NEPHROLOGICAL DISEASE DIAGNOSIS EXPERT SYSTEM IN LISP

P-160

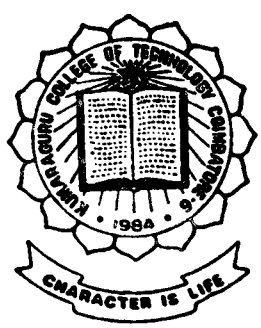
By

SUMANT. M
BIJU PAUL
ALEXANDER MATHEW

Under the Guidance of

Mrs. T. Gomathy, B. E.

PROJECT WORK SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF ENGINEERING IN COMPUTER SCIENCE AND ENGINEERING OF THE BHARATHIAR UNIVERSITY



APRIL - 1992

Department of Computer Science and Engineering

Kumaraguru College of Technology

COIMBATORE - 641 006

Department of Computer Science and Engineering

Kumaraguru College of Technology

COIMBATORE - 641 006

CERTIFICATE

Register No.

This is to Certify that the Report entitled

NEPHROLOGICAL DISEASE DIAGNOSIS EXPERT SYSTEM IN LISP

has been submitted by

Mr._____

in partial fulfilment of the award of Bachelor of Engineering in the Computer Science and Engineering Branch of the Bharathiar University Coimbatore - 641 046 during the academic year 1991 - 1992.

Head of the Department

Guide

Submitted for the Viva-voce Examination held on_____

Internal Examiner

External Examiner

ACKNOWLEDGEMENT

We whole-heartedly thank Professor **P. SHANMUGHAM, M.Sc. (Engg), M.S. (Hawaii), SMIEEE (USA), MISTE (INDIA),** without whose help our Project would have been impossible. We will never forget the sincere support and encouragement given to each one of us all along the course of development of our Project even though he was preoccupied with other activities of the department.

We also would like to render our sincere thanks to our Principal, Professor **T.S.RAMAMURTHY, B.E., MISTE (INDIA),** for providing us with the required computing facilities both inside and outside the college campus.

We extend our sincere gratitude to our assistant professor, **Mr.M. RAMASWAMY, M.E., MIEEE(USA), MISTE (INDIA),** for the moral support he gave us throughout the development. We thank our project guide and teacher, **Mrs.T. GOMATHY, B.E.,** whose devotion to the project and willingness to be with us anytime, anywhere, inspite of her busy schedule.

We have great pleasure in thanking our class Advisor, **Miss.R. PAVAI, B.E., MISTE (INDIA),** for extending her full support for making our project a success. We owe our project to each and every staff of computer science and engineering department, who have all considerably helped us in this venture.

We also like to extend our gratitude to **Mr.M. RAMACHANDRAN,** Regional CE Manager of HCL/HEWLETT-PACKARD LTD., who guided us to be under the care of **Mr. NATARAJAN** and **Mr. NARAYANASWAMY** of Coimbatore Institute of Technology, without whose help we would have never completed our project.

TABLE OF CONTENTS

SYNOPSIS

An Introduction to the work done.

The major phase in the course of development of our expert system was acquiring technical/medical knowledge from our relative, who has played the role of Expert.

Our expert system, meant to detect and diagnose syndrome of the human kidney imitates in every way a human 'Nephrologist'. It is in a way voiding all the limitation and deficiencies of a human doctor. Hence we hope similar expert system, would make their way into the 21st Century Medical diagnosis technologies.

The Artificial language - LISP provided a greater extent of ease in representing knowledge as lists and subsequent manipulations.

The Project in detail.

First Stage

The tool used for development is LISP. The representation used in LISP is List, which can

be manipulated to mould knowledge and acquire the same as needed by the user. It has proved to be the best suited knowledge base manipulation tool for our Expert System.

Writing down separately the knowledge acquired from the Expert with the aim to represent knowledge as lists, we have used a particular list called associated list to assign certain symptoms for the occurence / cause of certain diseases. Initially when the user (Patient in context) switches on the computer and start off the software, a detailed questionnaire is presented for this user to answer. Embedded Intelligence helps the software to understand the user's name, whether the patient is conducting the first consultation with the system or a later one. If he is not coming for the first time, the software will easily be able to understand/ recall the history of the patient. It is based on this history the current diagnosis is run or affected.

The software will then go into the deep stage of understanding the patient problem. It quiries the patient about the reason for consulting a kidney specialist - whether he is coming by himself

or was directed by the family physician. The symptoms are added up one by one as the quiries proceed, to add to the particular patient's current data base or file.

Now it performs pattern matching procedures to compare the truth values of each symptom with the stored data base, values of a particular disease. Inference is made based on the probabilistic values of these symptoms. If the person is having all the symptoms of a particular disease along with it's confirmatory symptoms, which is used to confirm existence of that disease in him at that particular time. The confirmatory symptoms assigns the probability as 90%.

The system further quiries for other deficiencies, if any, based on which an another set of diagnosis is made. Some of the minner diseases present along with major kidney's syndromes are discarded off. It informs the patient of their gravity. This completes one session of diagnosis and the patient is given a print-out which furnishes patient history, the symptoms present, the disease name, etc.

Second Stage

Remedy is furnished in this phase. Now that the diagnosis phase over and major guidelines like where to get admitted, chances of death are informed to the patient running short software programs, one for each disease.

Explaining briefly the points of the stage we can say as follows. Some major syndromes of the kidney like chronic renal failure, acute nephritis cannot be cured by consuming certain tablets or similar remedies. But these deseases are treated only in hospitals after getting the patients admitted so as to be given extra care by Doctors and Nurses. Hence we have included in this type of a documentation section, the kind of doctors to consult, the kind of hospital to get admitted in, the major tests and cures to be performed like 'dialysis', 'ultrasonic pilography' etc.

CHAPTER - 1

ARTIFICIAL INTELLIGENCE

1.1.1 A Definition

Although most attempts to define complex and widely used terms precisely are exercises in futility, it's useful to draw atleast an approximate boundary around the concept to provide a perspective on the discussion that follows. Artificial Intelligence (A.I) is the study of how to make computers do things at which, at the moment, people are better. This definition is ephemeral because of the current state of art of computer science. In fact this slow progress toward computers that could out perform people of certain difficult task was one of the first results to come out of experimental A.I. In the early days of 1960's, experts predicted a very rapid progress than has since occurred. So, for atleast the next few years this definition should provide a good outline of what A.I is, and it voids all the dominating philosiphic attempts made to define either 'Artificial' or 'Intelligence'.

1.2 The A.I Techniques

One of the few hard and first results to come out of the first twenty years of A.I. research is that 'Intelligence requires knowledge'. The knowledge, as such though required for representing intelligence, has a few less desirable properties. They are

* it's voluminous
* it's very hard to differentiate / characterise accurately.
* it's a very constantly changing one.

