Application of ML techniques for the analysis of hypertension and prediction of vein function in hemodialysis

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Domain

Artificial Intelligence-Machine Learning

Abstract

Millions of patients worldwide suffer from Kidney failure and require dialysis. In most cases, dialysis is started after the kidney function of the patient falls below a threshold. In this scenario the patient's kidney is essentially non functional. In order to conduct dialysis, native arteriovenous fistulas are constructed to increase blood flow in the superficial vein, and hence facilitate dialysis. Over time, as dialysis continues, the patient may suffer from hypertension and reduced vein function leading to the collapse of the fistula. The ultrasound doppler test for checking the state of the fistula is expensive and doing it again and again is not feasible. The proposed work explores the Chronic Kidney Diseases and proposes a mechanism that uses optimised data points to predict health of fistula.

Problem Definition

Predict the state of the native arteriovenous fistula considering several attributes like venous pressure, arterial pressure, systolic blood pressure, diastolic blood pressure, heart rate, etc

Literature Survey

A lot of research has been done in the field of dialysis. The focus lies in various methods and techniques involved in identifying Chronic Kidney Disease.

Manoj Reddy et al, in their paper deal with the identification of Chronic Kidney Disease using Machine learning techniques. This paper suggests trends in algorithms used. It does not specify the parameters considered. It specifies 6 different classification algorithms that were used to compare them. Of the algorithms used, SVM with linear kernel gives the highest accuracy of 98 percent.

Enes Celik et al, in their paper look to achieve the same goal but only using Decision trees and SVM. In this scenario, Decision trees and SVM give an accuracy of 97%-100% and 100% respectively. The results are based on the population of 250 patients with CKD and 150 healthy patients. Sequential minimal optimization and J48 was used for decision tree using WEKA and the dataset considered had 25 distinct parameters.

BV Ravindra et al, in their paper try to find significant parameters in kidney dialysis sets using the K-means algorithm. It relies on classifying parameters into ranges such as medium, low and high to further aid with clustering. This paper mainly focused on identifying survival period of patient undergoing dialysis using clustering techniques. In this scenario, creatinine plays an important part and it is found that patients with a level of creatinine which is either high or low suffer from adverse effects.

Jeffrey Navarro Rojas et al, deal with the effects of dialysis to the quality of life of a patient. It shows the results of a survey of patients undergoing hemodialysis. Starting hemodialysis involves a significant lifestyle change and can have a lot of effects on a patient's physical and mental health. Care needs to be taken that changes are not averse. The paper was restricted to specific region and results could not be generalized.

Based on the manual of the Nipro Surdial 55 Plus, a common dialysis machine, it is observed that it outputs a variety of factors on its display, updating second on second. Most of this data is considered in the present and not stored. However, the same can be done since the machines allow backup to a database.

Looking at all the related work it was identified that identification and classification is an important aspect of work in the field of dialysis. However, there is a need to provide for forecasting and prediction of life of arteriovenous fistula by making use of state of the art techniques such as Machine Learning and Big data.

The research papers surveyed and interactive sessions with nephrologists have furthered our understanding of the dialysis process and its subprocesses and motivated us to come up with relevant factors to be considered in relation to health of the fistula and work on the proposed problem statement.

Proposed Architecture with modular description

The various blocks that are implemented in the proposed system to predict life of arteriovenous fistulas are shown in the figure 1. The modules in the system are as follows:

a) Personal and Clinical Factors
b) Analysis of information
c) Prediction
d) Reports

The proposed system was envisioned after considering the data set of 200 patients. Firstly, normalcy was defined in the dataset and then the resulting data set was compared. Of the 200 patients 35 had normal functioning of arteriovenous fistula while the remaining had reduced function. 5 dialysis sessions were included for each patient to avoid any case of operator error.

The dataset comprises of over 30 values reported by the machine. Some of them are:

a) Dialysis flow
b) Blood flow
c) Arterial Pressure
d) Venous Pressure
e) Ultrafiltration speed
f) Heart rate
g) Trans membrane pressure
h) Total Ultrafiltration speed
i) Blood pressure
j) Target kT/V

There are four distinct modules need to be developed in the system in order to effectively predict the life of arteriovenous fistula:

Personal & Clinical data: This module takes in data which is being output from the dialysis

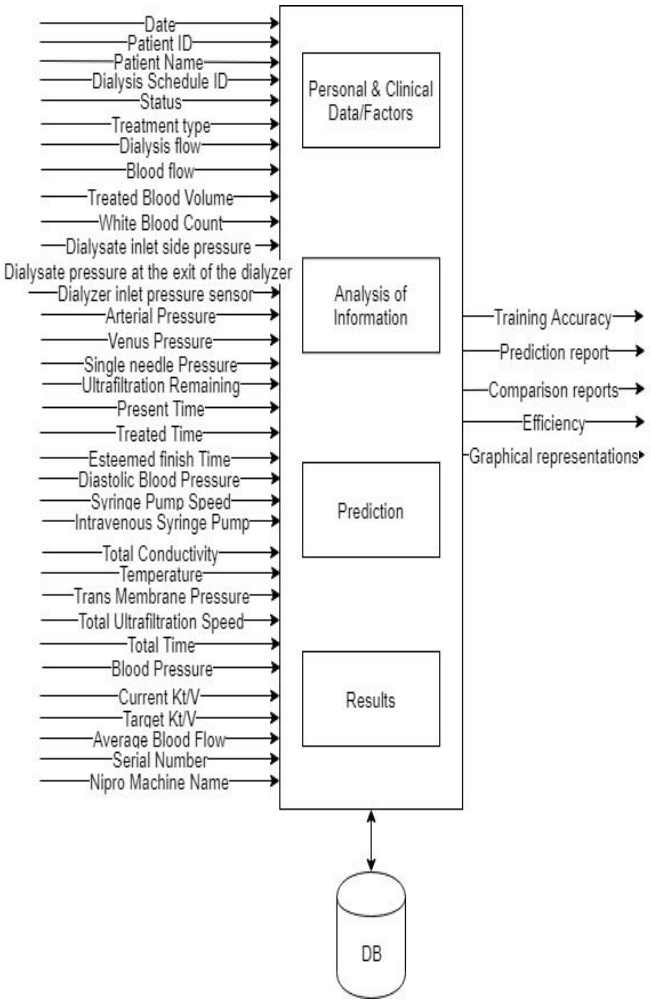

Fig 1: Architecture for the proposed system

machine and stores it within a database after segregating it based on the type of data. Data may be divided into the categories - personal, clinical or miscellaneous.

Analysis of Information: This module will take in data from the database, create graphs based on the same and analyze them to see which factors are significant in predicting health of fistula

Prediction: This module will consider the following algorithms: SVM, RFC, MLP. We will check their efficacy on the data at hand. Based on

the efficiency new algorithms may be developed to improve accuracy of the system.

Results: In this module, comparison of the predicted value of the state of fistula with the actual condition is performed to calculate the accuracy of the system and generate reports to track performance of the system.

Expected Outcome

The expected outcome comprises of a report consisting of all the factors considered for predicting the state of arteriovenous fistula, state of the fistula, comparative study of the accuracy of the algorithms used, graphical representations of accuracy, prediction, false positives and false negatives. The patient will be sent for an ultrasound doppler test only if the report states his/her fistula as an unhealthy fistula .