Sudan University of Science and Technology

College of Graduate Studies

Assessment of Patient’s safety

تقييم سلامة المرضى

Thesis submitted in partial fulfillment of the requirements of the Degree awards of M.Sc. in Biomedical Engineering

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Dedication

To my lovely beloved parents

To my lovely beloved family

I dedicate this research

Acknowledgment

All thanks to Allah Almighty who gave me strength, determination, health and granted me with patience to successfully complete of this research.

I cannot express enough thanks to my supervisor Dr. Altaher for his continued guidance, support, unlimited helps and encouragement; I offer my sincere appreciation for the learning opportunities provided by you.

My completion of this research could not have been accomplished without the support of my parents, family and friend. My deepest gratitude, and special appreciation and thanks to for their support and guidance.

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Abstract

Patient safety has become an international priority with major research programs being carried out. The aim of this research is to assess the concept of patient safety. Two artificial neural network systems were designed by using questionnaire for the classification of an idle and non-idle hospital. After training and testing the systems results were obtained for classification of data. The Two type of neural networks (Feed Forward Back propagation and Competitive neural network architecture) were tested for sensitivity, specificity and accuracy it was found that the Feed Forward Back propagation (FFBP) give more accurate results with an accuracy of 96.37%.

المستخلص

اصبح مفهوم حماية المريض لة اهمية كبيرة خاصة مع وجود الكثير من الابحاث اللتي تتحدث عنة. فالهدف من هذا البحث هو تقيم مفهوم حماية المريض. تم تصميم نظامين من الشبكات العصبية الاصطناعية باستخدام تحليل بينات ماخوذة من الاستبيان ليتم تصنيف المشتفيات . بعد تدريب واختبار النظامين تم الحصول على نتائج لوصف المستشفيات التي تطبق مفهوم حماية المريض و التي لا تطبق . تم اختبار النوعين من انواع الشبكات العصبية الاصطناعية وهما (الشبكة العصبية الاصطناعية التنافسية و الشبكة انتشار الخطأ الخلفي) لتحديد الحساسية والنوعية والدقة وقد اتضح شبكة انتشار الخطأ الخلفي تعطي نتائج افضل بدقة تساوي 96.37%

Chapter One

Introduction

1-1 General view

Patient safety is healthcare discipline that emphasizes the reporting, analysis, and prevention of medical error that often leads to adverse healthcare events. The frequency and magnitude of avoidable adverse patient events was not well known until the 1990s, when multiple countries reported staggering numbers of patients harmed and killed by medical errors. Recognizing that healthcare errors impact 1 in every 10 patients around the world, the World Health Organization calls patient safety an endemic concern. The discipline of patient safety is the coordinated effort to prevent harm to patient, caused by the process of health care itself.

By patient safety, that means the extent to which patients are protected from avoidable harm. So that patient safety was low or poor if patients are not in fact adequately protected. By harm, that means a loss of health outcomes as a consequence of the way that an episode of care was provided. Avoidable harm is that which is a consequence of the care providers having worked in a sub-optimal way. This is equivalent to the idea of affordable best practice we are indicating that better care could have been provided within the limits of reasonable resource availability. Despite the introduction of technology in medicine, challenges related to patient safety and quality health care delivery still abound. The economic and personal costs associated with these challenges are enormous. To address these challenges, systems engineering principles and best practices with clinical expertise to develop innovative approaches to the socio-technical dynamics involved in health car. [1]

1-2 The problem statement:

Many people suffer from mistakes happened to them in hospital. Patient safety is the absence of preventable harm to a patient during the process of health care. So to predict how far does patient safety existing in the hospital.

1-3 The Objective:

Design system to classification the patient safety in any hospitals.

1-4 Methodology:

Collect data from hospital and review the existing evidence on practices relevant and medical devices to improving patient safety. The total of 28 hospitals have undergone test. Each hospital will test and the values will record. These variables will be the input of artificial neural network. An exploratory three-layer ANN model with a feed forward back propagation algorithm and competitive neural network model will construct patient safety will predict from the output of artificial neural network

1-5 Thesis layout:

This research is consists of six chapters: Chapter one is an introduction. Literature reviews are found in Chapter two. Theoretical back ground presented in chapter three. The proposed system is presented in chapter Four. Chapter five describes the results and discussion. Finally chapter six is conclusion and recommendation.

Chapter Two

Literature Reviews

Konstantina S. Nikita. [2] in this book analyzes all possible risks and safety concerns related to medical devices with biomedical telemetry functionalities. Apart from the usual operational and patient safety issues such as product hazard, device integrity and malfunction, side effects, human factors, and erroneous use, guidelines which need to be applied in order to ensure patient safety against electromagnetic field exposure are being extensively analyzed. It provides future research directions related to patient safety and the understanding of how electromagnetic fields interact with the human tissues. The frequency bands which are of main interest to biomedical telemetry systems are the Medical Implant Communications Service (MICS) band and the industrial, scientific, and medical (ISM) bands. Regarding the device itself, operational and occupational safety, as well as user issues, human factors and device hazards were discussed

Gail Powell [3] report that general public believes that technology will improve health care efficiency, quality, safety, and cost. However, few people consider that these same technologies may also introduce errors and adverse events. Given that nearly 5,000 types of medical devices are used by millions of health care providers around the world, device-related problems are inevitable. While technology holds much promise, the benefits of a specific technology may not be realized due to four common pitfalls: (1) poor technology design that does not adhere to human factors and ergonomic principles, (2) poor technology interface with the patient or environment, (3) inadequate plan for implementing a new technology into practice, and (4) inadequate maintenance plan.

Fariba Shadabi, Robert Cox and Dharmendra Sharma. [4]

In this study we sought to use ANN to predict renal transplantation outcomes. Our results showed that although this was possible, the positive predictive power of the trained ANN was low, indicating a need for improvement if this approach is to be useful clinically. We also highlight potential problems that may arise when using incomplete clinical datasets for ANN training including the danger of pre-processing data in such a way that misleading high predictive value is obtained.

In 2012, Md Ashraf Jamal, [5] in his paper proposed committee neural network for classification of EEG signals. Committee neural network consists of different neural network that used multilayer perceptron back propagation algorithm. Redundant features and excessive hidden nodes of ANN increases modeling complexity without improving discrimination performance. Therefore optimum design of neural network which intern optimizes the committee neural network is required towards real time detection of signals.

Chapter Three

Theoretical of Back Ground

3.1 patient safeties:

Millennia ago, Hippocrates recognized the potential for injuries that arise from the well-intentioned actions of healers. Greek healers in the 4th century BC drafted the Hippocratic Oath and pledged to "prescribe regimens for the good of my patients according to my ability and my judgment and never do harm to anyone [6]. Since then, the directive primum non nocere (“first do no harm) has become a central tenet for contemporary medicine [7]. However, despite an increasing emphasis on the scientific basis of medical practice in Europe and the United States in the late 19th Century, data on adverse outcomes were hard to come by and the various studies commissioned collected mostly anecdotal events. [8]

3.2 kinds of errors:

Attempted to understand the causes and found that tend to group those under three headings. Errors of individual clinicians, errors that are a consequence of poor teamwork at the point of delivery of care (including failure to establish rules and processes for collaboration and communication), and errors that are a consequence of environmental factors. By environmental factors, we mean those that are external to an individual clinician or clinical team. They include the level of financial and other incentives and sanctions provided by external agencies such as regulators and health care purchasers, the levels of accountability, and the degree to which care settings have been designed in ways that affect the risks of error (such as workplace ergonomics). This is not to deny there are many people doing good things. But there are practice and cultural constraints that impede progress. [9]

