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Understanding Stroke in Dialysis and Chronic Kidney Disease

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Abstract

Patients with severe kidney failure need to be carefully monitored. One of the many treatments is called Continuous Ambulatory Peritoneal Dialysis (CAPD). This kind of treatment intends to maintain the blood tests as normal as possible. Data Mining and Machine Learning can take a simple and meaningless blood's test data set and build it into a Decision Support System. Through this article, Machine Learning algorithms will be explored with different Data Mining Models in order to extract knowledge and classify a patient with a stroke risk or not, according to their blood analysis.

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1. Introduction

Patients with Acute Renal Failure (ARF) can't live without the dialysis treatment. Dialysis is the procedure of removing all the waste substances and water from the blood using artificial machine that works similar as a kidney¹. The most popular types of dialysis are Hemodialysis and Peritoneal. This article is focused on a blood test's data set of patients with peritoneal dialysis. Peritoneal Dialysis is a treatment where the patients must place about two quarts of cleansing fluid into their belly and later drain it. Nowadays, 11 % of the Europe's dialysis patients, are undergoing Continuous Ambulatory Peritoneal Dialysis (CADP) treatment². These patients are dependent of this treatment and can't live without it. So, monitoring this patient's and know if everything is under control is extremely important.

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Machine Learning and Data Mining are two revolutionary features of Decision Support Systems in Healthcare. But, how will a dataset predict a patient from a stroke risk? When we are faced with a situation where the kidney is injured, all values related to glomerular filtration are modified. Some blood analysis may influence each other. For example, when a patient has high creatinine and high calcium, it's likely to have high urea's values as well.

The main objective of this current paper is to determine through patient's information and blood analysis, what is the risk of a patient to suffer stroke risk, knowing that dehydration that is directly related to stroke risk, which can happen when the BUN/CR ratio is superior to 15 on older patients. In this article, it will be explained all the phases to predict stroke risk: The Business Understanding and Data preparation will be referenced, the different models used will be exposed, and finally the data mining techniques will be compared and carefully analyzed, concluding which one is the best and the reason why. In this article, the algorithms with the best results were IBK and Random Tree. Data Mining is one of the processes of machine learning. It takes a meaningless from a big data set, pre-processes it, understands it and finally analyzes patterns, turns them into useful information and even predicts and classifies. Data mining tools predict future behaviors, allowing medical teams to make proactive decisions³. Data mining is a huge advantage in healthcare. Some experts believe the opportunities to improve care and reduce costs concurrently could apply to as much as 30% of overall healthcare spending⁴. A Clinical Decision Support System is a system design to provide a decision support for the medical team. A Decision support system is helpful and reminds the staff members, patients or others to knowledge a certain condition with intelligently, automatically, filtered information and presented at appropriate times, to enhance health and health care⁵. This decision support system also helps to decrease the number of Medical errors, because the staff team is more informed.

In this case, it is extremely important to take blood tests as input and output all the important diagnosis that should be considered by the doctor. It saves time for the medical team, and it can prevent a worse situation. For example, in this article, all the patient's that have a stroke risk, are diagnosed by simple machine learning classification's algorithm. This helps the doctor to understand that these patients should be more monitored.

2. Background and Related Work

Urea is connected directly with digestive and urinary systems. Urea is a waste molecule of the processes of protein digestion. At the end, it is carried by bloodstream to the kidney, where is excreted in urine. Creatinine on the other hand is a waste of muscle activity and it also is expelled by the human body through kidney's filtration. In this study, all the patients have kidney failure, which means that the urea and creatinine will not be properly expelled through urine. In these cases, dialyses is the only method that can helps to decrease Urea's and Creatinine's blood values. However, most of the times it isn't enough, so these patients need monitoring to make sure they are most of the times in non-dangerous values. Any BUN and Creatinine ratio value above 15 is considered dehydration⁶. Dehydration is one of the main causes of stroke risk in patients. It is associated with acute cerebral infarction⁶. A study done in an hospital discovered that patients with the ratio value's above 15, with age's above the 64 years old, and with acute ischemic stroke (AIS) have a big percentage of stroke risk than other patients who don't have this factors⁶. The data set doesn't give any information about the AIS, but it gives information about the other remaining factors. All the patients that are above 64 years old and have a ratio of Bun and creatinine above 15, should be monitored and be seen by a specialist to make sure they don't have AIS as well.

2.1. Related Work

Nowadays is more and more important to improve healthcare services. One of the ways is to predict bad situations to happen. Some works about data mining in healthcare field have been done during the last few years. It's the case of the article of 2014 "*Preventing patient cardiac arrhythmias by using data mining techniques*"⁷. This article explores data mining to prevent a patient cardiac Arrhythmias through a database with old cases. This study is important in healthcare services because it predicts Cardiac Arrhythmias with a 95% of Sensitivity, showing that Data Mining models are very useful for supporting the decision making process and for preventing future critical events such as Cardiac Arrhythmia. This study used the CRISP-DM approach to test each algorithm with different scenarios.

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