

COMPUTER ASSISTED DIAGNOSES FOR RED EYE (CADRE)

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ABSTRACT -This paper introduces an expert System (ES) named as “CADRE-Computer Assisted Diagnoses for Red Eye. Mostly the remote areas of the population are deprived of the facilities of having experts in eye disease. So it is the need of the day to store the expertise of Eye specialists in computers through using ES technology. This ES is a rule-based Expert System that assists in red-eye diagnosis and treatment. The knowledge acquired from literature review and human experts of the specific domain was used as a base for analysis, diagnosis and recommendations. CADRE evaluates the risk factors of 20 eye diseases and works just like an ophthalmologist, which will be useful for students, doctors and researchers as well as to patients. This expert system (ES) was developed through using ESTA, VISUAL BASIC, MS-EXCEL, Seagate Crystal Reports and Image Styler. This ES is not limited to the Red-eye diseases but can be extended to all types of eye-diseases.

I. INTRODUCTION

The interest of mankind in medical decision support systems and establishing guidelines for physicians reach back to New-Babylonian era (N650 Bc). In modern times, people have recognized that computers might support physicians in the diagnostic and therapeutic process. In the late 1950's articles dealing with this probability appeared___LEDLY and LUSTED published their classical paper “Reasoning foundations for medical diagnosis”, followed by the first generation of systems that attempt to assist the physicians in medical decision making. At the beginning of 1970's the researchers were drawn to the field of Artificial intelligence. Now it was possible to develop ES dealing with uncertain

and incomplete medical knowledge. The most famous examples of early Expert Systems are: Mycin., an expert system for diagnosing and recommending treatment of bacterial infections of the blood, developed by short liffe and associated at Stanford university, deDombal's leeds abdominal pain., an expert system for acute abdominal pain, developed by F.T deDombal at university of Leeds. Help System: a hospital-based system, developed at LDS Hospital in Salt Lake City. Recent years have seen an enormous development in medical expert systems and the systems now available are mature enough for targeted adoption in practice. In order to deliver health-care even more effectively, Expert systems will be impressively integrated. The CADRE's will be distributed free of cost to Ophthalmology depts.: of all medical colleges & hospitals.

All health care professionals including, ophthalmologists, medical students, pharmacists can keep their knowledge up-to-date regarding “Red-eye diagnoses and treatment”, as its knowledge base external database is updated on regular basis.

Up to the best of our knowledge no such system is available in the country.

CADRE will help ophthalmologists for diagnosing patients suffering from various eye diseases in which Red-eye is the common symptom.

II. OBJECTIVES

Following are the main objectives to develop CADRE.

- To assist the eye patients as first aid diagnosis
- To implement the IT in real world problems.
- To assist ophthalmologists for diagnosing various diseases associated with red eye i.e. to be a home assistant for ophthalmologists.
- To assist Medical students working as in ophthalmology labs.
- To help general practice doctors, nurses, nursing students etc:
- To provide researchers a huge and up-to-date repository of information regarding Red-eye (all those diseases of eye in which Red-eye is common Symptom).
- To provide a web based version that will facilitate all related individuals in their rooms.

III. MATERIALS AND METHODS

Methodology for development of the CADRE is given as under.

A. SCOPE & LIMITATIONS

CADRE deals with following *twenty* Red eye diseases:

1) Blepharitis, 2) Bacterial keratitis, 3) Endophthalmitis, 4) Episcleritis, 5) Scleritis, 6) Chalazion, 7) Corneal ulcers, 8) Uveitis, 9) Ocular Rosacea, 10) Ectropion, 11) Entropion, 12) Foreign body and Red eye, 13) Viral Conjunctivitis, 14) Orbital Cellulitis, 15) Allergic Conjunctivitis, 16) Iritis, 17) Acute Angle-closure Glaucoma, 18) Bacterial Conjunctivitis, 19) Herpes Zoster, 20) Dry Eye Syndrome.