2.3.1 Risks in hospitals:

2.3.1.1 Electrical risk:

Electrical hazards including electric shock, electrocutions fires, and explosions. Damaged electrical cords can lead to possible shocks or electrocutions. A flexible electrical cord may be damaged by door or window edges, by staples and fastenings, by equipment rolling over it, or simply by aging. [8]

2.3.1.2 Radiation risk:

Radiation is energy that travels as a wave or particle. Some types of radiation, called ionizing radiation, can be harmful. There is always a risk of damage to cells or tissue from being exposed to any amount of ionizing radiation. Over time, exposure to radiation may cause cancer and other health problems. But in most cases, the risk of getting cancer from being exposed to small amounts of radiation is small. [8]

2.3.1.3 Medication risk:

Medication errors are unfortunately common in the practice of health care. Hospital medication errors are especially scary. How would you even know if a nurse is giving you the wrong drug or the wrong dosage? [8]

2.3.1.4 Fire risk:

With the prevalence of electrical equipment on the premises of many healthcare facilities, the potential for fires breaking out through faulty or overworked sockets, cables and the like is high. Kitchen facilities, too, are a constant threat. The sensitive nature of healthcare environments means that fire detection and suppression is of high priority. A fire within a hospital where patients are receiving vital treatments is a serious threat to life, and evacuation procedures become far more complex when mobility is an issue for many. This makes the removal of fire hazards even more important, and could result in the need for more regular assessments of the risks present on the premises than might be necessary in other industries. [8]

3.3 The magnitude of the problem:

The purpose of this section is to gives an indication of the order of magnitude of the problem of patient safety, and the way that it is distributed across the health care systems. As will be evident from the literature cited, the overwhelming view is that the problem is large, is greater than many people have previously assumed, and does not seem to be responding rapidly to increased interest and effort. There are, however, important minority views – including an argument that the number of avoidable errors has been over-estimated and that there are dangers in over-emphasizing patient safety (and there by diverting attention from other causes of loss of health).

3.3.1 Number of incidents those indicate poor safety

The IOM study (Institute of Medicine, 2000) involved taking data from two analyses of adverse events and extrapolating them to estimate US national rates. The first was the Harvard Medical Practice Study that found a rate of adverse events of 3.7% in hospitals in New York of which 13.6% resulted in death. The second was conducted in hospitals in Colorado and Utah, which found that adverse events occurred in 2.9% of hospitalizations of which 6.6% led to death. In both studies, over half of the adverse events resulted from medical errors that could have been prevented. The IOM study extrapolated these results to the 33.6 million hospital admissions in the USA in 2012, and concluded that the Colorado and Utah studies gave an estimate of 44,000 deaths per year. Whereas the New York data gave an estimate of 98,000 deaths per year. [10] Finally, most authors argue that the magnitude of the problem is much the same in countries with similar health systems. [9] For example, Smallwood (2013) quotes the few reasonably comparable multi-national studies and concludes there are probably few differences between the USA, Australia and England. [10]

3.3.2 Estimates of costs:

There is frequent mention of the high cost of avoidable harm, in terms of loss of wellbeing for the patients and their families. An exception is the IOM study, which made reasonable estimates of the costs of poor patient safety. The estimated total costs were between US$17 billion and US$29 billion per year. And other costs related to lost income of patients, lost household production, and disability. Other costs were noted but not estimated. They included cost penalties as a result of loss of trust in the system by patients and diminished satisfaction by both patients and health professionals, increased physical and psychological discomfort for patients who experience a longer hospital stay or disability as a result of errors, and loss of morale and frustration at not being able to provide the best care possible among health care professionals. Employers and society in general pay in terms of lost worker productivity, reduced school attendance by children, and lower levels of population health status. [10]

3.4 The causes of poor patient safety:

There are two main views on this subject – although they overlap to a considerable extent. The first is that individual care providers make mistakes as a consequence of such factors as fatigue, lack of knowledge, or carelessness. The second is that the large majority of errors has little to do with the behavior of individuals, but is largely the inevitable consequence of underlying factors that present barriers to effective teamwork. It is difficult to classify the causes because many are closely related or subsets of each other. [9]

3.4.1 Fragmentation of the health care system:

The IOM study criticizes the high degree of fragmentation that results in poor communication, competition rather than collaboration, opportunities to transfer responsibilities elsewhere, absence of clear lines of accountability, and so on. [10] Technical problems include difficulties in ensuring care providers have access to complete information for reasons of insularity of many clinicians (and a consequent lack of commitment to sharing information). The problems are exacerbated by incompatible technologies (such as data definitions and software) that are mostly incapable of providing timely access to complete patient information. There are many important discontinuities, such as those between the formal and informal health care systems. Errors are more likely to occur in patients who need care across multiple settings over prolonged periods of time. [9]

3.4.2 Poor written and oral communications:

The importance of communication between clinicians has been underrated, as have the consequential problems of patient safety. That most medication errors are a consequence of poor methods of sharing of information. In some cases, the cause is a complicated and poorly understood chain of communication. In other cases, errors occur as a result of elementary weaknesses such as failure to involve the patient as a quality control check, poor handwriting on prescriptions, and the use of the elitists' arcane Latin words and shorthand abbreviations that are subject to misinterpretation. [9]

3.4.3 Few financial incentives to manage safety:

The IOM study argues that purchasers of health care typically make few demands for improvements in safety. Most purchasers do not provide little incentive for a health care organization to improve safety, nor do they recognize and reward safety or quality. Problems have included a lack of consistency of approaches across the various purchasing agencies, and a focus on short-term efficiency gains. [10]

3.4.4 Cultural aspect: blame

A demand for answers as to why "the event" occurred is not an uncommon response. It is human nature to want to blame someone and far more "satisfying" for everyone involved in investigating an incident if there is someone to blame. [10]Pivotal to our need to blame is the belief that punitive action sends a strong message to others that errors are unacceptable and that those who make them will be punished. Today most complex industrial/high technological managers realize that a blame culture will not bring safety issues to the surface. While many health-care systems are beginning to recognize this we are yet to move away from the person approach—in which finger pointing or cover-ups are common—to an open culture where processes are in place to identify failures or breaks in the “defenses”. Organizations that place a premium on safety routinely examine all aspects of the system in the event of an accident, including equipment design, procedures, training and other organizational features. [8, 10]

The IOM study claims there is a widespread culture of blame. The authors argue that "… building safety into processes of care is a more effective way to reduce errors than blaming individuals." The focus must shift from blaming individuals for past errors to a focus on preventing future errors by designing safety into the system. This does not mean that individuals can be careless. People must still be vigilant and held responsible for their actions. But when an error occurs, blaming an individual does little to make the system safer and prevent someone else from committing the same error. [10]

3.4.5 Resource shortfalls:

The IOM study made little reference to resource shortfalls, on the grounds that the challenge is to make better use of the available resources no matter how limited. However, there are many papers that mention the adverse effect of resource shortfalls on patient safety. [10]

Nicklin and McVeety (2012) conducted focus groups comprising Canadian nurses, and found they were overwhelmingly of the view that risks to patient safety were increasing. The main factors were increased workloads and nursing shortages, and communication problems between clinical professions and with patients. [10]

Cavorous (2012) describes some of the evidence of increased risks to patient safety as a consequence of fatigue among clinicians. [11] Several authors refer to shortages of supplies and equipment including disposables. For example, Nye and Wilson (1998) reported some of the risks to patient safety associated with reusing medical devices labeled by the manufacturer for single-use only. [10]

3.5 Actions:

As was the case for causes, there is no easy way to categories remedial actions. Most papers present more than one category of solution, and most solutions address more than one kind of problem. We have presented categories, but they could usefully be aggregated.

