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Neural Network Based Approach in Identifying Cardio Vascular Disease- A Survey

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ABSTRACT
The heart circulatory system is composed of the heart and blood vessels, including arteries, veins, and capillaries. Our bodies actually have two circulatory systems: The pulmonary circulation is a short loop from the heart to the lungs and back again, and the systemic circulation (the system we usually think of as our circulatory system) sends blood from the heart to all the other parts of our bodies and back again. The heart gets messages from the body that tell it when to pump more or less blood depending on an individual's needs. When we're sleeping, it pumps just enough to provide for the lower amounts of oxygen needed by our bodies at rest. When we're exercising or frightened, the heart pumps faster to increase the delivery of oxygen. Cardio vascular disease affects the heart circulatory system and damages the heart circulatory system and damages the valves resulting in heart attack or heart failure. To avoid such a situation a clinical expert system is developed to identify CVD in advance and to reduce the level heart failure and death.

Key Word- **C**ardio Vascular Disease, Neural Network, Back Propagation Algorithm, Pattern Recognition, Risk Level

I. INTRODUCTION

A.Introduction to Neural networks

An artificial neural network is an interconnected group of nodes, akin to the vast network of neurons in a brain. Here, each circular node represents an artificial neuron and an arrow represents a connection from the output of one neuron to the input of another. In computer science and related fields, artificial neural networks are computational models inspired by animal central nervous systems (in particular the brain) that are capable of machine learning and pattern recognition. They are usually presented as systems of interconnected "neurons" that can compute values from inputs by feeding information through the network.

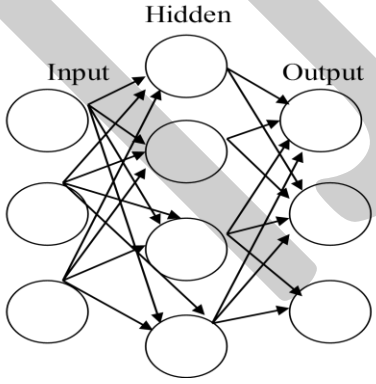

Fig.1 Artificial Neural Network

For example, in a neural network for handwriting recognition, a set of input neurons may be activated by the pixels of an input image representing a letter or digit. The activations of these neurons are then passed on, weighted and transformed by some function determined by the network's designer, to other neurons, etc., until finally an output neuron is activated that determines which character was read.

B. Use of Neural Network

Neural networks, with their remarkable ability to derive meaning from complicated or imprecise data, can be used to extract patterns and detect trends that are too complex to be noticed by either humans or other computer techniques. A trained neural network can be thought of as an "expert" in the category of information it has been given to analyze. This expert can then be used to provide projections given new situations of interest and answer "what if" questions. Other advantages include:

Adaptive learning: An ability to learn how to do tasks based on the data given for training or initial experience.

Self-Organization: An ANN can create its own organization or representation of the information it receives during learning time.

Real Time Operation: ANN computations may be carried out in parallel, and special hardware devices are being designed and manufactured which take advantage of this capability.

Fault Tolerance via Redundant Information Coding: Partial destruction of a network leads to the corresponding degradation of performance. However, some network capabilities may be retained even with major network damage.

II. CHALLENGES in identifying heart disease

From the various ECG characteristic points detected, 13 characteristic features were obtained from each beat of the ECG signal. The 13 characteristic features determined were:

- Heart rate – the interval between two successive QRS complexes, defined as the r-r interval (tr-rs) and the heart rate (beats/min), given as HR = 60/tr-r;
- Change in heart rate – the difference between two successive heart rates;
- QRS complex width – the duration between the QRS complex onset and offset;
- Normalized source entropy for the QRS complex – normalized source entropy determined for the part of the signal containing the QRS complex;
- Normalized source entropy for ST wave – Normalized source entropy determined for the part of the ECG signal containing the ST-segment;
- Complexity parameter for QRS complex – Lempel and Ziv temporal complexity parameter determined for the part of the signal containing the QRS complex;
- Complexity parameter for ST wave – Lempel and Ziv temporal complexity parameter determined for the part of the ECG signal containing the ST-segment;
- Spectral entropy – Shannon's spectral entropy determined for the entire beat;
- RT interval – time between the occurrence of R peak and T peak;
- ST-segment length – length of the ST-segment;
- ST-segment deviation – represented in binary as 1=elevation, −1=depression;
- ST-segment angle of deviation – the angle of elevation or depression of the ST-segment with respect to the base line; and
- ST-segment area – the area covered by the ST-segment and the base line.