A.I technique is a method in which knowledge should be represented in such a way that

* it captures generalizations in which it's not the least necessary to represent separately each and every situations that have very important properties as common factors are grouped together. If knowledge does not have such a property more memory than we posses will be needed to represent it and it would take a more elaborate timing to keep the knowledge base currently updated.

* it can be understood by the people who must provide it. Although many software program, dates can be acquired automatically in many an A.I domain, most of the knowledge in program has must ultimately be provided by the people in those terms in the follows.

* it can easily be modified to correct errors and reflect the metamorphosis taking place in the world around.

* it can be utilized in many a situation even when it's not accurate or complete in it's domain.

* it helps to overcome certain range of possibilities which need not be considered by taking into consideration only those ultimately necessary.

Although A.I techniques must be designed keeping in mind all these constraints, there is some degree of independence between the problems and problem solving techniques. It's possible to solve A.I problems without using A.I techniques and it's also possible to apply A.I techniques to those problems not in the A.I domain. This is likely

the best thing to do for problems that possess many of the same characteristics as A.I problems.

1.3 A final Word

An A.I system must contain a lot of knowledge if it's to handle anything but trivial toy problems. But as the amount of knowledge grows, it becomes hard to access the appropriate thing when needed, so that more knowledge will have to be added to overcome such as situation. But now, there is even more knowledge to manage, so more must be added, and so forth.

Our goal in A.I is to constituent working programs that solve the problems in which we are interested. In practice, of course it's often much easier to produce a program for a system, whose problem domain is much defined and available.

CHAPTER - 2

EXPERT SYSTEMS

2.1 What Are Expert Systems:

The phase of the computer revolution that spawned expert systems actually started in the early 70's. While the computer hardware specialists were developing microchips technology, software specialists were looking for a breakthrough in the software area. The goal of A.I scientist had always been to develop computer programs that could in some sense think, that is, solved problems in a way that would be considered intelligent, if done by a human. Expert systems are the fruits of a very long quest to define the nature of such program.

The figure 1.1 gives a very generalised but descriptive outlook of an expert system, in whose development are involved a domain expert and knowledge engineers. An expert is a person, who because of training and experience is able to do things ordinary people cannot and they know short-cuts, stricks and caveats to recognize problems they face as instances of time in which they are familiar. The knowledge

engineer extracts from the human experts the procedures, strategies etc. for problem solving and builds this knowledge into expert system software database as shown in fig 1.1.

2.1.1 What is knowledge engineering

Knowledge engineering is in short the process of building expert systems. It relies heavily on the study of human experts in order to develop intelligent and skilled programs / algorithms / heuristics. Majority of the programs under this context have been designed to perform "Common sense" reasoning tasks, ie. tasks any human will perform. Examples of this include medical diagnosis, electronic/ computer design etc. These programs called expert systems are constructed by the science of knowledge engineering.

2.1.2 Features of an Expert system :

The heart of any expert system is the powerful 'Corpus of knowledge' that acumalates during the system building. The knowledge is explicitly organised to simplify decision makings. The acumalation and coding of the knowledge is one of the most important aspects of the Expert systems.

The most useful feature of an Expert system is the 'high level expertise' it provides which helps in problem solving. This expertise can represent the best thinking of the top experts in the field, leading to problem solution, that are imaginative, accurate and efficient. It is the high level expertise together with the skill at applying it, that makes the system cost effective. The system flexibility is also an added advantage here.

Another useful feature is it's 'predictive modelling power'. The expert system can explain how a problem in a new situation changes and it can reason for the same just by letting the user evaluate the potential effects of new datas and understand their relationships to the solution. Similarly, the user can evaluate the effect of new strategies or procedures on the solution by adding new rules are modifying existing ones.

The corpus of knowledge that defines the proficiency of an expert system can also provide an additional feature, an institutional memory. If the personnel in an office is thoroughly interacted with, by the knowledge base, it will be able to represent the current policy all by itself. When

the key people leave, the expertise is maintained. This is very important in business, military and Government applications with their rapid turnovers.

A final feature of an Expert system is it's ability to provide 'training facility' for key personnels and important staff members of an organization. Expert system can be designed to provide such trainings since they already contain the knowledge and ability to explain their reasoning processes. The system can also be software control to train novices in specific tasks such as claims adjusting.

2.1.3 Who is involved in the Expert system building:

The main players in the expert system game are the 'Expert system' itself, 'domain expert', 'the knowledge engineers', 'the expert system building tool', and the 'user'.

The expert system is a collection of programs or computer software that solves problems in the domain of interest. The domain or area expert is a knowledged person with a reputation of producing solution for problems arising in a particular field.

The expert uses tricks and other shortcuts to make the search for the solution, a very efficient one. Although an expert system usually models one or more experts, it may also contain expertise from other sources like books, journals and magazines.

The knowledge engineer is a human, usually with the background in computer science and artificial intelligence, who knows to build expert system. The knowledge engineers interviews the expert, organizes the knowledge, decides how it should be represented in the expert system and will help the programmer who really sits in front of the computer terminals and enter the source code.

The expert system building tool is the programming language used by the knowledge engineer/ programmer to build the expert system. Examples of which are LISP, which is a high level A.I programming language and PROLOG, another language which makes use of logic programming.

The user is the human who uses the expert system once it is developed. The user may be a tool builder debugging the expert system tool/ language, a knowledge engineer refining the existing knowledge

in the system, a domain expert adding new knowledge to this system, an end-user who uses the system for an advice, or a member of the clerical staff adding data to the system.

Figure 1.3 illustrates the players in the expert system building game and their subsequent interaction in the same.

2.1.4 Representing knowledge in an Expert system

The efficient operation of the expert system will depend very much upon the way in which information is stored. Similarly the way in which the information is made available to the system is equally important. Currently, there are four main methods of knowledge representation employed. These are

* Frames
* Scripts
* Semantic networks
* Production rules.

They can be used seperately or in a combined fashion.

2.1.4.1 Frames :

A frame is a table of information on a particular subject. Individual entries are called slots. Four types of slots may be incorporated into a frame. One type simply states a particular piece of information appropriate to the subject. Another type, a default slot, will contain an inevitable piece of information. For example, in a frame referring to a domestic cat, the slat giving the number of legs will default to four. A procedure attachment slot defines a routine or procedure needed to determine further information for the frame. Finally, a reference slot links the current frame with another contains further relevant information.