3.5.1 Factors:

Several articles in the literature emphasis the need to use many kinds of interventions simultaneously. This is supported by the IOM study: its authors argue that there are both internal and external factors that can encourage improvements in patient safety. External factors include generation and dissemination of knowledge and tools, strong and visible professional leadership, legislative and regulatory initiatives, and actions of purchasers and consumers to demand safety improvements. Internal factors (those within health care organizations) include strong leadership for safety, an organizational culture that encourages recognition and 1learning from errors, and an effective patient safety program. None of these factors is sufficient by itself, and a comprehensive approach is needed. The IOM study said that "… there is no ‘magic bullet’ that will solve this problem (because) large and complex problems require thoughtful, multifaceted responses." There needs to be a balance between regulatory and market-based initiatives, and between the roles of professionals and organizations. No single action represents a complete answer, nor can any single group or sector offer a complete fix to the problem. [10]

3.6.2 Reporting systems:

The IOM study argues that much can be learned from the analysis of errors. All adverse events resulting in serious injury or death should be evaluated to assess whether improvements in the delivery system can be made to reduce the likelihood of similar events occurring in the future [10]. Errors that do not result in harm also represent an important opportunity to identify system improvements having the potential to prevent adverse events. [9] The emphasis is on the situation in the USA. The IOM study recommends that a national reporting system be established, that will require all state governments to collect standardized information about adverse medical events that result in death and serious harm. should be required to begin reporting first, and eventually all health care organizations should be required to report. This system will ensure a response to specific reports of serious injury, hold health care organizations and providers accountable for maintaining safety provide incentives to organizations to implement internal safety systems that reduce the likelihood of errors occurring, and respond to the public's right to know about patient safety. [10]

3.5.3 Research and analytical techniques:

By research, we mean investigation of the magnitude and types of patient safety problems, the causes, and potential solutions. Analytical techniques mean methods of extracting and interpreting potentially relevant information. Young (2001) reported that some pharmacists believe there is a need for more research with regard to safe prescribing and use of medications. [11] Meyer and Rall (2002) reported that the US Agency for Health Care Research and Quality (AHRQ) is committed to the sponsoring of further research. The Agency believes the research results "… will provide an evidentiary base for system improvements that, when implemented, will greatly enhance the safety of the nation's health care system." [10]

3.5.4 Education, training, and learning:

A wide variety of ideas is presented in the literature with regard to education. Several articles emphasis the need for training at all levels in the system. For example, Elkin and Gorman (2012) argued that it was necessary to design and implement training in patient safety that covered all levels and types of formal, informal, and continuing medical education programs. Eisenberg (2011) presented a continuing education program for care providers that focus on use of a systems approach to patient safety. The themes of the program are informatics for information, guidelines as learning tools, learning from opinion leaders, learning from the patient, decision support systems, the team learning together, learning organizations, and just-in-time and point-of-care delivery. [11]

3.5.5 Reference sources for clinical practice information:

The majority of authors believe that more should be done to make information about good clinical practice more easily available. For example, Williams and Zipperer (2013) suggested that nurses should make more use of library services, including seeking the advice of medical.

librarians.Zipperer, Gluck and Anderson (2012) suggested that health care professionals should make more use of knowledge maps (indexes to people and organizational resources) with the assistance of librarians. In this way, a blend will be created of the knowledge of the practitioner and the administrator with regard to managing problems of patient safety. Zablocki (2003) and others argued that more use should be made of the Internet for the purpose of finding and sharing information. Many references are made to the need to create and disseminate clinical practice guidelines. [12]

3.5.6 Consumerism and empowering patients:

It has long been argued that consumers must have the right to be involved in designing, monitoring, and evaluating the services they receive, relatively little progress has been made in most health systems. Vicente and Coulter (2002) reported that the need for involvement has been increased by the recent emergence of concern about patient safety. They argued that care providers must do more to ensure that patients play a major role in helping to reach an accurate diagnosis, deciding about appropriate treatment, choosing an experienced and safe provider, ensuring that treatment is appropriately administered, monitored and adhered to, and identifying adverse events and taking appropriate action. The IOM study suggested that patients themselves could provide a major safety check in most health care settings. For example, they should know which medications they are taking, their appearance, and their side effects, and they should notify their doctors of medication discrepancies and the occurrence of side effects. [10] The Agency for Healthcare Research and Quality (AHRQ) has produced a booklet of practical tips on what individual consumers can do to improve the quality of health-care services they receive. The booklet focuses on key choices that individuals and their families’ face, such as choosing doctors, hospitals, and treatments, and it stresses the importance of individuals taking an active role in selecting and evaluating their care. [11]

3.6 Attributes of patient safety:

The available evidence, as the basis for defining attributes that seem to be associated with an ability to recognize and address problems of patient safety. They are arranged in domains below:

3.6.1 Generating ideas:

All ideas should receive positive feedback. They should never generate negative responses. Ideas from new or junior staff should be especially encouraged and welcomed. It should be universally accepted that they have different perspectives which are more likely to lead to questioning of long-established approaches.

3.6.2 Good communication between junior and senior staff:

Easy accessibility to senior staff, junior staff must believe that they are always welcome to initiate discussions with senior staff. This might mean, for example, that senior staff always have their doors open, and it is not necessary always to make an appointment – or to explain the purpose to the senior staff's personal assistant.

3.6.3 Good communication between clinicians in different professions:

Patient care is almost always a task that requires teamwork among clinicians of different professions. Effective communication is therefore essential if processes are to be safe, and clinical work is to be less stressful.

3.6.4 Shared management of information:

Health care is an information-intensive industry. It is important that there is shared management of all aspects including design, operation, and evaluation. All clinical staff should view clinical documentation as an essential definition of what they need to know.

3.6.5 Shared responsibility and accountability:

There should be a willingness to share responsibility for all aspects of patient care. This includes sharing of responsibilities for identifying problems, defining solutions, and taking action to resolve problems of all kinds. There must also be shared accountability – that is, for ensuring that performance is accurately reported to all parties who have a right to know.

3.6.6 Continuous learning:

There should be attitudes and behaviors that ensure there is a continuous desire to identify opportunities for improvement through acquisition of knowledge. Learning should be driven by self-motivation – all staff should have a personal desire to improve. It should also be driven by an organization-wide respect for learning together with clear rewards for doing so. Processes are always subjected to monitoring and evaluation.

3.6.7 Team work:

Team work means there is recognition that good patient care requires the skills of many people. It means there is an understanding and respect for the contributions of everyone, and that there is a commitment to share ideas, information, responsibilities, and accountability. Patient care is a team task.

3.7 Artificial Neural Network:

3.7.1 Introduction:

Ever since eternity, one thing that has made human beings stand apart from the rest of the animal kingdom is, its brain .The most intelligent device on earth, the “Human brain” is the driving force that has given us the ever-progressive species diving into technology and development as each day progresses.

Due to his inquisitive nature, man tried to make machines that could do intelligent job processing, and take decisions according to instructions fed to it. What resulted was the machine that revolutionized the whole world, the “Computer” (more technically speaking the Von Neumann Computer). Even though it could perform millions of calculations every second, display incredible graphics and 3-dimentional animations, play audio and video but it made the same mistake every time.

Practice could not make it perfect. So the quest for making more intelligent device continued. These researches lead to birth of more powerful processors with high-tech equipments attached to it, super computers with capabilities to handle more than one task at a time and finally networks with resources sharing facilities. But still the problem of designing machines with intelligent self-learning, loomed large in front of mankind. Then the idea of initiating human brain stuck the designers who started their researches one of the technologies that will change the way computer work Artificial Neural Networks. [13]

In general, Neural Networks are simply mathematical techniques designed to accomplish a variety of tasks. Neural Networks uses a set of processing elements (or nodes) loosely analogues to neurons in the brain (hence the same, neural networks). These nodes are interconnected in a network that can then identify patterns in data as it is exposed to the data. In a sense, the network learns from the experience just as people do. Neural networks can be configured in various arrangements to perform a range of tasks including pattern recognition, data mining, classification, and process modeling. [14]

3.7.2 Neurons:

The conceptual constructs of a neural network stemmed from our early understanding of the human brain. The brain is comprised of billion and billions of interconnected neurons. The fundamental building blocks of this massively parallel cellular structure are really quite simply when studied in isolation. A neuron receives incoming electrochemical signals from its dendrites and collects these signals at the neuron nucleus. The neuron nucleus has a internal threshold that determines if neuron itself tires in response to the incoming information. If the combined incoming signals exceeds this threshold then neuron fires and an electrochemical signal is sent to all neurons connected to the firing neuron on its output connections or axons. Otherwise the incoming signals are ignored and the neuron remains dormant.

