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Diabetic Nephropathy Detection Using Bayesian Approach

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Abstract – Diabetic nephropathy is a disease which affects the kidney leading to end stage renal disease. This problem occurs in patients affected by type2 diabetes. The initial stage of clinical study consisted of microalbminuria which is a protein that is released in excess amount in patients affected by diabetic nephropathy. This research work aims at analyzing the risk factors involved in causing diabetic nephropathy using Bayesian classifier. The risk factors such as hypertension, hyperlipidemia, obesity, sedentary life style, urbanization and changing diets are analyzed and their probability in causing diabetic nephropathy is analyzed. Bayesian classifier is used to provide a decision support system to monitor the status about the health of patient and reduce the risk of creating nephropathy. The implementation is carried out using MATLAB and the risk is classified as low and high based on the probability.

Keywords: Bayesian classifier; Nephropathy; Type2 diabetes; Probability, Decision Support System

1. INTRODUCTION

Detection of kidney disease is not an easy task which could not be done with the knowledge gained from textbook or classroom[1]. Patients will be having varying symptoms and based on that the severity of the disease will be diagnosed and treatment will be done for it. The main cause for diabetic nephropathy is diabetes mellitus[2]. Diabetes is the occurrence of disease in exocrine gland that's placed behind the abdomen. The major supply of energy for the human cells is glucose which is generated from the food taken by the humans[3]. Insulin supports glucose to enter the cells wherever it's regenerated into energy kind. In diabetes, the exocrine gland either cannot turn out enough hormones or cannot use hormone properly. Glucose levels within the blood increase, once there is an improper functioning of the hormone due to which the glucose will not be supplied to the human cells and the cells will remain idle[4].

Diabetes is classified into two types: Type1diabetes and Type2 diabetes. In Type1 diabetes insulin will not be generated by the body[5]. As a result the pancreatic cells that produce insulin will be destroyed by the immune system. In Type2 diabetes, the body loses its ability to respond to insulin. People with Type2 diabetes have a high risk of getting diabetic nephropathy when compared to Type1 diabetes. There are certain risk factors in type2 diabetic patients which should be assessed to detect the occurrence of diabetic nephropathy.

The major risk factors include urbanization, sedentary life style, obesity, poor diet, hypertension, and high blood pressure[6]. Premature coronary artery disease occurs in women, especially with diabetes where the major risk factor for this disease is micoalbuminuria. The core idea of this paper is to use Bayesian classifier in classifying the risk factors of nephropathy especially in diabetic patients[7][8]. This provides a decision support system to reduce the death rate and to provide a full-fledged quality of life for people with type2 diabetes.

2. RELATED WORK

Images of patients affected with diabetic nephropathy can be categorized by using an image mining framework. An open source data mining tool called Rapid Miner is used for the classification of risk factors for diabetic nephropathy. Biopsy images can be considered for the analysis and detection of obstructive nephropathy which can be analyzed in three stages: First part will be block based segmentation, second part will be characterization of image using Random Forest Classifier, and finally with the development of a scoring system.

The deployment of web application in data mining field has been increasing rapidly. Necessary resources and medical image processing algorithms for the implementation of this project are provided through the INBIOMED platform. It provides different morphological operators and filters and various segmentation methods. Biomedical image mining functionalities are provided open access through Web Service framework.

3. BAYESIAN CLASSIFIER

A supervised learning technique and a geometric means of classification is represented by using the Bayesian Classifier. It assumes a fundamental probabilistic model and permits us to confine improbability regarding the model in an honorable way by determining probabilities of the outcomes. Diagnostic and predictive problems can be solved with the help of Bayesian classifier.

Bayes' Theorem laid the basic foundation for Bayesian classification. Bayesian classifiers are the statistical classifiers. Probabilities are classified into two types: (1) Posterior probability [P(A/B)] and (2) Prior Probability [P(A)] where B is the data tuple and A is some hypothesis. Joint conditional probability distributions are represented by using the Bayesian Belief Networks. Moreover, the Bayesian classifiers use directed acyclic graph to represent random variables. Bayesian networks are mainly used for analyzing and detecting the risk involved in diabetic nephropathy.

