Enhancing Effectiveness of Penetrating Keratoplasty Using Decision Support System

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Researchers so far has expanded the knowledge of MIS to include practice and operations management, developing more effective shared decision making and transparent medical records, and promoting the close personal connection that both doctors and patients want. In Ophthalmology Decisions based on clinical examination are critical in practice. The ophthalmologist will rely on the clinical examination, of the patient, to answer three basic questions: what is wrong (diagnosis), what can we expect in the future (prognosis), and what can we do about it (effect of treatment)? Complete information is required for clinical decisions related to patient care decisions which are made every day. Patients vary clinically, uncertainty exists in diagnostic and prognostic information and many preventive and treatment alternatives have not been formally assessed for their effectiveness. Since deterministic information will never answer all clinically questions, clinically decisions are partially based on probabilistic information. In case of penetrating Keratoplasty an ophthalmologist surgical process the decision making process involved in determining how an individual eye should be surgically customized, can therefore be complicated. These are the situations where decision support systems become most beneficial, to ensure consistent successful results, particularly if technical measurements are performed by individuals with varying degree of experience. In present work, a conceptual design of decision support system using neural network or genetic algorithms has been proposed, which can be used for forecasting of patients who have undergone penetrating keratoplasty, after validating design with past data. Methodology of proposed conceptual design includes firstly design of Decision support system using neural networks or genetic algorithm, after development of system design past data collection and using it for validation. The expected outcome are some very useful information for patients, are in term of diagnosis, prognosis and measuring effectiveness of treatment.

INTRODUCTION

There has been an exponential growth in medical and surgical techniques. Most of the steps adopted by surgeons during surgery depend on factors like clinical data available for decision making to surgeons, experience of own and Decision Support System (DSS) and Management Information System (MIS) designed for surgeons. The significance arises out of the complexity of decision-making, the human factors in the decision-making, the organizational and behavior aspects, and the uncertain environments. The MIS design addressing these significant factors turns out to be the best design.

The main purpose of management information system is to ensure the flow of appropriate information to the appropriate people as well as related parties. So that better decisions can be made by both internal and external agencies. The entire process objective is to provide complete, timely, reliable and quality information's to the decision makers. The relevance of the decision-making concepts is significant in the MIS design.

Various researches conducted proving uses and importance of DSS and MIS in surgical techniques. Robert L. Wears and Marc [1] in their research demonstrated that Process-supporting information technology (IT) has been heralded as an important building block in attempts to improve the quality and safety of health care. Two areas in particular have drawn both attention and funding. The first is clinical decision support; that is, information systems designed to improve clinicians' decision making. The second is computerized physician order entry (CPOE) as a means for reducing medication errors. David C. Classen et al [2] in their article also support the fact that Use of Computerized Physician Order Entry (CPOE) and isolated Clinical Decision Support Systems (CDSSs) can substantially reduce medication error rates. A number of studies have assessed the impact of CPOE with respect to a variety of parameters, including costs of care, medication safety, use of guidelines or protocols, and other measures of the effectiveness or quality of care. Peter A. Gros and David W. Bates [3] also support the fact that Incorporation of clinical decision support (CDS) capabilities is required to realize the greatest benefits from computerized provider order entry (CPOE) systems.

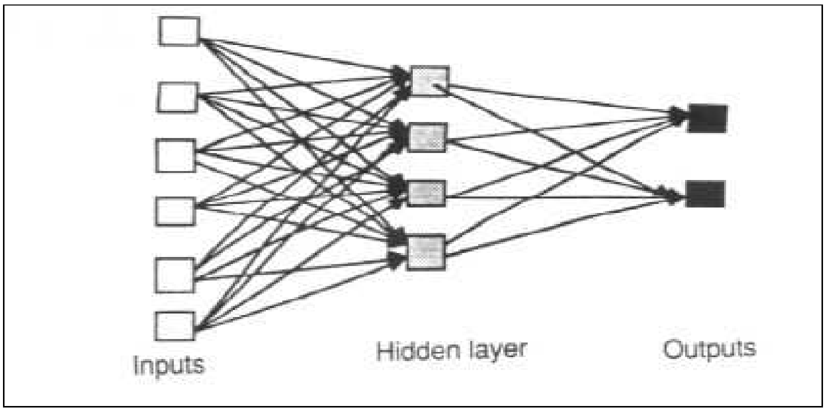
The present work is conceptual methodology to design DSS/MIS for ophthalmologist, in forecasting the surgical outcomes before surgery depending on the decision rules designed on basis of past surgical data. Collected past surgical data can be programmed with the help of neural network (NN) so that it can help in forecasting outcome before surgery.

Use of MIS/DSS in Ophthalmology

In the field of ophthalmology also various researches conducted related to DSS, which help the ophthalmologist at various stages of deceased management. Research conducted by J van der Meulen and J Rahi [4]shows that the ophthalmologist will rely on the clinical examination, in particular ophthalmoscope, to answer three basic questions: what is wrong (diagnosis), what can we expect in the future (prognosis), and what can we do about it (effect of treatment)? But how reliable and accurate are ophthalmoscope observations and how useful is ophthalmoscope to support therapeutic decisions?