There are many types of neurons or cells. From a neuron body (soma) many fine branching fibers, called dendrites, protrude. The dendrites conduct signals to the soma or cell body. Extending from a neuron's soma, at a point called axon hillock (initial segment), is a long giber called an axon, which generally splits into the smaller branches of axonal arborization. The tips of these axon branches impinge either upon the dendrites, somas or axons other neurons or upon effectors. [15]

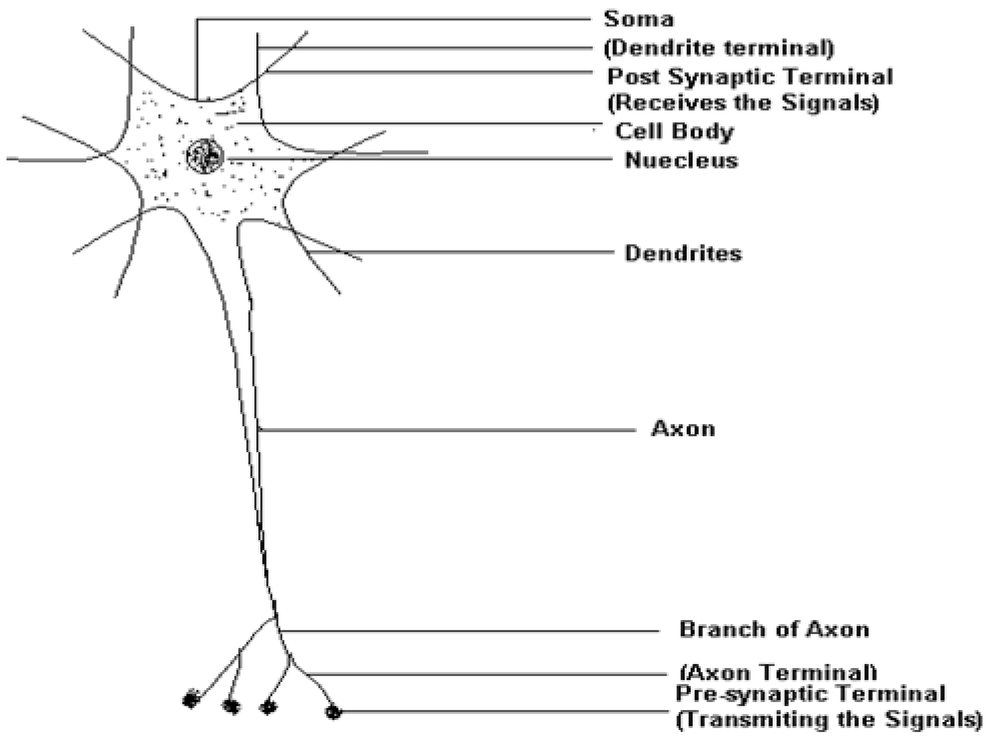

Figure (3.1): A Biological Neuron

3.7.3 Basics of Artificial Neural Models:

The human brain is made up of computing elements, called neurons, coupled with sensory receptors (affecters) and effectors. The average human brain, roughly three pounds in weight and 90 cubic inches in volume, is estimated to contain about 100 billion cells of various types. A neuron is a special cell that conducts and electrical signal, and there are about 10 billion neurons in the human brain. The remaining 90 billion cells are called glial or glue cells, and these serve as support cells for the neurons. Each neuron is about one-hundredth size of the period at the end of this sentence. Neurons interact through contacts called synapses. Each synapse spans a gap about a millionth of an inch wide. On the average each neuron receives signals via thousands of synapses.

The motivation for artificial neural network (ANN) researches is the belief that a human’s capabilities, particularly in real-time visual perception, speech understanding, and sensory information processing and in adaptively as well as intelligent decision making in general, come from the organizational and computational principles exhibited in the highly complex neural network of the human brain. Expectations of faster and better solution provide us with the challenge to build machines using the same computational and organizational principles, simplified and abstracted from neurobiological of the brain. [16]

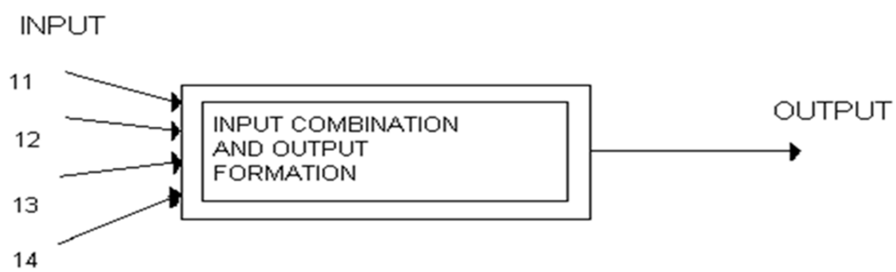

Figure (3.2): Artificial Neural Network Model

3.7.4 Artificial Neural Network:

Artificial neural network (ANNs), also called parallel distributed processing systems (PDPs) and connectionist systems, are intended for modeling the organization principles of the central neurons system, with the hope that the biologically inspired computing capabilities of the ANN will allow the cognitive and logically inspired computing capabilities of the ANN will allow the cognitive and sensory tasks to be performed more easily and more satisfactory than with conventional serial processors. Because of the limitation of serial computers, much effort has devoted to the development of the parallel processing architecture; the function of single processor is at a level comparable to that of a neuron.

ANN structures, broadly classified as recurrent (involving feedback) or non-recurrent (without feedback), have numerous processing elements (also dubbed neurons, neurodes, units or cells) and connections (forward and backward interlayer connections between neurons in different layers, forward and backward interlayer connections or lateral connections between neurons in the same layer, and self-connections between the input and output layer of the same neuron. Neural networks may not have differing structures or topology but are also distinguished from one another by the way they learn, the manner in which computations are performed (rule-based, fuzzy, even nonalorithmic), and the component characteristic of the neurons or the input/output description of the synaptic dynamics). These networks are required to perform significant processing tasks through collective local interaction that produces global properties.

Since the components and connections and their packaging under stringent spatial constraints make the system large-scale, the role of graph theory, algorithm, and neuroscience is pervasive. [15]

3.7.5 Perceptron:

At the heart of every Neural Network is what is referred to as the perceptron (sometimes called processing element or neural node) which is analogus to the neuron nucles in the brain. The second layer that is very first hidden layer is known as perceptron. As was the case in the brain the operation of the perceptron is very simple; however also as is the case in the brain, when all connected neurons operate as a collective they can provide some very powerful learning capacity.

Input signals are applied to the node via input connection (dendrites in the case of the brain.) The connections have “strength” which changes as the system learns. In neural networks the strength of the connections are referred to as weights. Weights can either excite or inhibite the transmission of the incoming signal. Mathematically incoming signals values are multiplied by the value of those particular weights.