III. NEURAL NETWORK BASED APPROACHES TO DEAL WITH HEART DISEASE

K.S.Kavitha*et al.* have studied about Coronary artery disease cause severe disability and more death than any other disease including cancer. Coronary artery disease is due to athermanous narrowing and subsequent occlusion of the coronary vessel. It manifests as angina, silent ischemia, unstable angina, myocardial infarction, arrhythmias, heart failure and sudden death. The term Heart disease encompasses the diverse diseases that affect the heart. Heart disease is the major cause of casualties in the world. Coronary heart disease, Cardiomyopathy and Cardiovascular disease are some categories of heart diseases. The term "cardiovascular disease" includes a wide range of conditions that affect the heart and the blood vessels and the manner in which blood is pumped and circulated through the body. Cardiovascular disease (CVD) results in severe illness, disability, and death. Narrowing of the coronary arteries results in the reduction of blood and oxygen supply to the heart and leads to the Coronary heart disease (CHD).

Myocardial infarctions, generally known as a heart attacks, and angina pectoris, or chest pain are encompassed in the CHD. A sudden blockage of a coronary artery, generally due to a blood clot results in a heart attack. Chest pain arise when the blood received by the heart muscles is inadequate. High blood pressure, coronary artery disease, vascular heart disease, stroke, or rheumatic fever/rheumatic heart disease are the various forms of cardiovascular disease. The World Health Organization has estimated that 12 million deaths occurs worldwide, every year due to the cardiovascular diseases. Half the deaths in the United States and other developed countries occur due to cardio vascular diseases. It is also the chief reason of deaths in numerous developing countries. On the whole, it is regarded as the primary reason behind deaths in adults.

Almost all the physicians are confronted during their conformation by the task of learning to diagnose. Here, they have to solve the problem of deducing certain diseases or formulating a treatment based on more or less specified observations and knowledge. The diagnosis of disease is a significant and tedious task in medicine. The detection of heart disease from various factors or Symptoms is a multi-layered issue which is not free from false resumptions often accompanied by unpredictable effects. With the complexity of information available from health care domain, human intelligence alone is not good enough to ascertain the proper diagnosis.

The problems associated with people involve in the diagnosis can considered broadly as not having very high accuracy in decision, shortage of expertise, difficulties in knowledge up gradation time dependent performance as shown in Fig.1. Because of these problems there is necessity to develop the expert system to provide the assistance mechanism in diagnosis procedure. A new insight about problem and requirement associated with health care solution has presented. To develop the intelligent solutions, support for artificial neural network has shown. Most of the developed solution utilized the feed forward architecture and back propagation as a learning algorithm. Because of trapping tendency in local minima, problem may appear at the time of up gradation and in result no consistency in result.

To overcome this problem a new way, genetic algorithm has applied for training purpose. Untold and unseen side of tournament selection has discovered. This will give a new meaning to understand the selection method. The primary intent of our research is to design and develop a model and design efficient approach for detection of heart disease, which can be utilized for real world applications as a computer aided diagnostic tool. With the presented research, in future we are going to develop an expert system for heart disease detection.

