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COMPARATIVE ANALYSIS OF DECISION SUPPORT SYSTEM FOR HEART DISEASE

RAJNEESH KUMAR[1] AND POOJA RANI

ABSTRACT. Health resources in developing countries are limited. So, efficient utilization of these resources is necessary. Limited medical staff is a challenge faced by many countries. Heart Disease is a critical disease that is usually not detected in the initial stages. Using the Decision Support System (DSS), heart disease can be diagnosed in a cost-effective way and in a timely manner. Several researchers have proposed different methods for prediction of heart disease using machine learning techniques. This paper provides an insight into the need and a variety of issues and challenges to use decision support systems to predict heart disease.

1. INTRODUCTION

The heart is the most important part of the human body responsible for pumping oxygen-rich blood to other body parts through a network of arteries and veins. In heart disease, the heart is not able to supply enough oxygen-rich blood to the organs of the body that can cause a heart attack. Different factors can contribute to heart disease and a person suffering from it can have various symptoms. The decision support system, also known as DSS, is a system that helps in the human decision making process. It helps in making the right decisions and improving the quality of decisions [1].

[1]*corresponding author*

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DSS has three main Components:

(i) Data management subsystem.
(ii) Model base management subsystem.
(iii) Dialog generation and management subsystem.

Data management subsystem also known as DMS is responsible for storing the data which is required by DSS. The model base management subsystem also known as MBMS is responsible for analyzing the data to make decisions with the help of models. Dialog generation and management subsystem also known as DGMS is an interface between user and DSS.

This paper is structured as follows: Section 2 describes types, symptoms and risk factors for heart disease. Issues and challenges for heart disease prediction are described in section 3. Section 4 presents a comparative analysis of different DSS for heart disease prediction. The conclusion is discussed in section 5.

2. Types, Symptoms and Risk factors for heart disease

2.1. **Types of heart diseases.**

(i) **Coronary Artery Disease (CAD)**
In this disease blockage occurs in the arteries that supply oxygen-rich blood to the heart. Due to blockage in the arteries, required amount blood is not supplied to the heart and the heart gets less oxygen. Blockage occurs in the arteries due to plaque deposition in the arteries. Plaque is formed of cholesterol and calcium. Formation of plaque in arteries is known as atherosclerosis [1].

(ii) **Cerebrovascular Disease**
In this disease blockage occurs in blood vessels that supply blood to brain. The brain gets less oxygen and nutrients due to reduced blood supply. It leads to damage of brain cells. It can also cause damage of brain permanently. This condition is called stroke. Bleeding inside the brain causes an intracerebral stroke. Bleeding between the brain and the tissue that envelops the brain causes a subarachnoid stroke [2].

(iii) **Peripheral Artery Disease**
In this disease, there is a blockage in the arteries that supply blood to the limbs. Blockage reduces the blood supply to the limbs. It mostly affects the feet. The person may experience cramps in the calf muscles

and pain in the hips and legs. Patients suffering from this disease can be classified into three groups.10% to 30% of patients suffer from intermittent claudication.20% to 40% of patients suffer from atypical leg pain and 50% of patients are asymptotic patients [3].

(iv) **Congenital Heart Disease**
Children are mostly affected by Congenital Heart Disease. It occurs due to the improper development of structure in the fetus. This is a birth defect. 8 to 10 out of 1000 live births are affected by this disease. The exact cause of this disease cannot be identified. The use of drugs, alcohol during pregnancy and higher stress during pregnancy can also be a cause of this disease [1].

(v) **Arrhythmia**
Heart rate is not normal in this disease. The heartbeat is very slow or very fast. The heartbeat is produced by electrical impulses. These electrical impulses control the functioning of the heart. The abnormal rate of heartbeat is due to abnormal behavior of electrical impulses. Prolonged low oxygen supply to the heart can cause arrhythmia [4].

2.2. **Symptoms of heart disease.** Chest Pain is major symptom of heart disease. Chest pain occurs because of reduced supply of oxygenated blood to heart. This Condition is known as angina. Person can feel Breathlessness. Pain that travels from chest to any body part is also a symptom of heart disease. Dizzy Sensations, Vomiting and profound sweating are also symptoms of heart disease. The swelling of the feet and weakness of the physical body are also symptoms of heart disease [4].

2.3. **Heart disease risk factors.**

(i) **Gender**
The risk of CAD is higher in men while the risk of cerebrovascular disease is lower in women. CAD risk in women is lower due to the cardioprotective effects of estrogen. It also reduces atherosclerosis. Estrogen reduces with menopause therefore risk of CAD increases in females with age [5].

(ii) **Age**
With Age risk of CAD increases. However this factor is more relevant to women than men. With increasing age cholesterol and blood pressure

increases. In women increase in blood pressure with age is more than men [5].

(iii) **Obesity**
Obesity means an increase in body fat to such a level that it adversely affects health. One cause of obesity may be a low metabolic rate in a person leading to the accumulation of body fat. Another reason may be an improper lifestyle such as unhealthy dietary intake [5].

(iv) **High blood pressure**
If the blood pressure in the arteries becomes high then the arteries begin to narrow. There is a high probability of accumulation of plaque in narrowed arteries which increases the risk of heart disease.