3.2 KNOWLEDGE ACQUISITION

- Searching for relevant books, libraries and World Wide Web (WWW).
- Meetings with ophthalmologists, medical students and patients.
- Personnel observations and getting historical data from various ophthalmology clinics, depts. and wards in hospital, free eye camps, other health care units and medical colleges.

3.3 KNOWLEDGE REPRESENTATION

- Using production rules facilitated by ESTA.

- Storing additional information using external database.

3.4 SOFTWARE DEVELOPMENT

Different software modules, like: Visual Prolog, ESTA, MS Excel, Visual Basic, Seagate Crystal Reports, and Image Styler, were integrated to develop the software. Validity of software was checked for sample data being acquired through various sources.

3.5 IMPLEMENTATION & MAINTENANCE

Expanding scope of CADRE by giving it inputs from different sources like World Wide Web, recent research conducted in the field of ophthalmology.

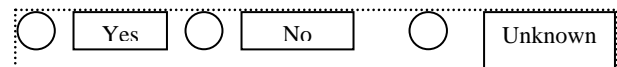
Implementation of software in different health care depts.: e.g. hospitals, clinics medical college labs, free eye camps etc.

IV. HOW THE CADRE DOES WORK?

Proposed system strictly incorporates the diagnostic criteria followed by human experts. There are twenty diseases associated with "Red Eye" with each disease having average of twelve symptoms. System is able to diagnose all twenty diseases of eye in which Red-eye is the common symptom. CADRE's working model is comprised of following modules symptom analysis phase-I, symptom analysis phase-II, disease selection with appropriate percentage, medicine selection for disease diagnosed, knowledge base, and user interface design.

V. SYMPTOM ANALYSIS

When system is turned on and option "consultation" is selected from the main menu then all symptoms of 20 diseases i.e. 20*10=200 symptoms approx: appear in question answer format. User answers "yes" or "no" when "yes" is clicked/checked then risk factor retains its previous value. e.g. Do you feel that your eyelashes are turning inwards?



If user checks "yes", then following action takes place:

Assign bleph_fact:=bleph_fact+10

If "No" or "Unknown" is checked then bleph_fact retains its previous value. In this Question answer session if risk factor of one/more diseases get increased from 40 then their follow-up question are asked. This is beginning of phase-II.

VI. SYMPTOM ANALYSIS

In this phase, detailed/remaining/follow-up questions of only those diseases are asked whose risk factors are greater than 40. Thus no. of questions (symptoms) in this phase are less than phase-I. User again answers yes/no/unknown to follow up questions. At the end of this follow up session disease(s) is/are diagnosed in the form of percentage i.e. all possible diseases are listed along with percentages that a patient can suffer from. Diagnostic report also contains suggested treatment /prescription. Annex-III & Annex-IV shows CADRE's diagnostic report. Internal working model of CADRE's symptom-analysis phase -I and symptom analysis phase-II is shown in Annex-I.

VII. CADRE'S KNOWLEDGE BASE DESIGN

CADRE is developed on shell based approach. In shell based approach knowledge acquisition subsystem, inference engine, explanation facility, interface subsystem and knowledge management system are integrated into one component called shell. PDC's expert system shell, ESTA is easy to use and great stand-alone environment for constructing advisory and decision support system. Building advance knowledge bases with ESTA (Expert system Shell for Text Animation) requires NO previous programming experience, which is suitable for many problem domains. No extensive programming experience is required to formulate declarative and procedural knowledge. IF-THEN-ELSE rules are represented in plain English. ESTA's K.B, is comprised of sections and parameters. Sections contain rules that tell the ESTA how to solve problem. Section tree used in CADRE is shown in Annex-IV.

Parameter is a variable that can have a value (text, number, true/false). Example of parameter used in CADRE is shown in Table 1.

TABLE I. SAMPLE PARAMETER USED IN CADRE

Parameter red: 'redness in the eye'
Type: Boolean
Explanation 'there is red patch in the White area of your eye'
Question 'Is there any redness in your eye?'
Picture 'red eye'

7.1 RISK FACTORS

As there are twenty diseases in CADRE's scope, so twenty different risk factors are declared and initialized for each disease, shown in Table 2 (ANNEXURE-II).