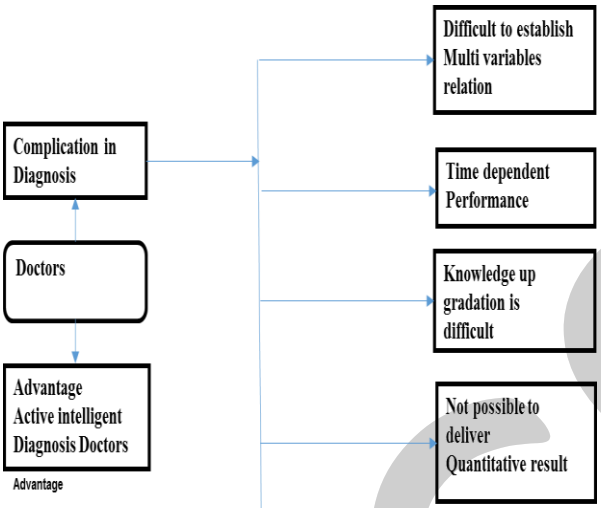

Fig.2Complexity diagnosis with doctor

M.Anbarasi*et al*. have studied about Clinical diagnosis is done mostly by doctor's expertise and experience. But still cases are reported of wrong diagnosis and treatment. Patients are asked to take number of tests for diagnosis. In many cases, not all the tests contribute towards effective diagnosis of a disease. The objective of our work is to predict more accurately the presence of heart disease with reduced number of attributes. Originally, thirteen attributes were involved in predicting the heart disease. In our work, Genetic algorithm is used to determine the attributes which contribute more towards the diagnosis of heart ailments which indirectly reduces the number of tests which are needed to be taken by a patient.

Thirteen attributes are reduced to 6 attributes using genetic search. Subsequently, three classifiers like Naive Bayes, Classification by clustering and Decision Tree are used to predict the diagnosis of patients with the same accuracy as obtained before the reduction of number of attributes. Also, the observations exhibit that the Decision Tree data mining technique outperforms other two data mining techniques after incorporating feature subset selection with relatively high model construction time. Naïve Bayes performs consistently before and after reduction of attributes with the same model construction time. Classification via clustering performs poor compared to other two methods.

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Resul das*et al*. had studied on Diagnosis of vascular heart disease through neural networks ensembles. In the last decades, several tools and various methodologies have been proposed by the researchers for developing effective medical decision support systems. Moreover, new methodologies and new tools are continued to develop and represent day by day. Diagnosing of the vascular heart disease is one of the important issue and many researchers investigated to develop intelligent medical decision support systems to improve the ability of the physicians. In this paper, we introduce a methodology which uses SAS Base Software 9.1.3 for diagnosing of the vascular heart disease. A neural networks ensemble method is in the center of the proposed system. The ensemble-based methods creates new models by combining the posterior probabilities or the predicted values from multiple predecessor models. So, more effective models can be created. We performed experiments with proposed tool.

We obtained 97.4% classification accuracy from the experiments made on data set containing 215 samples. We

also obtained 100% and 96% sensitivity and specificity values, respectively, in vascular heart disease diagnosis.

Robert F. Harrison*et al.* developed Artificial Neural Network Models for Prediction of Acute Coronary Syndromes Using Clinical Data from the Time of Presentation. Clinical and ECG data from presentation are highly discriminatory for diagnosis of acute coronary syndromes, whereas definitive diagnosis from serial ECG and cardiac marker protein measurements is usually not available for several hours. Artificial neural networks are computer programs adept at pattern recognition tasks and have been used to analyze data from chest pain patients with a view to developing diagnostic algorithms that might improve triage practices in the emergency department. The aim of this study is to develop and optimize artificial neural network models for diagnosis of acute coronary syndrome, to test these models on data collected prospectively from different centers, and to establish whether the performance of these models was superior to that of models derived using a standard statistical technique, logistic regression.

The study used data from 3,147 patients presenting to 3 hospitals with acute chest pain. Data from hospital 1 were used to train the models, which were then tested on independent data from the other 2 hospitals. From 40 potential factors, variables were selected according to the logarithm of their likelihood ratios to produce models using 8, 13, 20, and 40 factors. Identical data were used for logistic regression and artificial neural network models. Calibration and performance were assessed, the latter using receiver operating characteristic (ROC) curve analysis.

Although the performance of artificial neural network models generally increased with increasing numbers of factors, this was insignificant. The 13-factor model was therefore used for the rest of the study owing to its marginally improved calibration over the smallest model. Area under the ROC curve (with standard error) was 0.97 (0.006). The overall sensitivity and specificity of this model for acute coronary syndrome diagnosis using the training data was 0.93. ROC curves for logistic regression and artificial neural network models applied to data from the 3 hospitals were identical. For the 13-factor artificial neural network model tested on data from hospitals 2 and 3, area under the ROC curves (standard error) were 0.93 (0.006) and 0.95 (0.009), respectively. Investigation of the performance of the artificial neural network models throughout the range of predicted probabilities showed that they were well calibrated.