2.1.4.2 Scripts :

A script is very much like a frame, in that it stores detailed and fairly specific information. Unlike a frame, it describes a process rather than specific subjects. Variations in a script are called Tracks. Roles are the principle characters involved and probs are the objects. Scenes relate the actual process in order. Entry conditions trigger this part of the script. Results show the final situation.

2.1.4.3 Semantic Networks :

A semantic network is an easily comprehensed way of representing information. It is simply a network of nodes containing related items linked by arcs representing their relationships. It is fairly obvious that this type of network can be incorporated in a very useful way into an expert system and have sensible decisions to be made.

2.1.4.4 Production Rules :

The method most often used for storing information in an expert system is to include a large set of IF-THEN ,known as production rules. These allow sequences of decisions to be made and logical consequences to be inferred. Production rules can be especially easy to understand as they reflect a human way of reasoning.

2.2 The Inference Engine :

The part of the expert system which does the reasoning is known as the inference engine. This draws upon both the stored knowledge and replies from the user of the system in order to reason it's way through to an answer. In a production rule system, two different types of inferences can be

made. One is forward chaining and other is backward chaining. In the forward chaining the inference Engine begins with the information currently provided by the user and draws inferences according to the conditional rules that it already knows. During this process it may request further details from the user, whereas in the backward chaining the system starts with a required answer and then searches through it's production rules to seek out what prior conditions would be required for the answer. Again it eventually arrives at a set of ultimate clauses which are necessary for the final state and it seeks to match these against the details provided by the user. Figure 1.4 illustrates the structure of an Expert system in general.

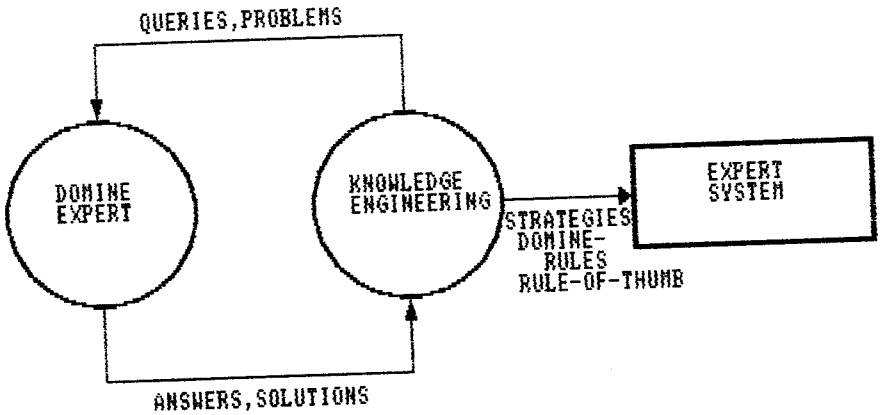
2.3 Phases of development :

The first stage of development was knowledge acquisition phase, in which datas/knowledge is gained from a nephrologist. Then we got the knowledge in a structured form in order to represent in LISP, we associated truth values 't' and 'nil' for each symptoms read from the user console and thus did the process. Charting out all the knowledge, we developed the inference engines for all modules and tried to run the software. Now our aim was to

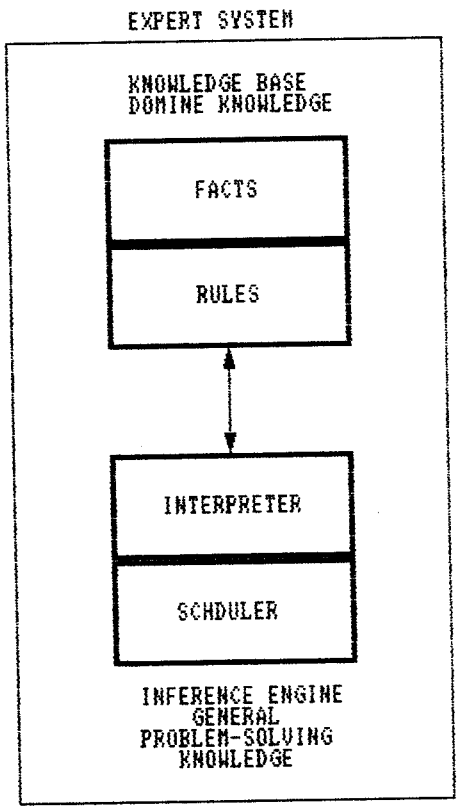
optimise the programs to reduce memory requirements and run time. Achieving optimised modules, we demonstrated live, the performance to a human expert and let him evaluate the changes come up in the automation rather than a human performing the same.