7.2 EXTERNAL DATABASE

CADRE's K.B is supported by external database, which contains different files to store drugs, disease, symptom and patient information.

VIII. USER INTERFACE DESIGN

The acceptability of an expert system depends to a great extent on the quality of user interface. The easiest to implement interfaces communicate with the user through a scrolling dialogue. The user can enter commands and respond to questions. The system responds to commands, and asks questions during the inference process.

Fig.1 shows the working details of the CADRE having buttons like:

OK: this button is used to accept the value for the parameter in the interface, as user selects the value or enter the value.

Stop: this button is used to stop consultation.

Why: explain for which purpose the value of the parameter is required or question is asked from user.

Explain: explains question in detail.

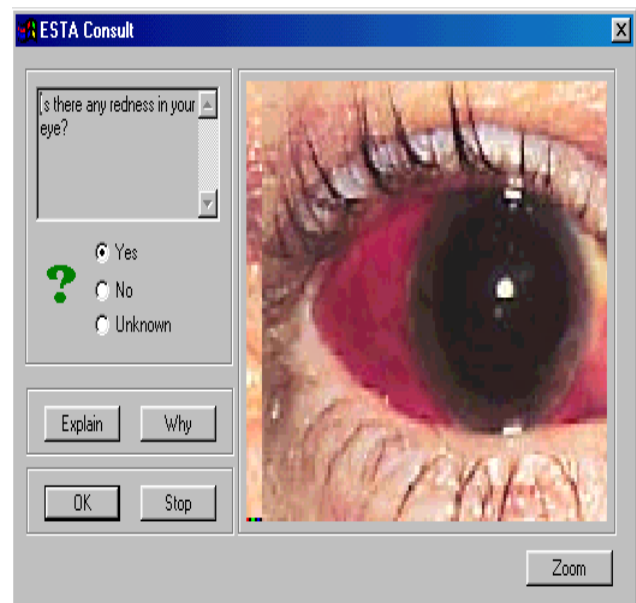


Fig. 1: CADRE Main Menu

CADRE provides advance interface design making heavy use of pop-up menus, windows, pictures and graphs.

IX. RESULTS AND DISCUSSION

When the patient visits an ophthalmologist, he/she consults "CADRE" to diagnose the patient. He turns on "CADRE" and series of questions appear on computer screen. The ophthalmologist thoroughly checks the patient and accordingly he/she

(Ophthalmologist) answers the questions asked by the “CADRE”. This ES gets inputs from the users, after symptoms analysis, pattern matching is made through using forward as well as backward reasoning of the production rules. The end result of this phase is a “diagnostic report” about the patient under examination, suggesting a possible disease. It also suggests proper consultation and treatment for that particular disease. If the patient himself/herself uses this system without the services of ophthalmologist, he/she can easily get benefit from it through getting answer to questions, like, EXPLAIN and WHY. Table-3 shows a sample session with CADRE.

Table 3: Sample Session with CADRE

CADRE:	Do you feel eye-pain, especially with eye movement?
Patient	Yes.
I. CADRE:	IS THERE ANY PAINFUL SWELLING OF THE UPPER EYELID?
Patient	Yes.
CADRE:	Eyes red or not?
Patient	Yes.
CADRE:	Is there any irritation, gritty or sandy feeling?
Patient	No.
CADRE:	Do you feel fever, malaise or headache?
Patient	Yes
CADRE:	Is there any light sensitivity?
Patient	No
CADRE:	The eye movement is restricted or not?
Patient	Yes.
CADRE:	Eye lids appear shiny and appear red or purple in color?
Patient	Yes.
CADRE:	Do you feel partial loss of vision?
Patient	Yes.

After a detailed dialogue system resulted in with the following suggestion:

You have chances of suffering from a red-eye disease “ORBITAL CELLULITIS” Risk factor = 80%. See anextures I, II, III and IV for detail.