This study confirms that artificial neural networks can offer a useful approach for developing diagnostic algorithms for chest pain patients; however, the exceptional performance and simplicity of the logistic model militates in favor of logistic regression for the present task. Our artificial neural network models were well calibrated and performed well on unseen data from different centers. These issues have not been addressed in previous studies. However, and unlike in previous studies, we did not find the performance of artificial neural network models to be significantly different from that of suitably optimized logistic regression models.

Davut Hanbay*et al.* presented an expert system based on least square support vector machines for diagnosis of the vascular heart disease. There has been a growing research interest in the use of intelligent methods in biomedical studies. This is the result of developments in the area of data analysis and classifying techniques. In this paper, an expert system based on least squares support vector machines (LS-SVM) for diagnosis of vascular heart disease (VHD) is presented.

Wavelet packet decomposition (WPD) and fast-Fourier transform (FFT) methods are used for feature extracting from Doppler signals. LS-SVM is used in the classification stage. Threefold cross-validation method is used to evaluate the proposed expert system performance. The performances of the developed systems were evaluated in 105 samples that contain 39 normal and 66 abnormal subjects for mitral valve disease. The results showed that this system is effective to detect Doppler heart sounds. The average correct classification rate was about 96.13% for normal subjects and abnormal subjects.

Machine Kemal Polat*et al.* have studied about a cascade learning system for classification of diabetes disease: Generalized Discriminant Analysis and Least Square Support Vector. The aim of this study is to diagnosis of diabetes disease, which is one of the most important diseases in medical field using Generalized Discriminant Analysis (GDA) and Least Square Support Vector Machine (LS-SVM). Also, we proposed a new cascade learning system based on Generalized Discriminant Analysis and Least Square Support Vector Machine. The proposed system consists of two stages.

The first stage, we have used Generalized Discriminant Analysis to discriminant feature variables between healthy and patient (diabetes) data as pre-processing process. The second stage, we have used LS-SVM in order to classification of diabetes dataset. While LS-SVM obtained 78.21% classification accuracy using 10-fold cross validation, the proposed system called GDA–LS-SVM obtained 82.05% classification accuracy using 10-fold cross validation. The robustness of the proposed system is examined using classification accuracy, *k*-fold cross-validation method and confusion matrix. The obtained classification accuracy is 82.05% and it is very promising

compared to the previously reported classification techniques

SerdarUckun had studied about intelligent system in patient monitoring and therapy management. Although today's advanced biomedical technology provides unsurpassed power in diagnosis, monitoring, and treatment, interpretation of vast streams of information generated by this technology often poses excessive demands on the cognitive skills of health-care personnel. In addition, storage, reduction, retrieval, processing, and presentation of information are significant challenges. These problems are most severe in critical care environments such as intensive care units (ICUs) and operating room (ORs) where many events are life-threatening and thus require immediate attention and the execution of definitive corrective actions.

This article focuses on intelligent monitoring and control (IMC), or the use of artificial intelligence (AI) techniques to alleviate some of the common information management problems encountered in health-care environments. This article presents the findings of a survey of over 30 IMC projects. A major finding of the survey is that although significant advances have been made in introducing AI technology in critical care, successful examples of fielded systems are still few and far between. Widespread acceptance of these systems in critical care environments depends on a number of factors, including fruitful collaborations between clinicians and computer scientists, emphasis on evaluation studies, and easy access to clinical information.

Curt G. DeGroff, MD*et al.* have studied on Artificial Neural Network–Based Method of Screening Heart Murmurs in Children. Early recognition of heart disease is an important goal in pediatrics. Efforts in developing an inexpensive screening device that can assist in the differentiation between innocent and pathological heart murmurs have met with limited success. Artificial neural networks (ANNs) are valuable tools used in complex pattern recognition and classification tasks. The aim of the present study was to train an ANN to distinguish between innocent and pathological murmurs effectively.