KNOWLEDGE ENGINEERING

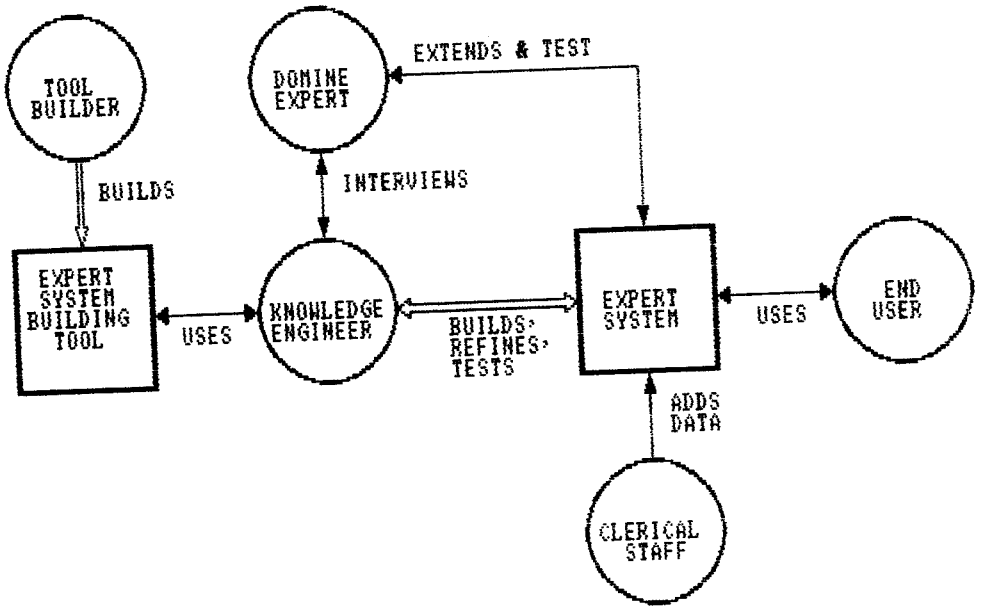
TRANSFERRING KNOWLEDGE FROM AN EXPERT TO A COMPUTER PROGRAM



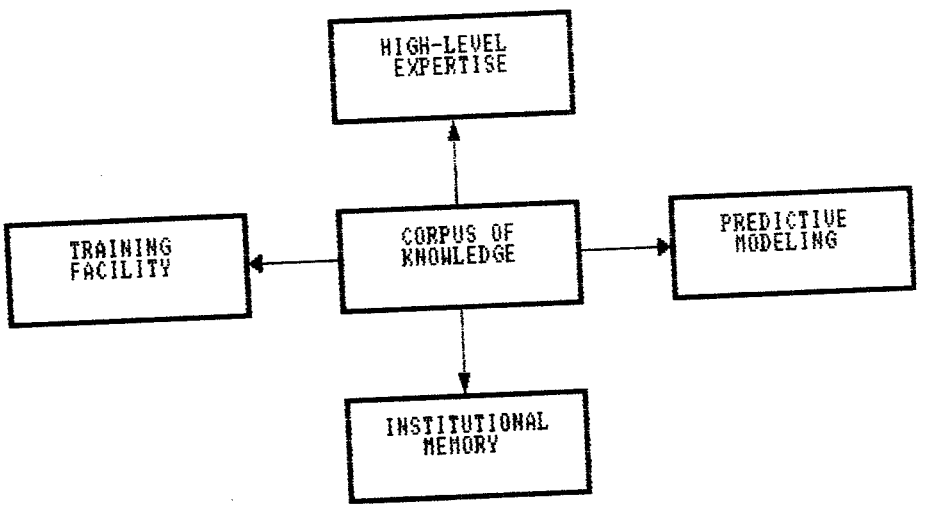
THE NATURE OF AN EXPERT SYSTEM



THE PLAYERS IN THE EXPERT SYSTEM GAME



GENERAL FEATURES OF EXPERT SYSTEM



CHAPTER - 3

NEPHROLOGY, AN OVERVIEW

THE KIDNEY

3.1 Anatomy and Physiology

The kidneys are composed of each one having approximately one million nephrons. The blood supply of the kidneys is relatively large, about one quarter of the cardiac output at rest, ie. 1300 ml/minute, and subject to considerable physiological variations. The afferent arterioles which give rise to the glomerular capillaries arise from the branches of the renal artery emerging from the glomeruli the capillaries unite to form the afferent arterioles which supply blood to proximal and distel convoluted tubules in the cortex. The medulla is supplied by arterioles arising from glomeruli in the deeper regions of the cortex.

Glomerular filtration is the process whereby water and solutes pass across the glomerular memory by bulk-flow or diffusion. The mean filtration pressure results in production of filtrate similar in it's compostion with plasma except that it normally contains no fat and very little protein. The filtrate thus formed passes through the tubule and is modified

according to the needs of the body by selective reabsorption of its constituent and by tubular secretion. The glomerular filtration rate (GFR) remains remarkably constant over a range of values of the renal perfusion and renal blood flow. The figure 2.1 shows the posterior aspect in the anatomy of the kidney. This figure clearly illustrates the anatomy of various organs and tissues of the body (kidney in context) which are frequently attacked by infection.

3.1.2 Structure and Function of the Kidney :

The kidneys play a major role in maintaining the internal environment of the body. The advent of electron microscopy, immunmofluorescence studies, dialysis, and renal transplantation have considerably advanced the knowledge about renal structure and function in health and disease. The kidney measures approximately 12 cm in length, 6 cm in breadth and 3 cm in thickness, and it ranges in weight from 120-170 g. Section reveals an outer zone which is the cortex and an inner pale zone which is the medulla. The corticomedullary junction is indistinct. The renal papillae project into the renal pelvis. The pelvis takes origin from the major calyces which are formed by fusion of 2 or 3 minor

calyces. Each kidney consists of about a million nephrons which are the functional units. At the hilum the renal artery enters the kidney and the renal vein and lymphatics leave the organ.

Microscopic anatomy :

The spatial arrangement of different parts of the nephrons in different zones of the renal substance play an important role in their function. On a functional basis the nephrons may be divided into the glomerulus, proximal convoluted tubule, loop of Henle, distal convoluted tubule, and collecting ducts.

The glomerulus :

It consists of a central mesangial stalk surrounded by a capillary network. The Bowman's capsule encircles the capillary network all around except for the space for the entry and exit of the afferent and efferent arterioles. The wall of the capillary loop is lined by endothelial cells, basement membrane, and specialised epithelial cells which have projections called foot processes. Under the electron microscope, small fenestrations can be identified in the endothelial cell cytoplasm. The foot processes of epithelial cells seem to rest on

the epithelial side of the glomerular basement membranes. The glomerulus acts as an ultrafilter, filtering about 120 ml of filtrate from nearly 1500ml of blood passing through it every minute. The ultrafiltrate contains all the solutes in the blood such as glucose, sodium, potassium, calcium, bicarbonate, phosphate, and the small and medium molecular weight substances such as urea, creatinine, uric acid, aminoacids, etc.

The proximal tubule :

It is lined by columnar cells with brush border towards the lumen. The cells contain several mitochondria and other organelles and are metabolically very active. About 60-70 per cent of the filtrate and solutes are reabsorbed here. Glucose, bicarbonate, amino acids, and phosphate are nearly completely reabsorbed.

The descending limb of the loop of Henle: It is lined by cells which are freely permeable to water and urea.

The ascending limb :

It is lined by small columnar cells which actively pump out sodium and chloride from the lumen.

This segment is impermeable to water. Isotonic fluid which enters the descending limb of the loop of Henle becomes hypertonic by the time it reaches the tip of the loop. This is due to the water reabsorption. As it traverses the ascending limb, the active chloride and sodium transport makes the fluid markedly hypotonic. This hypotonic fluid enters the distal tubule. On account of these phenomena the medullary interstitium is maintained hypertonic and this plays an important role in concentrating the tubular fluid. The cells of the distal convoluted tubule do not have brush border. The reabsorption of sodium and water in the distal convoluted tubule are under the control of aldosterone and antidiuretic hormone respectively. The distal tubule also secretes ammonia into the tubular lumen thus helping to acidify the urine and excrete acid ions. Reabsorption of water and final adjustments in the concentration of urine are done in the distal tubule and collecting duct.

3.1.3 Symptomatology in Renal Disease :

As in any other branch of medicine, a properly conducted full clinical examination is absolutely essential for diagnosis.

Common Symptomatology

Dysuria :

Difficult and painful micturition is called dysuria. The pain may be a burning sensation in the urethra and tip of the penis or colicky or dull pain over the suprapubic area. Infection of the lower urinary tract, stones, foreign bodies, and new growths of the bladder or urethra are the common causes for dysuria.