At the perceptron all weighted input are summed. This sum value is than passed to a scaling function. The selection of scaling function is part of the neural network design. [17]

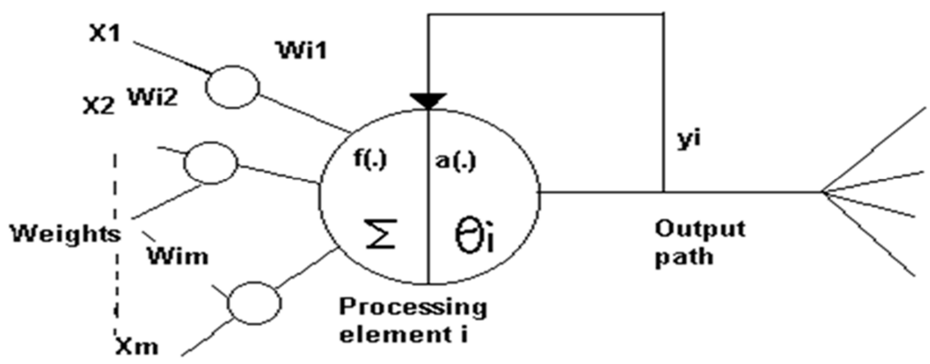

Figure (3.3): Perceptron

3.7.6 Basic Structure of artificial neural network:

3.7.6.1 Input layer:

The bottom layer is known as input neuron network in this case x1 to x5 are output neurons input layer neurons.

3.7.6.2 Hidden layer:

The in-between input and output layer the layers are known as hidden layers where the knowledge of past experience

3.7.6.3 Output Layer:

The top most layer which give the final output. In this case z1 and z2 are [9]

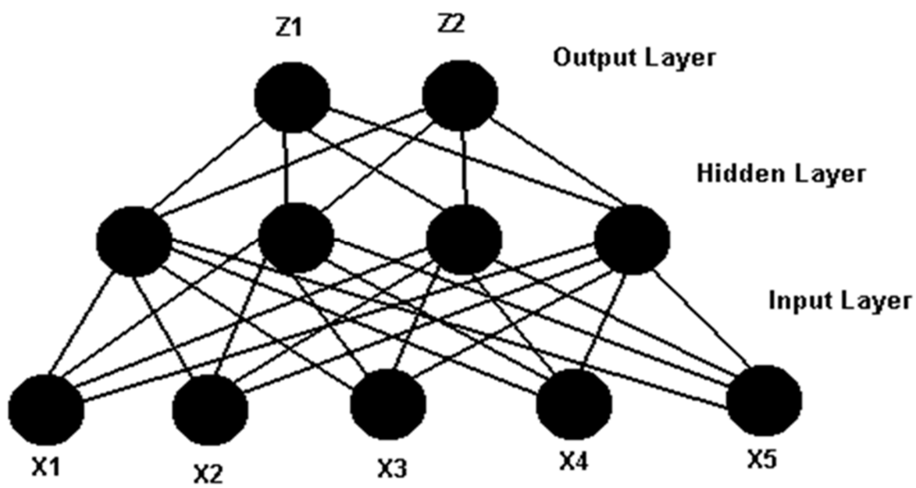

Figure (3.4): Basic structure of Artificial Neural Network

3.7.7 Network architectures:

1). Single layer feed forward networks:

In this layered neural network the neurons are organized in the form of layers.

In this simplest form of a layered network, we have an input layer of source nodes those projects on to an output layer of neurons, but not vise-versa. In other words, this network is strictly a feed forward or acyclic type [13]. It is as shown in figure:

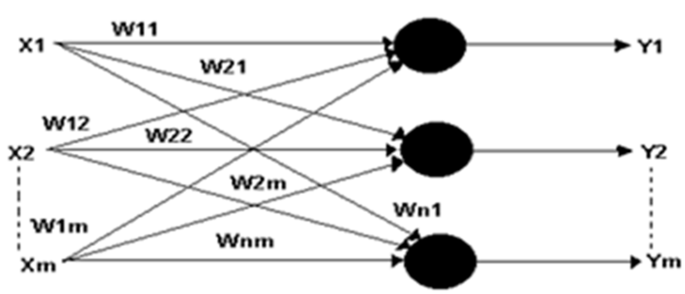

Figure (3.5): Single –layer feed forward Network

Such a network is called single layered network, with designation “single later” referring to the o/p layer of neurons.

2). Multilayer feed forward networks: The second class of the feed forward neural network distinguishes itself by one or more hidden layers, whose computation nodes are correspondingly called neurons or units. The function of hidden neurons is intervenue between the external i/p and the network o/p in some useful manner. The ability of hidden neurons is to extract higher order statistics is particularly valuable when the size of i/p layer is large.

The i /p vectors are feed forward to 1st hidden layer and this pass to 2nd hidden layer and so on until the last layer i.e. output layer, which give actual network response [13].

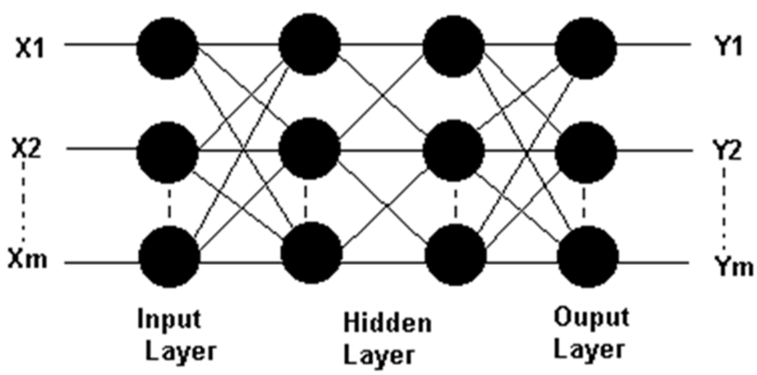

Figure (3.6): Multilayer feed forward network

3). Recurrent networks:

A recurrent network distinguishes itself from feed forward neural network, in that it has least one feed forward loop. As shown in figures output of the neurons is fed back into its own inputs is referred as self-feedback

A recurrent network may consist of a single layer of neurons with each neuron feeding its output signal back to the inputs of all the other neurons. Network may have hidden layers or not.

Figure (3.7): Single node with feedback to itself

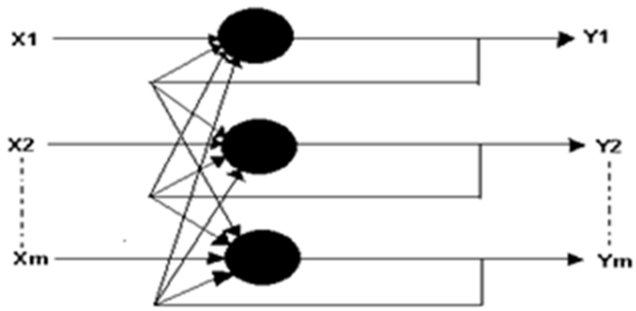

Figure (3.8) Multilayer recurrent network

3.7.8 Training of ANN:

3.7.8.1 Supervised training

- Supplies the neural network with the input and desired output.

- Response of the network is measured.

3.7.8.2 Unsupervised training

- Only supplies input without desired output.

- The neural network adjusts its own weighs so that similar input causes similar output [15].

3.7.9 Advantages of Neural Networks:

1) Networks start processing the data without any preconceived hypothesis. They start random with weight assignment to various input variables. Adjustments are made based on the difference between predicted and actual output. This allows for unbiased and batter understanding of data.

2) Neural networks can be retained using additional input variables and number of individuals. Once trained they can be called on to predict in a new patient.

3) There are several neural network models available to choose from in a particular problem.

4) Once trained, they are very fast.

5) Due to increased accuracy, results in cost saving.

6) Neural networks are able to represent any functions. Therefore they are called ‘Universal Approximators’.

7) Neural networks are able to learn representative examples by back propagating errors

3.7.10 Application of Artificial Neural Network:

1. Classification

   Pattern recognition, feature extraction, image matching.

2. Noise reduction

   Recognize pattern in the input and produce noiseless outputs.