Using an electronic stethoscope, heart sounds were recorded from 69 patients (37 pathological and 32 innocent murmurs). Sound samples were processed using digital signal analysis and fed into a custom ANN. With optimal settings, sensitivities and specificities of 100% were obtained on the data collected with the ANN classification system developed. For future unknowns, our results suggest the generalization would improve with better representation of all classes in the training data. We demonstrated that ANNs show significant potential in their use as an accurate diagnostic tool for the classification of heart sound data into innocent and pathological classes. This technology offers great promise for the development of a device for high-volume screening of children for heart disease.

Cardiovascular disease, diabetes and established risk factors among Populations of sub-Saharan African descent in Europe by Charles Agyemang, Juliet Addo, Raj Bhopal. Most European countries are ethnically and culturally diverse. Globally, cardiovascular disease (CVD) is the leading cause of death. The major risk factors for CVD have been well established. This picture holds true for all regions of the world and in different ethnic groups.

However, the prevalence of CVD and related risk factors vary among ethnic groups. This study provides a review of current understanding of the epidemiology of vascular disease, principally coronary heart disease (CHD), stroke and related risk factors among populations of Sub-Sahara African descent (henceforth, African descent) in comparison with the European populations in Europe.

Compared with European populations, populations of African descent have an increased risk of stroke, whereas CHD is less common. They also have higher rates of hypertension and diabetes than European populations. Obesity is highly prevalent, but smoking rate is lower among African descent women. Older people of African descent have more favorable lipid profile and dietary habits than their European counterparts.

Alcohol consumption is less common among populations of African descent. The rate of physical activity differs between European countries. Dutch African-Suriname men and women are less physically active than the White-Dutch whereas British African women are more physically active than women in the general population. Literature on psychosocial stress shows inconsistent results.

Hypertension and diabetes are highly prevalent among African populations, which may explain their high rate of stroke in Europe. The relatively low rate of CHD may be explained by the low rates of other risk factors including a more favorable lipid profile and the low prevalence of smoking. The risk factors are changing, and on the whole, getting worse especially among African women. Cohort studies and clinical trials are therefore needed among these groups to determine the relative contribution of vascular risk factors, and to help guide the prevention efforts. There is a clear need for intervention studies among these populations in Europe.

Peter O. Kwiterovich*et al.* have studied Recognition and Management of Dyslipidemia in Children and Adolescents. Cardiovascular disease (CVD) remains the number one cause of death in the United States. The origins of atherosclerosis and CVD begin in childhood.

Dyslipidemia and obesity are endemic in American youth and require urgent action. Early atherosclerotic lesions in children, adolescents, and young adults who died from accidental deaths are significantly related to higher antecedent levels of total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C), lower levels of high density lipoprotein (HDL)-C, and other cardiovascular disease (CVD) risk factors, such as obesity, higher blood pressure levels, and cigarette smoking.

Four major prospective epidemiological studies from Muscatine, Bogalusa, the Coronary Artery Risk Development in Young Adults (CARDIA), and the Special Turku Coronary Risk Factor Intervention Project (STRIP) showed that CVD risk factors in children and adolescents, particularly LDL-C and obesity, predicted clinical manifestations of atherosclerosis in young adults, as judged by carotid intima medial thickness (IMT), coronary artery calcium, or brachial flow-mediated dilatation. Medical students at Johns Hopkins who had a TC higher than 207 mg/dl had five times the risk of developing CVD 40 year later than those students who had a TC lower than 172 mg/dl.

A detailed literature search from 1985–2008 was performed using PubMed and subsequent reference searches of retrieved articles. Selection of included articles was based on Igor of scientific design, adequate sample size, and quality of the data, statistical analysis, and hypothesis testing. CVD risk factors in children predict pathological lesions of atherosclerosis in young adults, and their clinical manifestations, as judged by carotid intima medial thickness, coronary artery calcium, or brachial flow-mediated dilatation. About half the offspring of a parent with premature CVD have a primary dyslipidemia. However, use of family history to identify such youth will miss the majority of children with dyslipidemia. Treatment of dyslipidemia starts with a low-fat diet supplemented with water-soluble fiber, plant stools, and plant sterols, weight control, and exercise.