(v) **Smoking**
Smoking causes blood vessels to constrict. Smoking increases the viscosity of blood, causing blood clots to form. Smoking causes a lack of oxygen in the blood [5].

(vi) **Diabetes**
People which suffer from diabetes have higher risk of suffering from heart disease. High glucose levels in blood may cause blood vessels to become stiffer which increases risk of heart disease [5].

(vii) **Unhealthy diet**
Unhealthy diet increases cholesterol which is the main reason of heart disease. Consumption of cholesterol more than body requirements leads to increase the levels of LDL (Low density lipoprotein). Increased level of LDL leads to accumulation of fat in the arteries [5].

(viii) **Physical Inactivity** An accumulation of plaque can occur due to physical inactivity. It is also a cause of heart disease [5].

3. Issues and challenges for heart disease prediction

Major issues and challenges in predicting heart disease are discussed below:

(i) The heart disease data set may contain missing values for some features. These missing values must be dealt with to make a correct prediction.

(ii) Researchers have faced the problems of imbalanced data. If the instances of one class are more compared to the other class then the data

becomes imbalanced. The model will not provide good performance if the model will be trained using an imbalanced dataset.

(iii) A data set may have irrelevant features that will reduce system performance. Many redundant features in the dataset are known as the curse of dimensionality that will slow down the model. Therefore it is necessary to reduce the dimension using some feature selection algorithms before training the model. Each feature selection algorithm can provide a different set of features for the same dataset so the selection of feature selection algorithms is a major challenge.

(iv) Attributes in training dataset can have different types or different level of values. Some attributes can have continuous values and some attributes can have discrete values. Continuous values may need to be converted into discrete values. Scaling may be required to bring the values of all attributes to the same scale.

(v) Performance measures sensitivity, specificity, and accuracy are measured on a particular dataset. Performance measures can have different values for different datasets.

(vi) Heart disease and other diseases may have the same symptoms. Identifying the correct disease based upon symptoms is not easy. Symptoms must be correlated for disease prediction.

(vii) There are many risk factors that contribute to heart disease. Identifying these factors is challenging.

4. COMPARATIVE ANALYSIS OF DIFFERENT DECISION SUPPORT SYSTEMS FOR PREDICTING HEART DISEASE

Different researchers have proposed different decision support systems to predict heart disease making use of various machine learning algorithms. Methodology used by different researchers in the prediction of heart disease is presented in Table 1.

Table 1: Methodology used by different researchers in the prediction of heart disease

S. No.	Author	Year	Methodology

1	M. Ilayaraja and T. Meyyappan [5]	2015	Risk factors of heart disease are predicted using the frequent itemset algorithm.
2	E. O. Olaniyi and O.K. Oyedotun [6]	2015	Performed diagnosis of heart disease using multilayer perceptron and SVM Kernel. The back propagation algorithm is used in a multilayer perceptron.
3	E. Miranda et al. [7]	2016	Detected risk of CVD using Naive Bayes classifier.
4	W. wiharto et al. [8]	2016	Used C4.5 algorithm to classify heart disease.
5	L.Verma et al. [9]	2016	Used CFS, PSO and K-means for feature selection. The classification was performed using MLP MLR, FURIA, and C4.5 algorithms.
6	M. A. Jabbar et al. [10]	2016	Used chi-square for feature selection and random forest for classification.
7	J.K. Kim and S. Kang [11]	2017	Performed detection of heart disease using neural network model.
8	Z. Arabasadi et al. [12]	2017	Used neural network to perform classification and genetic algorithm to set weights of the network.
9	X. Liu et al. [13]	2017	Used ReliefF and RS for feature selection and ensemble classifier using a C4.5 decision tree for classification.
10	A. Ul Haq et al. [1]	2018	Used LR, SVM, NB, ANN, DT and KNN for classification.
11	V. Poornima and D. Gladis [14]	2018	Used neural network for the classification of heart disease. LM and GSO are used to set weights of the network.
12	L. Ali et al. [15]	2019	Feature selection is performed using the chi square method. Classification is performed using deep neural network.

13	S. Mohan et al. [16]	2019	Feature selection is performed using a decision tree. Classification is performed using random forest and linear methods.
14	Y. Khourdifi and M. Bahaj [17]	2019	Used PSO and ACO for feature selection and SVM, KNN, MLP, NB, RF for classification.

5. Conclusion

Heart disease is the leading worldwide disease causing death. Timely detection of the disease can help in effective treatment and preventive measures. Although a decision support system may not be a replacement of a doctor but can still be very helpful in helping to make the right decision on time. The decision-making system proposed by various researchers is very effective for predicting heart disease, but there is great scope for improvement in the accuracy of existing system is future work.

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DEPARTMENT OF COMPUTER ENGINEERING
MAHARISHI MARKANDESHWAR (DEEMED TO BE UNIVERSITY)
MULLANA, AMBALA, HARYANA, INDIA
E-mail address: drrajneeshgujral@mmumullana.org

MMEC (RESEARCH SCHOLAR), MMICT AND BM (A.P.)
MAHARISHI MARKANDESHWAR (DEEMED TO BE UNIVERSITY)
MULLANA, AMBALA, HARYANA, INDIA