A simple probabilistic classifier called as Naive Bayes classifier based on Baye's theorem with strong independence assumptions between the features is used. A Bayesian network N is defined by using, N=(S,μ):
The random variables used in Bayesian classfier are represented as follows:

- G= {G_1, G2, G3, --------, Gn}.
- S=(G,H), directed acyclic graph (DAG),where variable Y is assigned to each of the nodes.
- μ = {μi} = P(Gi/Pa(Gi)), set of probability distributions for each node Xi conditionally on its immediate parents in the graph G.

P(G1, G2, ------, Gn) =$^{n}\Pi_{i=1}$ P(Gi/Pa(Gi)) **(1)**

4. BAYES THEOREM

Assume two events R and S such that P(R)≠ 0 and P(S) ≠ 0, we have:

$$P(R/S) = \frac{P(S/R)\,P(R)}{P(S)} \quad \textbf{(2)}$$

Assuming the n mutually exclusive and exhaustive events R1,R2, R3,-------,Rn, such that for all i: P(Ri) ≠ 0 with 1≤ i ≤ n, we have:

$$P(Ri/S) = \frac{P(S/Ri)\,P(Ri)}{P(S/R1)P(R1)+--+P(S/Rn)P(Rn)}$$

5. IDENTIFICATION OF RISK FACTORS

The intention of this research work is to classify the risk factors having major contribution leading to the end stage renal failure in kidney. These risk factors are analyzed in patients having type2 diabetes. The risk factors are as follows:

RISK FACTOR	DESCRIPTION
BP	Blood Pressure
UD	Unbalanced Diet
OB	Obesity
HG	Hyperglycemia
GS	Genetic Susceptibility
SB	Systolic Blood Pressure
PU	Proteinuria
Kp	Nehropathy

Table 1. Risk factors of diabetic nephropathy

6. CALCULATION OF PRIORI PROBABILITIES

RISK FACTOR	DESCRIPTION
P(BP)	Probability of people with high blood pressure
P(UD)	Probability of people following an unstable diet
P(OB)	Probability of people with obesity
P(HG)	Probability of hyperglycemia knowing genetic

	susceptibility and obesity
P(GS)	Probability of people with genetic susceptibility
P(SB)	Probability of hypertension knowing blood pressure and unbalanced diet
P(PU)	Probability of people with high rate of proteinuria
P(Kp)	Probability of people with kidney disease

Table 2. Description of probabilities

7. RESULTS AND DISCUSSION

The probability of various risk factors against diabetes are calculated as shown in the below table.

Factors of Risk	**Calculation of probability value**	**Risk Factor Value**
RF1	P(Kp=T,|D=T, PU=T, UD=F)	0.43913
RF2	P(Kp=T,|D=T, HT=F)	0.26413
RF3	P(Kp=T,|D=T, HG=T, BP=F)	0.80432
RF4	P(Kp=T,|D=T, OB=F, BP=V)	0.61905
RF5	P(Kp=T,|D=T, HT=T)	0.860021
RF6	P(Kp=T,|D=T, PU=F,UD=T)	0.512023

Table 3. Risk of nephropathy based on probability value

The probability of various risk factors are calculated and based on that, it is clear if hypertension is not present then the risk of nephropathy is minimum(R2), whereas the risk is high(R5) in the presence of hypertension. This result shows the use of Bayesian classifier in assessing the risk factors for early diagnosis of diabetic nephropathy.

8. CONCLUSION

Type 2 diabetes is a disease, which should be predicted in its early stages which results in some future complications. Bayesian approach is used for classification of risk factors that produce diabetic nephropathy in type2 diabetic patients. The risk factors classified and results demonstrated are more accurate for nephropathy risk. Future work includes classification of risk factors based on real time data set.

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