Urgency (Precipitancy):

It is the sudden and strong desire to micturate. It may be so severe that the patient may void involuntarily. This is a prominent symptom in inflammatory lesions of the trigone of the bladder or poterior urethra. Precipitancy may occur in neurological disorders, but this is not associated with pain.

Strangury :

This refers to the painful desire to pass urine even though the bladder is empty. This is caused by severe lower urinary infections.

Frequency of the micturition :

This is the desire to pass urine more frequently than normal. The normal bladder can

hold up to 500 ml of urine without discomfort. Normally adults pass urine once in 4.5 h. during day time and they do not have to wake up from sleep for micturition. Considerable variation occurs even in normal subjects. Increased frequency may occur when the bladder capacity is reduced as a result of chronic inflammatory lesions, tumour invasion, neurogenic over-stimulation, and longstanding obstruction. In such conditions, the quantity of urine during each voiding is reduced. This should not be mistaken for the increased frequency of micturition which occurs with polyuria.

Retention of urine :

This term refers to inability to pass urine. This is often due to mechanical block to the urethra or neurogenic factors. Common causes include phimosis,, urethral valves, bladder neck obstruction by enlarged prostate, vesical and urethral stones, or bladder tumours.

Enuresis :

Unintentional voiding of urine, usually during sleep is called enuresis. This is normal in infants till the age of 2 years. If it occurs in older age groups, it may be due to a delay in

the development of bladder control, or loss of control due to obstruction, infection or neurogenic dysfunction.

Alterations in the volume of urine :

The daily output in normal persons varies from 500 to 2500 ml depending on the fluid intake and climatic factors-two-thirds passed during day and one - third during night. Estimation of the volume of urine is great help in monitoring the development and progress of renal diseases.

Oliguria :

Reduction in the daily urinary volume below 400 ml is called oliguria.

Polyuria :

Increase in urine volume above 3000 ml in 24 h. is called polyuria..

Nocturia :

This term denotes the urge to urinate night, leading to interruption of the patient's sleep.

Pain arising from the excretory organs :

The quality, severity, and character of the pain varies depending on the site of disease, type of onset and other factors.

Turbidity of urine :

Pus, blood, or crystals may impart turbidity to the urine.

Pneumaturia :

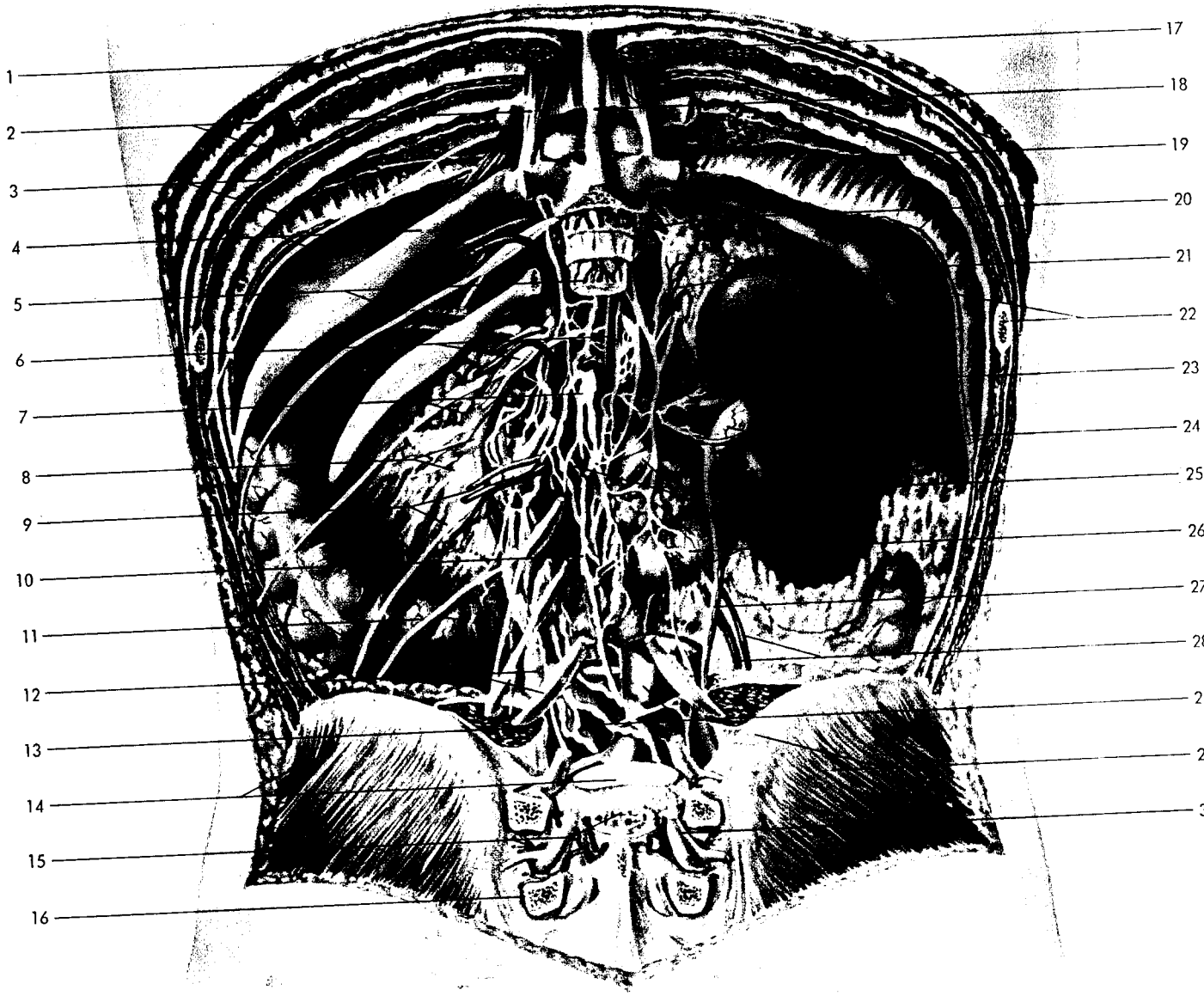
This term denotes the presence of gas in urine. It may occur as a result of fistulous communication between the bowel and urinary tract or infection of the bladder by gas-forming organisms.

Edema :

Acute glomerulonephritis and nephrotic syndrome are characterised by fluid retention. In acute glomerulonephritis, puffiness of the eyelids and face occurring especially on waking up from sleep is suggestive. Other areas where the areolar tissue is loose such as the scrotum and breasts also show edema. In nephrotic syndrome the edema is more pronounced over dependent parts.