3. Prediction

   Extrapolation based on historical data. [18]

Chapter Four

Methodology and the Proposed System

Collect data from hospital and review the existing evidence on practices relevant and medical devices to improving patient safety. The total of 28 hospitals have undergone test. Each hospital will test and the values will record. These variables will be the input of artificial neural network. An exploratory three-layer ANN model with a feed forward back propagation algorithm and competitive neural network model will construct patient safety will predict from the output of artificial neural network

4.1 Data set:

The database used for prediction of patient safety using artificial neural network is collected from many hospitals. The database has been collected from 28 hospitals and used for this proposed system.

4.2 Attribute selection:

The database has 28 hospitals and 7 attributes. Attribute 1 through 7 are used to represent hospital. Each hospital has one of two possible cases: idle and non-idle. According to the class distribution 8 are idle and 20 are non-idle. All attributes are:

Generating ideas
Good communication between junior and senior staff
Good communication between clinicians in different professions
Shared management of information
Shared responsibility and accountability
Continuous learning
Team work

4.3 Artificial Neural Network model:

For building neural network model there are two main steps:

1. Create the neural network.

2. Train and test the neural network

4.3.1 Create Neural Network:

MATLAB software package version 10 is used to implement the software for the current work. The data was input to the neural network from the work space. Data were randomly divided into a training sample (8 cases) and a test sample (20 cases).

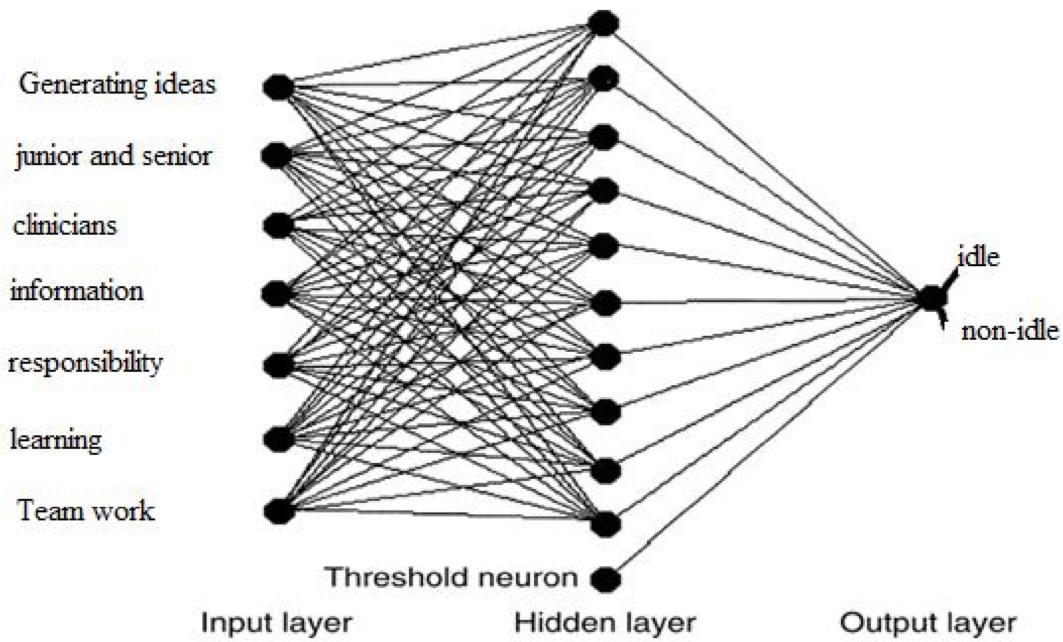

Figure (4.1) Architecture of ANN using for prediction of patient safety

4.3.2 Training and Testing of ANN Network:

4.3.2.1 Feed Forward Back propagation Network:

Feed forward back propagation artificial neural network model shown in figure (4.1) consists of input, hidden and output layers. Back propagation learning algorithm was used for learning these networks.

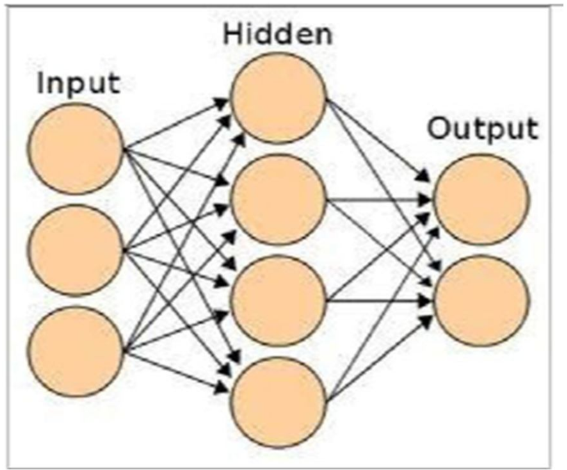

Figure (4.2) Feed Forward Back propagation Network

During training this network, calculations were carried out from input layer of network toward output layer, and error values were then propagated to prior layers. Feed forward networks often have one or more hidden layers of sigmoid neurons followed by an output layer of linear neurons. Multiple layers of neurons with nonlinear transfer functions allow the network to learn nonlinear and linear relationships between input and output vectors. The outputs of a network such as between 0 and 1 are produced, then the output layer should use a sigmoid transfer function (tansig).

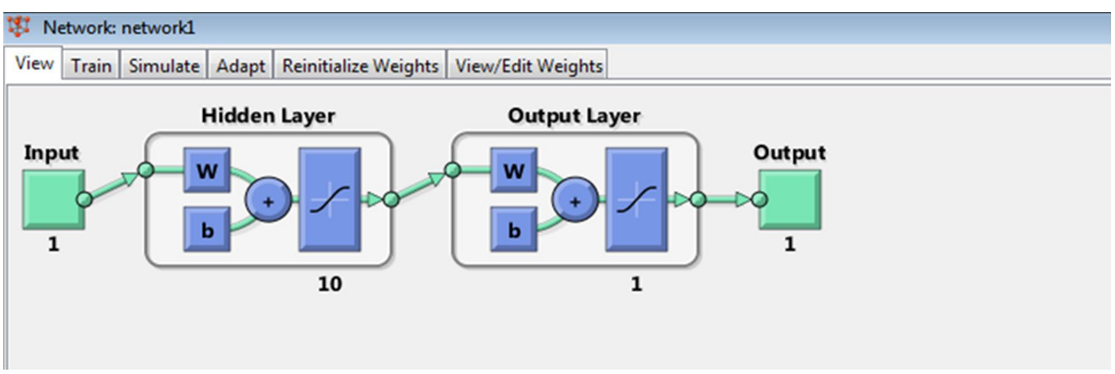

Figure (4.3) training of Feed Forward Back propagation Network

4.3.2.2 competitive network:

Competitive learning is a form of unsupervised learning in artificial neural networks, in which nodes compete for the right to respond to a subset of the input data. Competitive learning works by increasing the specialization of each node in the network. It is well suited to finding clusters within data

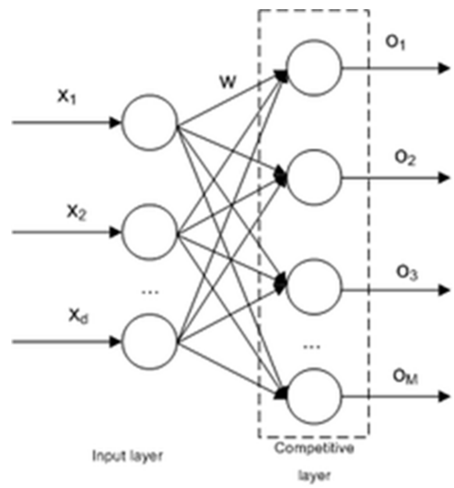

Figure (4.4) Competitive neural network architecture

Competitive Learning is usually implemented with Neural Networks that contain a hidden layer which is commonly known as “competitive layer”. Every competitive neuron is described by a vector of weights and calculates the similarity measure between the input data and the weight vector. For every input vector, the competitive neurons “compete” with each other to see which one of them is the most similar to that particular input vector. The winner neuron m sets its output and all the other competitive neurons set their output. [6]

Set initial synaptic weights to small random values, say in an interval [0, 1], and assign a small positive value to the learning rate parameter a. Activate the Kohonen network by applying the input vector X, and find the winnertakes-all (best matching) neuron X at iteration p, using the minimum-distance Euclidean criterion then update the synaptic weights. Increase iteration p by one, go back and continue until the minimum-distance Euclidean criterion is satisfied or no noticeable changes occur in the feature map.