- **Artificial neural networks as a tool**
  An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. ANNs, like people, learn by example. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process.

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. Other advantages include Adaptive learning, Self-Organization, Real Time Operation, Fault Tolerance via Redundant Information Coding. With application in Sales forecasting, Industrial process control, Customer research, Data validation, Risk management, Target marketing
The commonest type of artificial neural network consists of three groups, or layers, of units: a layer of "input" units is connected to a layer of "hidden" units, which is connected to a layer of "output" units.



An example of a simple feed forward network

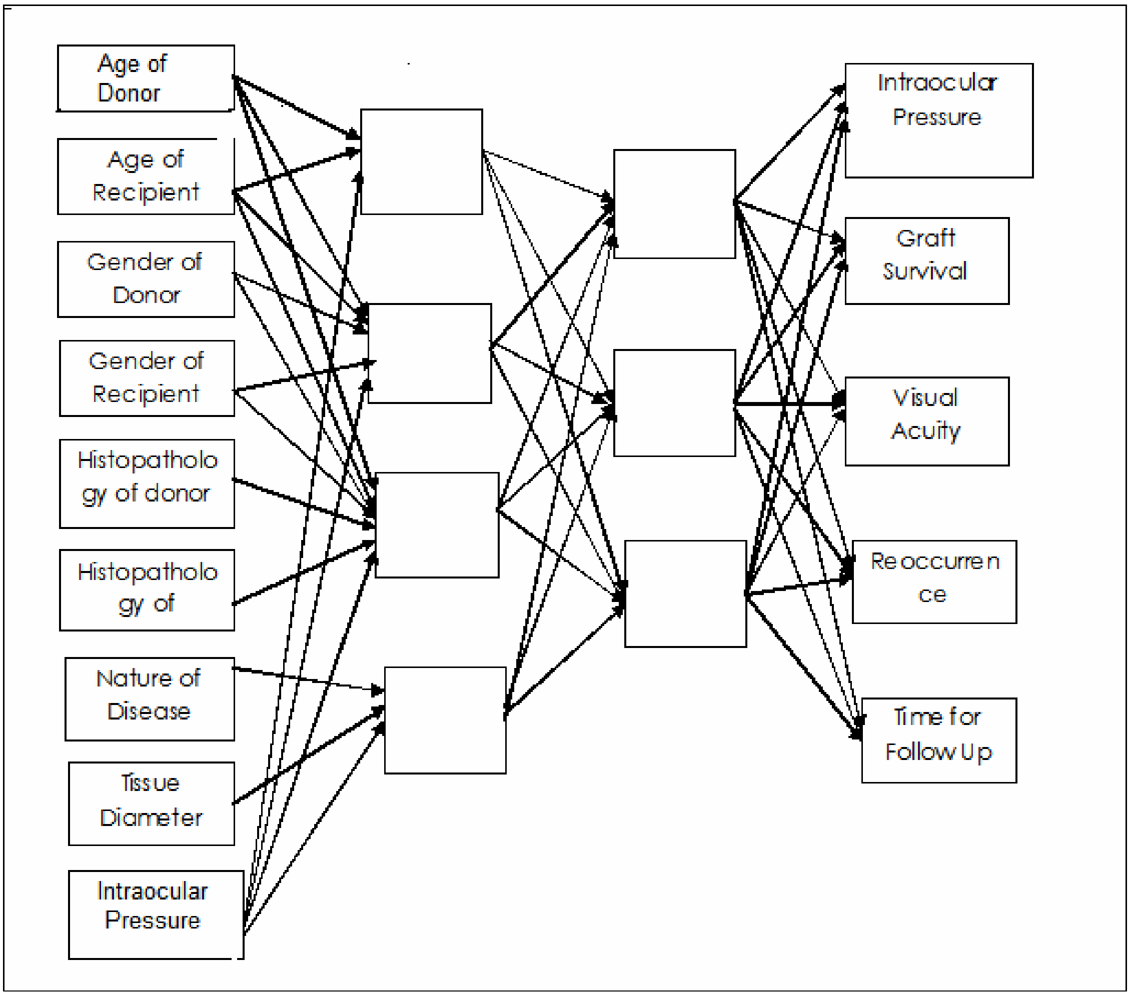
In feed forward neural network connections between the units do not form a directed cycle. In this network, the information moves in only one direction, forward, from the input nodes, through the hidden nodes (if any) and to the output nodes.
A recurrent neural network (RNN) is a class of neural network where connections between units form a directed cycle. This creates an internal state of the network which allows it to exhibit dynamic temporal behavior.
The hidden units are free to construct their own representations of the input. The weights between the input and hidden units determine when each hidden unit is active, and so by modifying these weights, a hidden unit can choose what it represents.
The single-layer organization, in which all units are connected to one another, constitutes the most general case and is of more potential computational power than hierarchically structured multi-layer organizations. With two memorization patterns viz. supervised learning, which incorporates an external teacher and unsupervised learning uses no external teacher and is based upon only local information.
Artificial Neural Networks (ANN) is currently a research area in medicine and it is believed that they will receive extensive application to biomedical systems in the next few years. At the moment, the research is mostly on modeling parts of the human body and recognizing diseases from various scans (e.g. cardiograms, CAT scans, ultrasonic scans, etc.).