Drug therapy with inhibitors of hydroxyl methylglutaryl coenzyme A reductase, bile acid sequestrate (BAS), and cholesterol absorption inhibitors can be considered in adolescents with a positive family history of premature CVD and a low-density lipoprotein cholesterol of more than 160 mg/dl. Such dietary and drug therapy appears safe and efficacious and is likely to retard atherosclerosis. Early identification and treatment of youth at risk for early atherosclerosis will require an integrated assessment of predisposingCVDrisk factors and a comprehensive universal screening and treatment program.

Anita K *et al.* Have reviewed on Racial and ethnic differences in CVD risk factors. This systematic review was undertaken to expand our understanding of the factors associated with racial/ethnic disparities in cardiovascular disease (CVD) risk factors (hypertension, diabetes, obesity, hypercholesterolemia, no leisure-time physical activity, and smoking), to assess the potential differences in the CVD risk factors by race/ethnicity, and to update and expand on existing reviews.

A series of trial searches was performed initially by using a wide array of relevant search terms. Foremost, an Ovid search of MEDLINE and PubMed were undertaken to identify relevant studies. An effective combination of search terms was used to search the electronic databases. Electronic bibliographic databases, reference lists from relevant publications, conference proceedings (the Conference Papers Index29), and the internet (using general search engines such as Google) were also searched to ensure a thorough critical search of existing research studies. Furthermore, key journals were also hand searched to identify very recent publications.

Sixteen studies were included in this review. Most of the studies found hypertension to be significantly higher in Blacks than Whites. Minority status was also significantly associated with diabetes. No one racial/ethnic minority population was consistently found to have a higher or lower prevalence of obesity or hypercholesterolemia. Mexican Americans had a significantly lower prevalence of smoking than Whites and Blacks; American Indian/Alaskan Natives (AIANs) had significantly higher prevalence of smoking compared to Whites. Mexican Americans had the highest prevalence of no leisure-time physical activity, followed by AIANs and Blacks.

Cardiovascular disease (CVD) is the leading cause of death in the United States and a growing public health concern. Much of the burden of CVD morbidity and mortality is linked to the modifiable CVD risk factors and the differences in the incidence and prevalence of these risk factors by race/ethnicity are substantial while the death rates from CVD declined 22.1% from 1993 to 2003, the actual number of deaths declined 4.6%, in the same 10-year period. Systematically assessing and quantifying modifiable CVD risk factors is therefore crucial in these populations. Better understanding and awareness of the disparities of CVD risk factors by race and ethnicity may help clinicians and public health professionals develop culturally sensitive interventions, prevention programs, and services specifically targeted toward risk burdens in each of these populations.

IV.CONCLUSION

We proposed a set of attributes relating to signs and symptoms and high-risk groups that was tested and was proved to be proficient for recognizing cases of IHD.. The preliminary results of the work suggest that IHD can be diagnosed using clinical decision support systems. KSTAR segregates the negative and positive cases more appropriately than the other methods. Sensitivity and Accuracy are better than the other methods. It is essential to have future studies on classifier accuracy including attribute selection for IHD to develop an electronic protocol along with CDSS. This study may help people to determine their heart disease risk, as it involves simple procedure for decision making in an effective way extracting hidden knowledge from a historical database.

In the present study, an automatic system for the classification of ICU patients employing ANN techniques for decision-making was developed and implemented. The decision-making was performed using features extracted from ECGs. Emphasis was placed on selection of the characteristic features and for the accurate extraction of these features. The proposed approach exhibited a superior performance in terms of classification accuracy and was also easier and simpler to implement and use, as it only requires the ECG signal to determine the patients' states.

The performance of the system can be further enhanced by training with a larger number of training inputs, which increase the network ability to classify unknown signals. The system performance can be further improved by considering other features of ECG that were not included in the current system. Thus, the present study shows the feasibility of the application of ANN for the classification of patient states in an intensive care environment.

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