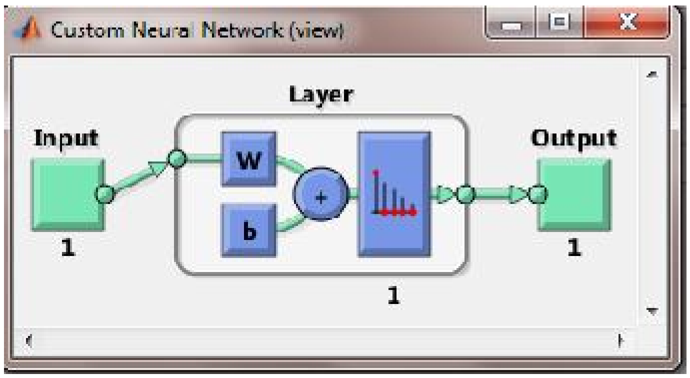

Figure (4.5) Training of the competitive neural network

The performance of competitive nural network and feed forward back propagation were evaluated. The data set having seven input and one target is divided as training and testing as 8 used for training and 20 for testing to develop different models in Feed forward back propagation and competitive nural network. The results are in the next chapter.

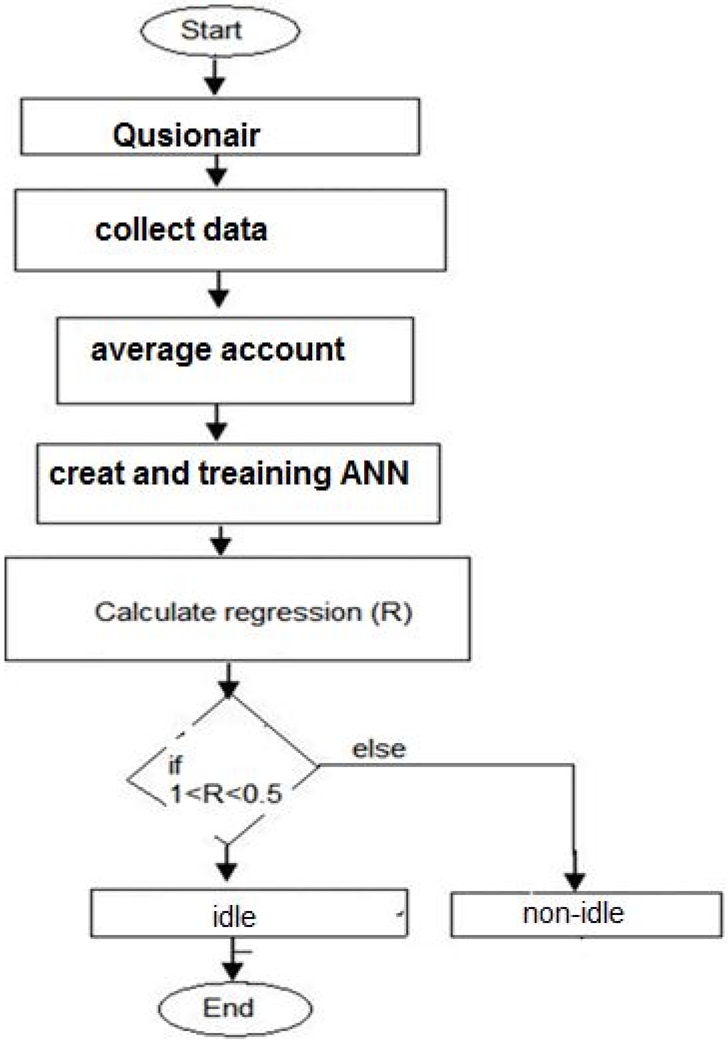

Figure (4.6) Flow diagrams for creating and training of a neural network

Chapter five

Resulte and Discution

5.1 Results:

prediction by neural network is the black – box approach. Competitive neural network and Feed Forward Back propagation were evaluated represent an efficient tool for the prediction of patient safety in hospital. The ANN is trained with 21 inputs. After successful training, the system is able to make prediction.

5.1.1 Data classification:

The classification process is divided into the training phase and the testing phase. During training, the data from hospitales is known. After training is over, the trained networks are stored to be used in the algorithm. Whenever a data is taken as input in the algorithm, it is simulated with the trained networks and goes for testing the data. The accuracy, sensitivity, specificity of the classification is depends on the efficiency of the training.

5.1.2 Test work:

In order to test work calculate accuracy, sensitivity and specificity. Using four categories output which are true positive (TP), false positive (FP), true negative (TN) and false negative (FN).

5.1.2.1 Accuracy: The accuracy of a measurement system is the degree of closeness of measurements of a quantity to that quantity's actual (true) value

Accuracy = (TP + TN) / The number of data……… (1)

5.1.2.2 Sensitivity: The sensitivity tells us how likely the test is come back positive in someone who has the characteristic. Among all people that have the characteristic, what proportion will test positive?

$$\text{Sensitivity} = TP / (TP+FN) \quad \ldots\ldots\ldots\ldots\ldots \quad (2)$$

5.1.2.3 Specificity: The specificity tells us how likely the test is to come back negative in someone who does not have the characteristic. Among all people without the characteristic, what pro-portion will test negative?

$$\text{Specificity} = TN / (FP+TN) \quad \ldots\ldots\ldots\ldots\ldots. \quad (3)$$

Where:

- True positive: abnormal signal correctly diagnosed as abnormal
- False positive: normal signal incorrectly identified as abnormal
- True negative: normal signal correctly identified as normal.
- False negative: abnormal signal incorrectly identified as normal.

5.1.3 An idle hospital:

Table (5.1): An idel hospital regression

Hospital number	1	2	3	4	5	6	7	8
Reg of Comp	0.83	0.75	0.72	0.75	0.63	0.72	0.71	0.60
Reg of FFB	0.96	0.85	0.75	0.89	0.72	0.71	0.60	0.65

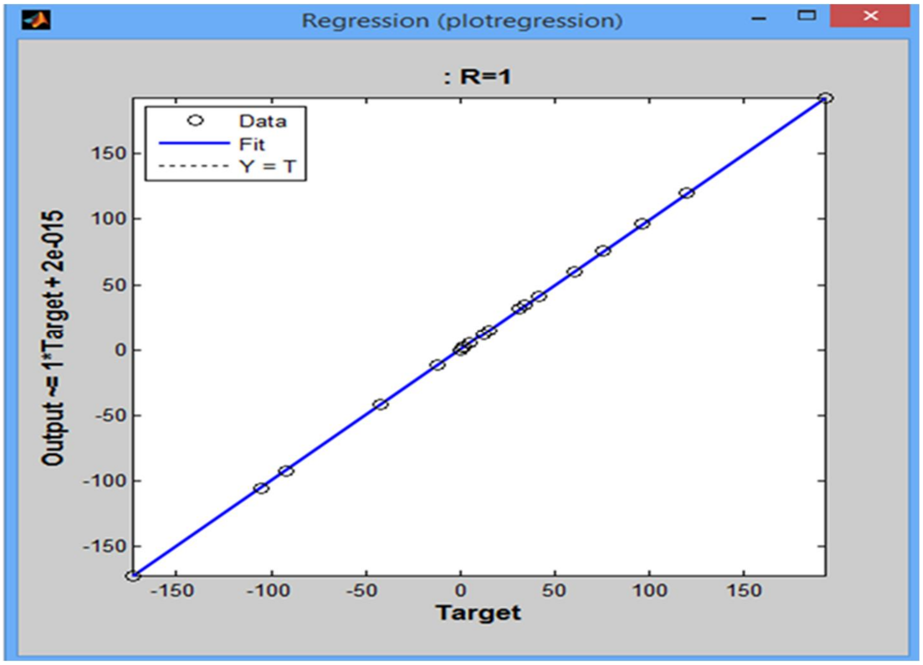

Figure (5.1): an idel hospital regressions

Figure (5.1) shown the regression of idel hospital is equal to 0.96. Which the range of idel hospital is between (0.5 to 1). Table (5.1) describes the regression of 8 idel hospital.