Anatomy *of the* Kidney

POSTERIOR ASPECT



1. Iliocostalis lumborum muscle
2. Intertransversari muscle and lumbodorsal fascia
3. Internal and external intercostal muscles and pleura
4. Spleen and eleventh rib
5. Spinal cord and eleventh thoracic nerve
6. Crus of diaphragm and twelfth thoracic ganglion
7. Cisterna chyli and pancreas
8. Mesocolon and inferior mesenteric vein
9. Dorsal branches of first lumbar artery and vein, and iliohypogastric nerve
10. Right lumbar lymphatic trunk
11. Obliquus abdominis externus muscle, descending colon and ilioinguinal nerve
12. Lumbar lymph node and fourth lumbar ganglion
13. Psoas major muscle
14. Intervertebral fibrocartilage and gluteus medius muscle
15. Cauda equina
16. Interosseous sacroiliac ligament
17. Longissimus dorsi muscle
18. Supraspinal ligament and multifidus muscle
19. Lung and latissimus dorsi muscle
20. Diaphragm and superior suprarenal arteries, veins and nerves
21. Right suprarenal gland and inferior suprarenal artery and vein
22. Liver and tenth rib
23. Renal artery and vein
24. Renal pelvis and perirenal fat
25. Abdominal aorta and inferi vena cava
26. Duodenum and sympathet trunk
27. Ureter and ascending colon
28. Internal spermatic artery and vein
29. Crest of ilium and gluteus maximus muscle
30. First sacral ganglion

This is one of a series of paintings for Lederle by Paul Peck, illustrating the anatomy of various organs and tissues of the body which are frequently attacked by infection, where aureomycin may prove useful.

Lederle

3.1.4 Clinical Approach in the Diagnosis of Renal Disease.

All the medical renal disorders fall into one of ten different clinical syndromes. Assignment to these syndromes can be done by clinical and preliminary laboratory criteria. These clinical syndromes may result from different etiological factors and, therefore it should be the endeavour to identify the cause in each case.

1. Acute nephritic syndrome :

This is characterised by hematuria, red blood cell casts, proteinuria, oliguria, hypertension, fluid retention and varying degrees of renal failure. Many cases are caused by poststreptococcal acute glomerulonephritis. Other causes include disseminated lupus erythematosus polyarteritis nodosa, infective endocarditis, and Henoch - Schonlein purpura.

2. Nephrotic syndrome :

This is characterised by massive proteinuria. As a consequence of heavy proteinuria, hypoalbuminemia, edema and hyperlipidemia follow.

3. Asymptomatic urinary abnormalities :

In this condition significant proteinuria hematuria or pyuria occur in an asymptomatic

individual. Since many illnesses may start as asymptomatic urinary abnormalities, these findings should not be brushed aside. It may be possible to detect renal or systemic diseases even at this stage by proper investigation.

4. Acute renal failure :

This condition is characterised by acute deterioration of renal function, often but not invariably associated with oliguria.

5. Chronic renal failure :

It is characterised by persistent reduction of renal function for at least 6 months and is caused by irreversible nephron loss.

6. Urinary tract infection :

It is characterised by excretion of pus and significant numbers of pathogenic bacteria in urine, and associated with symptoms referable to upper or lower urinary tract.

7. Urinary tract obstruction :

Ureteric obstruction leads to ipsilateral renal pain and the development of hydronephrosis. Lower urinary obstruction is characterised by thin urine stream or total block resulting in retention of urine.

8. Renal tubular defects :

Anatomical defect or renal tubules manifests as cysts of various types and are often diagnosed by intravenous urography. Functional disorders are characterised by abnormalities in one or more of the tubular functions.

9. Hypertension :

Renal diseases account for the major proportion of secondary hypertension.

10. Nephrolithiasis :

It is the presence of calculi in the kidneys or the urinary passages. It is characterised by the combination of renal colic with hematuria, presence of stones in urine or radiological visualisation of the stone.

3.2 Chemical Constituents of serum and urine :

3.2.1 Serum normal values :

1.	Protein	:	5.5 - 8 g/dl
2.	Cholestrol	:	152 - 265 %
3.	Urea	:	10 - 20 %
4.	Sodium	:	136 - 145 meq/litre

5.	Creatinin	-	less than 1.5 meq/ltr.
6.	Phosphate	-	0.1 - 0.63 units
7.	Phospho lipids	-	150 - 250 %
8.	Nitrogen	-	15 - 35 %
9.	Potassium	-	3.5 - 5 meq/litre
10.	Calcium	-	4.5 - 5.5 meq/litre