X. IX. CONCLUSION AND FUTURE ENHANCEMENT

Medical experts systems are doctor’s silent partners. They make them help in diagnoses and treatment of disease in the form of clicks. System will be extended and upgraded to diagnose all ophthalmic diseases, soon it will be made available on Gomal University official website as free/open downloadable source. It will be distributed free of cost to ophthalmology departments of all hospitals and medical colleges of Pakistan and other countries.

XI. REFERENCES

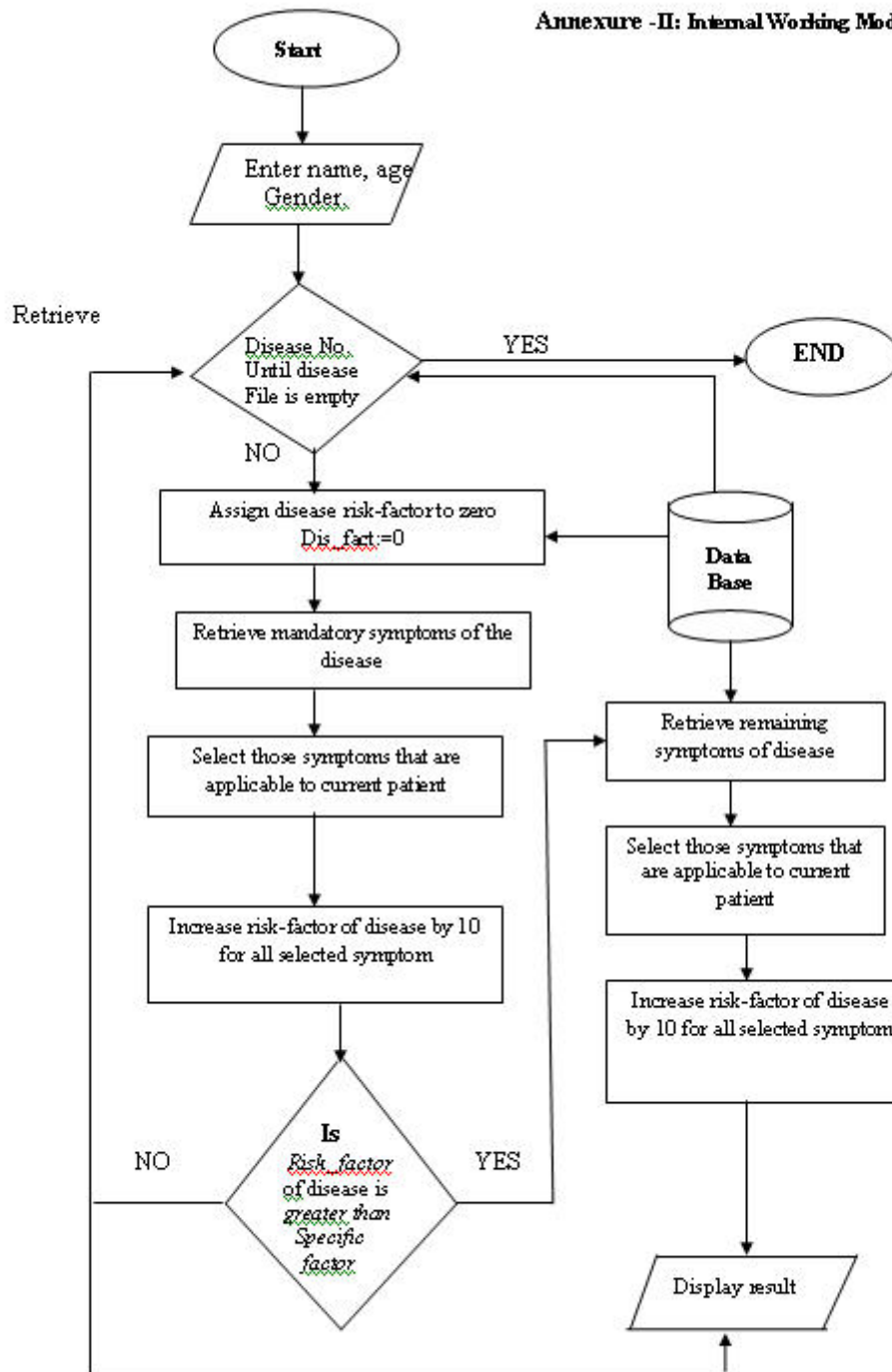
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Annexure-I: Diseases with their Risk Factors