5.1.4 Non-idle hospital:

Table (5-2): non-idel hospital regression

Hospital num	FFB Regretion	comp Regretion
1	0.40	0.37
2	0.45	0.53
3	0.18	0.42
4	0.31	0.34
5	0.05	0.22
6	0.38	0.24
7	0.14	0.17
8	0.34	0.71
9	0.44	0.73

10	0.35	0.45
11	0.06	0.26
12	0.22	0.33
13	0.46	0.20
14	0.24	0.35
15	0.22	0.27
16	0.34	0.25
17	0.47	0.25
18	0.29	0.33
19	0.26	o.39
20	0.18	o.45

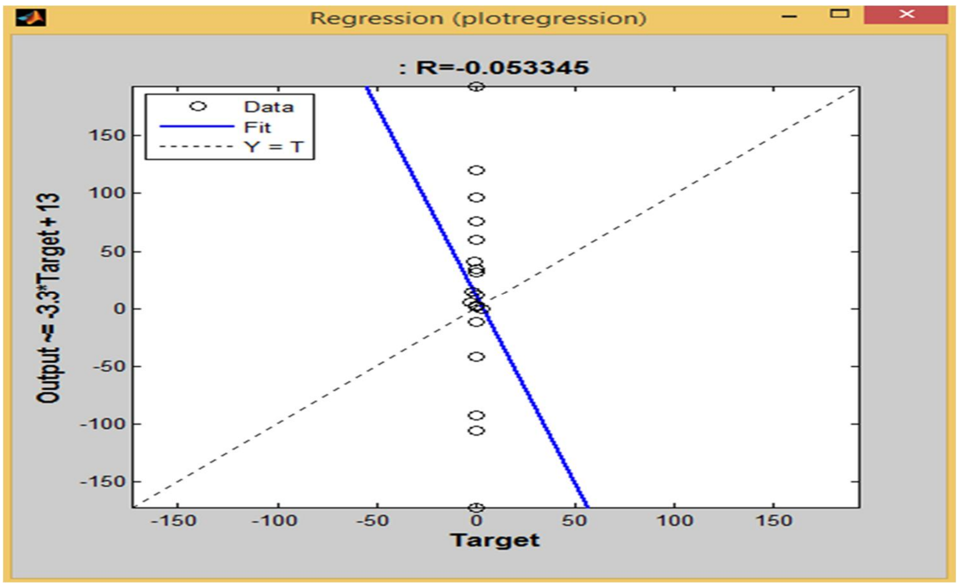

Figure (5-2): non-idel hospital regression

Figure(5-2) shown the regression of non-idel hospital which is equal to 0.05. The range of non-idel hospital is between (0 to 0.5). Table (5-2) describes the regression of 20 non-idel hospital.

5.1.5 Performance evaluation of ANNS:

For checking the results the accuracy, sensitivity and specificity for FFBP and Competitive nueral network are calculated from table (5-1) and (5-2) using four categories output which are true positive (TP), false positive (FP), true negative (TN) and false negative (FN). This performance analysis is given in table (5-3).

Table (5-3): Performance analysis

Categories	Sensitivity	Specificity	Accuracy
FFBP	97.61%	97.5%	96.37%
Comp net	90.63%	89.5%	88.67%

5.2 Discussion

The study for prediction of patients saftey has been carried out using Feed forward back propagation algorithms and competitive neural network. The results of this study demonstrate that an ANN model with variables consisting of is classified a total of 20 of hospitals correctly to idle and nonidle.

Comparison of Feed forward back propagation and Competitive Network values from table (5-1), table (5-2) and table (5-3) shows that good performance is obtained in Feed-forward Backpropagation (FFBP) than Competitive networks. These results were obtained after many training, validation and performance evaluations.

From the results it is evident that the Feed forward back propagation FFBP network is better when compared to the Competitive network.

Chapter Six

Conclusions and recommendations

6.1 Conclusions:

In this research a method for the analysis of patient safety to detect an idle hospital and non-idle hospital using questionnaire has been presented. The data from questionnaire extracted are successfully used to train the neural network to detect the non-idle hospital. The performance of the FFBP network is better compared to the CNN networks in classifying hospitals. This contribution presented a new application of the neural network classifier to detect the idle and non-idle hospital.

6.2 Recommendations:

The recommendations are to

1. Patient safety helps to minimize errors because errors cannot be eliminated just can reduce them learn from them.

2. Increase the sample size to get more accurate result.

3. Use more artificial neural network model for comparison or use another technique to get better result.

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Appendix A

MATLAB code:

```
fprintf('enter the data\n');
q=input('enter ur data as matrix');
q(1)=((q(1)-1)/(9-1+1));
q(2)=( (q(2)-1)/(9-1+1));
.
.
.
q(20)=( (q(20)-1)/(9-1+1));
net=setx(net,w);
y=sim(net,x);
r=corrcoef(x,y);
z=r(1,2)
R=abs(z)
If 1>R>0.5
disp('an idle hospital')
Else
Disp('non-idle hospital')
net=setx(net,w);
y=sim(net,a1);
r=corrcoef(y,l);
R=r(1,2)
End
```

Appendix B

Questionnaire

Domain 1: generating ideas

Statement	Yes	No
All ideas for change are welcomed, and they always receive positive feedback.		
Ideas from new or junior staff are especially encouraged and welcomed.		
If someone has a good idea, it is usually given rapid approval.		

Domain 2: good communication between junior and senior staff

Statement	Yes	No
Junior staff are always able easily to initiate discussions with senior staff.		
Senior staff encourage junior staff to talk about problems.		
Senior staff voluntarily share information with junior staff.		

Domain 3: good communication between clinicians in different professions

Statement	Yes	No
Almost all patient documentation is shared among all clinical professions.		
We have clear rules about the conduct of our clinical team meetings.		

- In our clinical team meetings, we make sure that everyone feels free to participate regardless of seniority or clinical profession.

Domain 4: shared management of information systems

- All patient care documents are subject to review by the entire multidisciplinary team.
- All patient information is easily available for all the care team.
- There are too many routine statistics to collect.

Domain 5: shared responsibility and accountability

- Every problem is a shared problem.
- We don’t spend time trying to find someone to blame.
- We believe that we should openly admit our mistakes.

Domain 6: continuous learning

- We are always monitoring and evaluating.
- We regularly ask each other for advice.

Domain 7: team work

If someone asks for help, people are happy to give it.

Everyone talks about ‘our’ patients rather than ‘my’ patients.

Patients are considered part of the team.

Appendix C

Equations

Accuracy = (TP + TN) / the number of data …………….. (1)

Sensitivity= TP / (TP+FN) ……………………………………….. (2)

Specificity= TN / (FP+TN) …………………………………….. (3)