3.2.2 Urine Normal Values :

1.	Specific gravity	-	1.003 - 1.025
2.	Protein	-	less than 0.150 g/day

3.3 Major syndromes of the kidney in consideration:

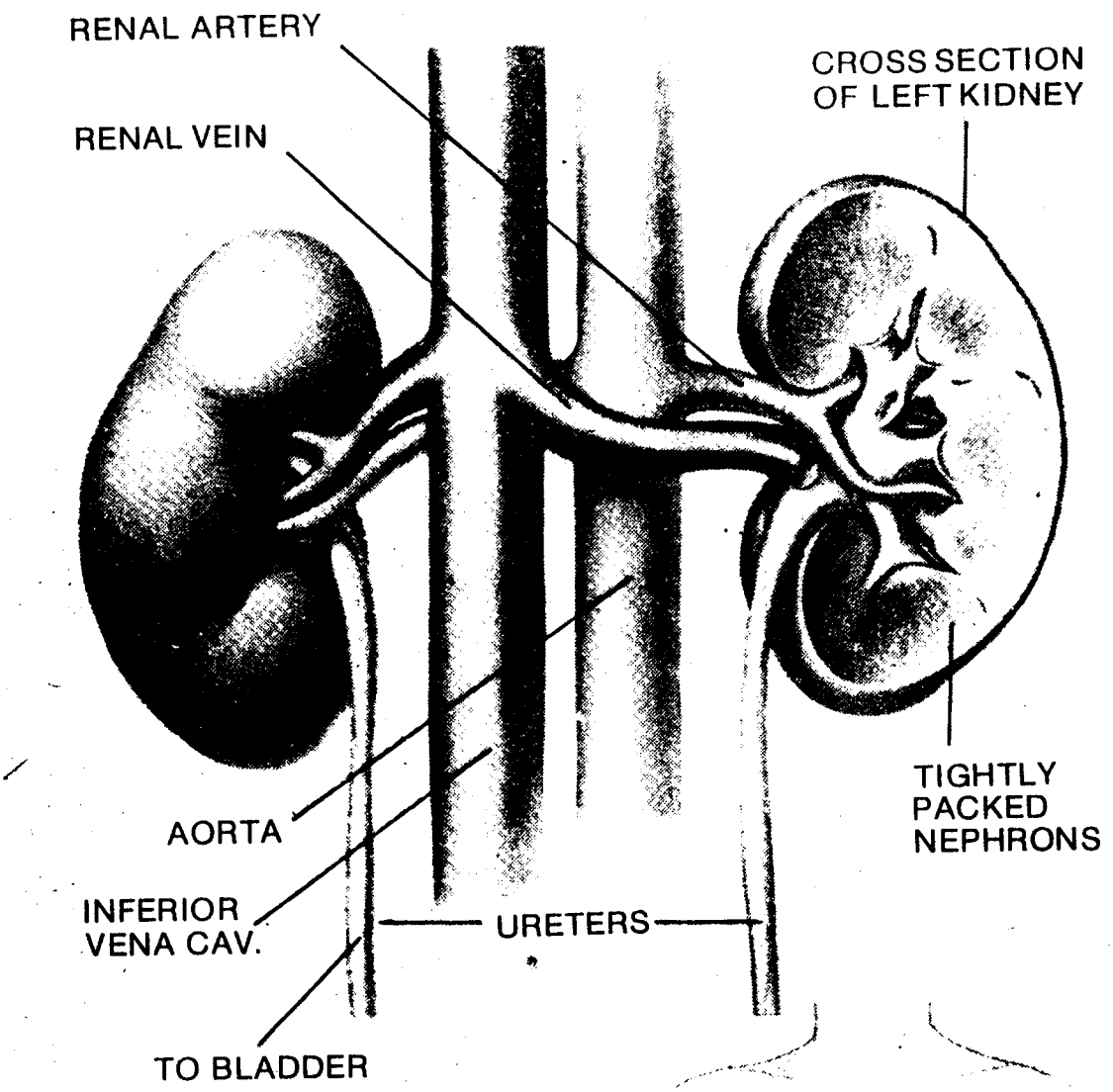
1. Acute Nephritis (Type 1 Nephritis)
2. Acute Nephritis (Type 2 Nephritis) or Membraneous Glomerulo Nephritis.
3. Acute Renal failure.
4. Chronic renal failure.
5. Pilonephritis or pilitis.
6. Renal tubule defects.
7. Nephrolithiasis.
8. Acute Focal nephritis.
9. Nephrotic syndrome.
10. Exogeneous Nephritis (Intesticial Nephritis)
    - 10.a. due to phinacetin
    - 10.b. due to lead
    - 10.c. due to gout diseases.

11. Irradiation Nephritis.
12. Diabetic Glomerulo Sclerosis.
13. Congenital renal diseases.
    - 13.a. congenital polycystic disease
    - 13.b. renal amyloidosis.
    - 13.c. renal abscess.
    - 13.d. renal tuberculosis.
    - 13.e. renal tumors.

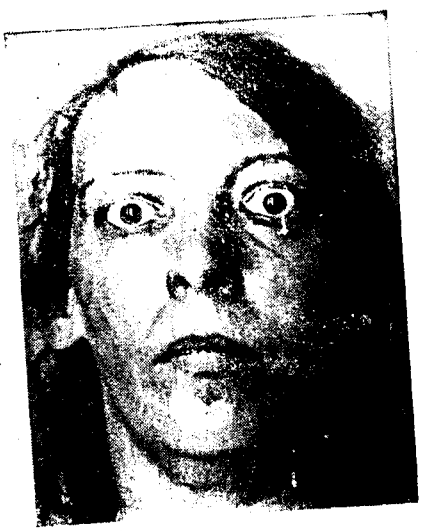
3.4 Minor diseases coming under the differential diagnosis sections :

1. Angeoneurotic edema.
2. Polyarthiritis Nodosa and lupous Aerythromatsous.
3. Conjustive cardiac failure.
4. Nutritional edema
5. Hepatic edema
6. Amyloid disease of the kidney.
7. Acute Appendicitis
8. Diaphragmatic pleurisy.
9. Perinephric Abscess due to infection by staphelococus aureous.
10. Renal vein thrombosis.
11. Peripheral thrombosis.
12. Pulmonary embolism.

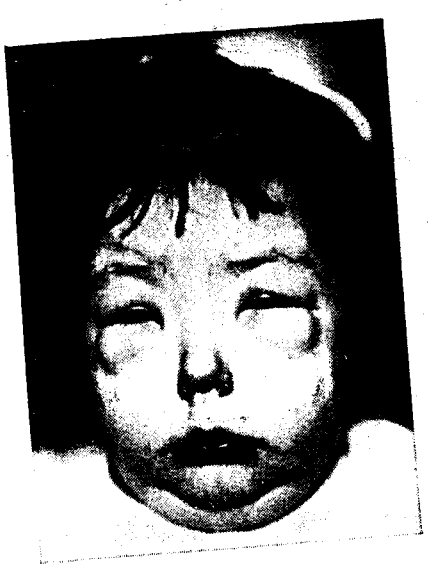
URINARY TRACT: KIDNEY



Myxoedema



Hyperthyroidism



Nephrotic œdema

Tabes dorsalis

Plate 2.—FACIES

* Sample Photographs of EDEMA infected persons.

CHAPTER - 4

PACKAGE DESIGN AND DEVELOPMENT

4.1 Introduction :

The whole package is consisting of a large number of modules, one module activating the other based on the current user input. Very small inference engine modules are designed for subsequent activation of modules, manipulation of datas and user queries. Basically there are three main modules in our expert system.

1. The initial user introduction module.
2. The diagnosis module.
3. Remedial actions module.

4.2 User Introduction module :

This module is activated whenever a user tries to run our software package. It's main use is to update it's existing knowledge base with details of current user - name, age, sex, history etc. During the start time the user is queried whether he/she is coming for the first consultation or not. Once the user tells it is the first time, a series of questionnaire follow, which creates the current user's knowledge base or file with all the details.

Now the diagnosis module is activated. Whereas when the user is coming for the second time, he will be asked just his name and age constraints, depending upon which the software loads all the relevant information previously stored about this person into the main memory for subsequent processing. This saves the user time/monotony to enter the same datas he previously entered. Now this user is asked whether he is recovered from the disease he had, depending on the answer of which the module activates the necessary diagnosis module.

4.3 The diagnosis module :

This module is the heart of the expert system which performs the main job of diagnosing the disease pertaining to a particular person. This section is characterised by a detailed questionnaire sheet on the computer screen which is to filled up by the user. Initially symptoms are gathered one by one whose truth values are stored on a scratch-pad in the main memory which is used to diagnose diseases. A module pertaining to a particular disease when activated gathers the symptoms and along with the other symptoms of a differential diagnosis and the current disease confirmatory symptoms, will confirm the probable percentage of existence of a

disease in the patient at a particular time. The advantage of differential diagnosis is achieved by activating other modules while the module of a particular syndrome is running, which helps in a faster diagnosis.

