. The Low-density Lipoprotein cholesterol (which is made up of saturated- and trans-fats) can deposit in the cell walls of the valves, which is referred to as plaque build-up, in a process known as atherosclerosis, defined as “the hardening of the arteries” (Arnett et al., 2019). This hardening narrows the lumen, hence, causing hypertension. With the artery now narrowed, it is much easier for the inflammatory system to falsely-activate the clotting cascade and only a micro-thrombi may be required to block the artery which would lead to a stroke.

### Atrial fibrillation

Asdfasd

### Diabetes

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