Neural networks are ideal in recognizing diseases using scans since there is no need to provide a specific algorithm on how to identify the disease. Neural networks learn by example so the details of how to recognize the disease are not needed. What is needed is a set of examples that are representative of all the variations of the disease. The quantity of examples is not as important as the 'quantity'. The examples need to be selected very carefully if the system is to perform reliably and efficiently.

- **Use of Ann in Opthalmology**
  Various researches have been conducted showing uses of NN in ophthalmology. Luca Brigatti et al [5] concluded in their study that A neural network can be trained to recognize visual field progression in good concordance with experienced observers. Neural networks may be used to aid the physician in the evaluation of glaucomatous visual field progression.Mutlukan E, Keating D[6] in their study suggested that neural networks incorporated into PC-based video-camp meters may enable correct interpretation of results in non-specialist clinics or in the community.Vitali Sintchenko and Enrico Coiera in their book of Clinical Bioinformatics [7] wrote that there is a growing demand for tools to support clinicians utilize genomic results generated by molecular diagnostic and cytogenesis methods in support of their decision-making. It provides a roadmap for identifying decision tasks for automation and selecting optimal tools for building task-specific systems. Key success factors for EDSS implementation and evaluation are also outlined. Alfredo Vellido and Paulo J. G. Lisboa [8] shows in their book Computational and Ambient Intelligence that Evidence-based medicine has grown in stature over the last three decades and is now regarded a key development of modern medicine. The evidence base can be heterogeneous, involving both qualitative knowledge and measured quantitative data. Machine Learning (ML) methods have also begun to establish themselves as an alternative and promising approach to computer-based data analysis in oncology, as this field moves gradually away from being the preserve of traditional statistical analysis. In this paper, we describe the main areas of cancer research in which ML methods are currently being applied, and briefly discuss some of the advantages and disadvantages of their application.

METHODOLOGY

The present work is conceptual methodology to design DSS/MIS for ophthalmologist, in forecasting the surgical outcomes before surgery depending on the decision rules designed on basis of past surgical data. Collected past surgical data can be learned with the help of artificial neural network (ANN) so that it can help in forecasting outcome before surgery. Past surgical data both pre and post operated has been collected and for developing ANN, parameters used for training are age, gender, nature of diesease, intraocular pressure (IOP) and histopathological data of the cornea and tissue diameter. Also parameters of training are the donor tissues data like Age, Gender and histopathology.



INPUT LAYER FIRST HIDDEN LAYER SECOND HIDDEN LAYER OUTPUT LAYER

Proposed Feed Forward Four Layered Artificial Neural Network

The proposed ANN is of feed forward type as it is best suited for forecasting purpose. There are total nine parameters (Age of Donor, Age of Recipient, Gender of Donor, Gender of Recipient, Histopathology of Donor, Histopathology of Recipient, Nature of Disease, Tissue of Diameter, Intraocular Pressure),treated as an input to ANN. These parameters are associated as shown in diagram with four layered architecture. Association of inputs at second layer (first Hidden Layer) are-

- Between Age of Donor & Recipient and Intraocular Pressure.
- Between Age of Donor &Recipient, Gender of Donor &Recipient and Intraocular Pressure.
- Between Age of Donor &Recipient, Gender of Donor &Recipient, Histopathology of Donor& Recipient and Intraocular Pressure.
- Between Nature of Disease, Tissue of Diameter, Intraocular Pressure.

At the third layer(second hidden layer)all output from second layer(first hidden layer) associated mutually and finally output layer obtained where expected output will be in terms of Intraocular Pressure, Graft survival, visual Acuity, Reoccurrence and time of follow up. After the construction supervised training of network shall be done with past, pre and post operative, data of patient with corneal disorders and who has undergone same procedure. So that the weights between associations are defined and network shall be validated again with past data which has not been used for training data. So it is expected that proposed four layered ANN will help in forecasting, so ophthalmologist can use forecasted result for betterment of patient.

OUTCOME

It has been expected that proposed DSS/MIS will help in forecasting visual function of patient in term of Intraocular Pressure, Graft survival, visual Acuity, Reoccurrence and time of follow up. It has been observed that when forecasted outcome of surgery is predefined prior to surgery necessary measures can be taken for the betterment of visual condition and satisfaction of patient as well. So this work focuses on the same and expected outcome is forecasted surgical outcome which help ophthalmologist to take better measure at time of surgery.

CONCLUSION

It has been expected that proposed DSS/MIS will help in forecasting visual function of patient in term of Intraocular Pressure, Graft survival, visual Acuity, Reoccurrence and time of follow up. It has been observed that when forecasted outcome of surgery is predefined prior to surgery, necessary measures can be taken for the betterment of visual condition and satisfaction of patient as well. So this work focuses on the same and expected outcome is forecasted surgical outcome which help ophthalmologist to take better measure at time of surgery.

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