Table 2: Diseases and Risk factors

Disease Name	Risk Factor	Initial Value
Blepharitis	blep_fact	0
Bacterial keratitis	bkera_fact	0
Endophthalmitis	endo_fact	0
Episcleritis	epis_fact	0
Scleritis	scle_fact	0
Chalazion	chal_fact	0
Corneal ulcers	ulcer_fact	0
Uveitis	uve_fact	0
Ocular Rosacea	ocu_fact	0
Ectropion	ect_fact	0
Entropion	ent_fact	0
Foreign body	fbody_fact	0
Viral Conjunctivitis	vcong_fact	0
Orbital Cellulitis	ocell_fact	0
Allergic Conjunctivitis	acong_fact	0
Iritis	irit_fact	0
Acute Angl-Clsr Glcma	glau_fact	0
Bacterial Conjunctivitis	bact_fact	0
Herpes Zoster	hzos_fact	0
Dry eye Syndrome	dry_fact	0

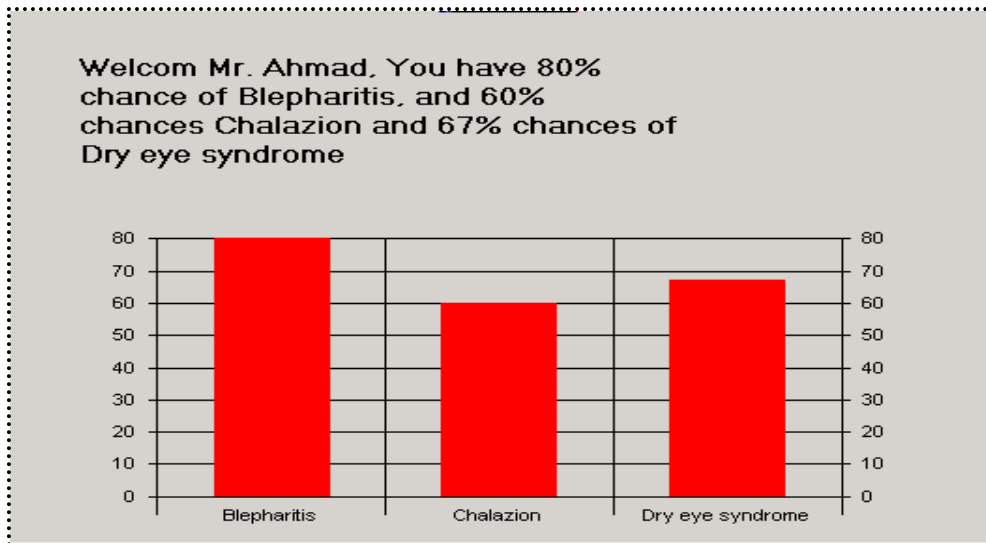
Annexure -II: Internal Working Model of CADRE



Annexure -III Sample Report

CADRE'S (Computer Assisted Diagnoses for Red Eye)			
DIAGNOSTIC REPORT			
Patient's Biodata			
NAME	<i>Asghar</i>	AGE	<i>27</i>
GENDER	<i>M</i>		
DISEASE DIAGNOSED	<i>Blepharitis</i>	CHANCES (Risk factor)	<i>91 %</i>
PRESCRIPTION			
DRUG NAME	TYPE	FREQUENCY	REGIME
Maxitrol	Eye Ointment	_____	at night
Erythrocin	Tablets	1-tablet	2- times daily
Erythrocin	Tablets	1-tablet	2- times daily
DATE	<i>2/25/2004</i>		
	Signature -> _____		

Annexure-IV Sample Graphical Diagnostic Report



Annexure -V: Section Tree used in CADRE Knowledge Base

