MEMCONSULT : AN APPROACH TO USER-ORIENTED COMPUTER-ASSISTED DECISION MAKING IN MEDICINE FOR DIFFERENTIAL DIAGNOSIS AND TREATMENT

By

Lieut. Colonel N. G. RAO

Army Medical Corps.

Thesis submitted to the
INDIAN INSTITUTE OF TECHNOLOGY
for the award of the degree of
DOCTOR OF PHILOSOPHY

Centre for Biomedical Engineering
INDIAN INSTITUTE OF TECHNOLOGY NEW DELHI
1985

C E R T I F I C A T E

This is to certify that the thesis entitled "MEMCONSULT : AN APPROACH TO USER-ORIENTED COMPUTER ASSISTED DECISION MAKING IN MEDICINE FOR DIFFERENTIAL DIAGNOSIS AND TREATMENT" submitted herewith by Lt. Colonel (Dr.) N.G. Rao to the Indian Institute of Technology, New Delhi for the award of the degree of Doctor of Philosophy in Biomedical Engineering is a bona fide research work carried out by him. He worked under our guidance and supervision. His work and thesis fulfils the requirements and regulations relating to the award of the degree.

The contents of this thesis have not been submitted in part or full to any other university or institute for the award of any degree or diploma.

(Prof. P.G. Reddy)
Dean, School of Mathematics
and Computer Science,
University of Hyderabad,
Hyderabad.

(Prof. S.K. Guha)
Professor of Biomedical Engineeri
Indian Institute of Technology, a
All India Institute of Medical
Sciences, New Delhi.

Dedicated to

My parents Dr (Late) N. Rama Rao and
Mrs (Late) Rajeswari

and

My organisation, ARMY MEDICAL CORPS

To parents go love, faith and honesty
To teachers go obedience and respects among many-a-thing
To colleagues go gratitude, loyalty and modesty
To parent organisation let go everything.

ACKNOWLEDGEMENT

The author is highly indebted to his two supervisors, Prof. S.K. Guha and Prof. P.G. Reddy for their eminent guidance, constant supervision and overwhelming encouragement throughout his research work. He is also grateful to all the teaching and non-teaching staff in the Centre for Biomedical Engineering, All India Institute of Medical Sciences and Indian Institute of Teohnology, New Delhi, Centre for Computer Sciences and Engineering, I.I.T. New Delhi, the patient records sections in AIIMS, Safdarjung Hospital, and Jaiprakash Narayan Hospital, Army Hospital and Base Hospital, New Delhi and Armed Forces Medical College and Command Hospital, Pune. He is thankful to all the internes, residents, and consultants in medicine, haematologists, pathologists and statisticians in all the above merrtioned hospitals for their kind help in providing patient data on many interesting cases, atypical patients and their valuable discussions. Speoial mention of gratitude is due to Dr. (Miss) Manorama Gaiha, Dr. (Mrs) M. Bhargava, Dr. (Mrs) V. Kochupillai, Dr. B. Ram and Maj. Gen. I.M. Ahuja for their consultant level disoussions, suggestions and untiring overtime work.

The author owes his debt much to Lt. Gen. S.N. Chatterjee (Retd), Lt.Gen. Ved Prakash (Retd) and Lt.Gen. L.N. Budh Raja (Retd) who were all ex Director Generals of Armed Forces Medical Services and Lt.Gen. A.R.Subramanian, the present DGAFMS, Lt.Gen. A. Banerjee, the present DGMS (Army), Lt.Gen. P.V. Ramanaiah (Retd), Maj.Gen. B.A. Rao (Retd), Maj.Gen. N. Narasimhan (Retd) who directly or indirectly encouraged the author to take up and pursue this high level research work in Biomedical Engineering.

The author remains grateful for ever to Dr. B.E. Prasad and Mr. Sanjay Gupta for their kind association with him from the beginning of his work, suggestions, discussions, guidance and help at all stages and in all aspects of the present work and its implementation in ICL-2960 Computer System at I.I.T., New Delhi.

His gratitude can not be expressed in words to his wife Vijaya and children Anu and Ram Kiran for their immense patience, cooperation and help throughout his study and research years.

The author is highly indebted to Dr. Y.B. Reddy for his enormous patience in sorutinising the whole thesis repeatedly a number of times, to his wife for providing the necessary climate and timely refreshments, to C.S. Krishna Rao and C. Sriniwas for their help in the strenuous job of proof reading and corrections, to Mr. Lakhvinder Singh, Dr. Jagdish, Dr. Vijaya Saradhi for their kind general assistance, and finally to Mr. J.S. Bedi for his excellent typing.

ABSTRACT

Making an early and correct decision in diagnosis of a disease and a therapeutic schedule for it when faced with a case of not an ordinary and common nature has always been a challenging task to clinicians. Since the earliest introduction of computers in medical field, an intensive search is going on to find whether computers can be of some help in this type of situations. Many systems and programs have been developed based on different methodologies suiting some specific diseases and disease groups. Suitability for generalised application, user-orientation and user satisfaction have been lacking in many of these. The nature of the 'expert systems' in medicine and their purpose have been clearly defined by many research workers. Mimicking a human expert's thinking and mode of action has been identified as the major factor for earning users' acceptance and making a routinely usable system. The main aim of the computer-assisted clinical consultation has been accepted as imparting the clinical acumen and expertise of an experienced clinician of a consultant level to an inexperienced junior clinician to achieve the best possible health care delivery to the society.

Considering essentially, the conditions of Indian hospitals and their environment, the search for

a simpler expert consultation system with a semi-artificial intelligence approach and a minimum response time to obtain the consultation resulted in a user-oriented methodology named 'MEMCONSULT' meaning in short consultation of memory of past experiences on similar types of patients. In this method of decision making, the program consults a large number of actually occurred and treated past cases (both typical and atypical) stored in the memory in the form of a data base to find the nearness of an undiagnosed fresh case to one of the stored cases and thereby to come to a decision on the most likely diagnosis and a desirable therapeutic schedule. This process is similar to the action of a human clinician who consults his own memory on similar cases when faced with a problematic patient.

Many useful facilities have been incorporated to make 'MEMCONSULT' equivalent to an ideal expert system such as self reviewing and decision revising capability, detection and differentiation of atypical cases, a simple access to past cases of similar nature, as a step towards reasoning of the decision on the most likely diagnosis and accessing standard text book knowledge base to serve as a counter check for the accuracy of 'MEMCONSULT's decisions.

A most common and complex disease group, 'Anaemia' which has many differential diagnoses has been taken for evaluation of the presented methodology. The results are very encouraging.

The procedure and methodology of validation of clinical data also has been planned on the basis of qualitative requirements of users and also based on importance as a prerequisite for usage of the computerised clinical data for diagnostic and therapeutic decision making. A non-statistical approach aimed at multi-user satisfaction has been adopted for validation.

This research work is a step towards the development of a user-oriented computer-assisted medical expert system to have a quick consultation equivalent to an experienced clinician of consultant status and it can fulfil the existing needs of Indian hospitals.

CONTENTS

PAGE