The major syndromes of the kidneys are detected first and in the absence of which minor defects or deficiencies are detected one by one in the person.

4.3.1 Knowledge Base used :

The knowledge base used in our expert systemis slightly similar to the conceptual frames of knowledge base representations. This is achieved in LISP by making use of a special list called the associated list or property list. The advantage is that it will be able to connect properties to a particular symbol. The LISP codes given gives a very clear idea how access, manipulations etc. are done in the so called A-Lists.

4.4 Remedial Actions Module :

The first part of this module is informing the user of the disease he has, it's gravity, death factors, survival factors and the remedial actions

In this session, the user is informed what to do and where to go after consultation after the earliest recovery. Normally the remedy for the major nephrotic syndromes are - getting hospitalized, keeping himself/herself under a nurse's or doctor's custody for getting the full care and undergoing treatments. For instance, when a patient comes with acute renal failure, he will be asked to undergo doctor's treatment in a hospital with

(i) Balancing body water/fluid

(ii) Balancing the electrolyte levels undergoing tests.

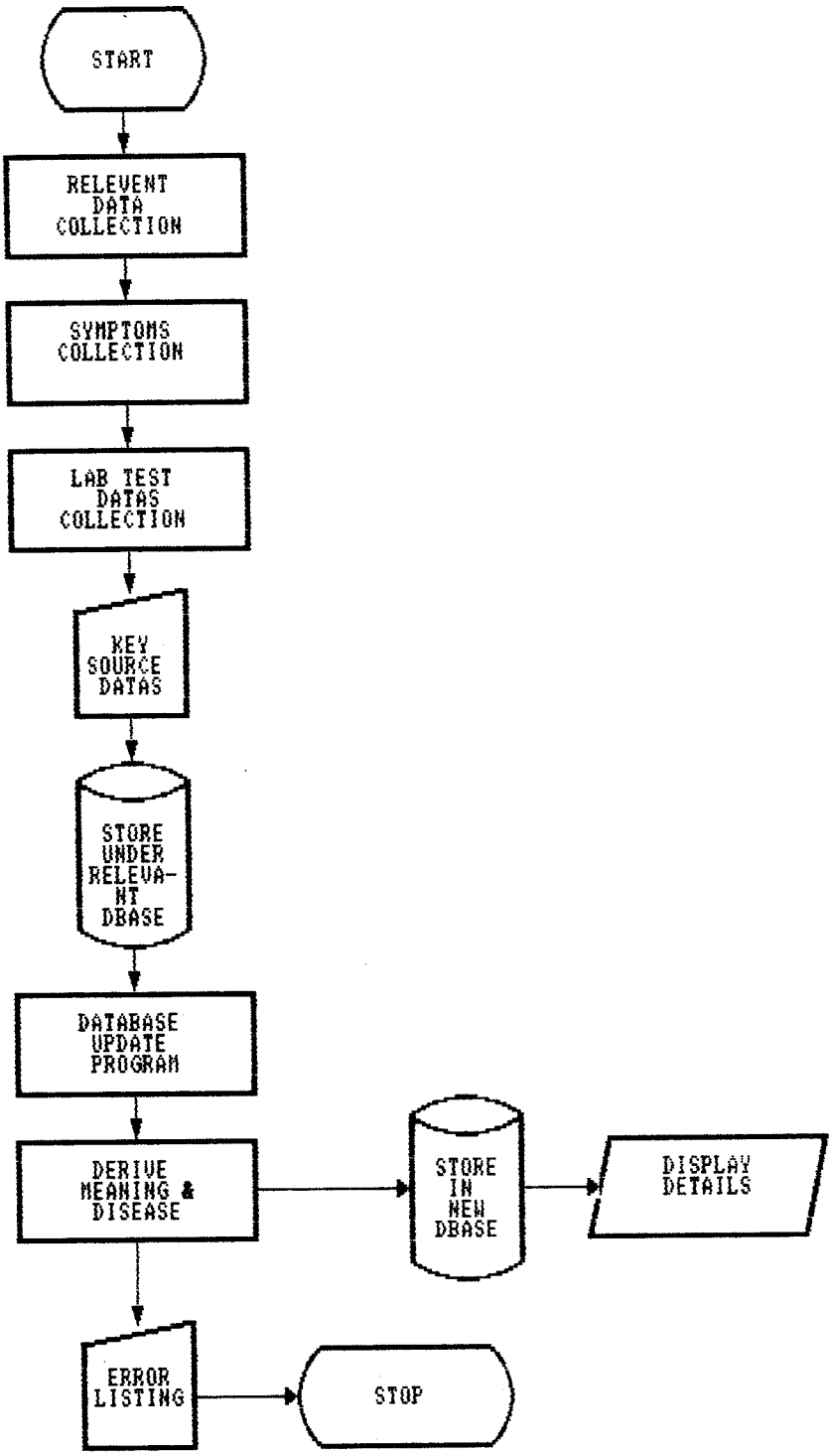
(iii) Maintaining calories and proteins.

(iv) Dialysis treatment if needed.

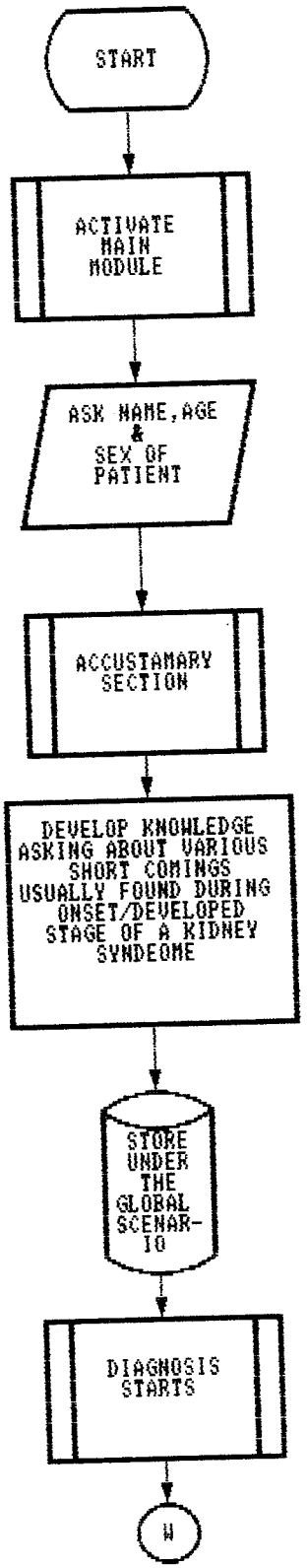
4.5 The software working in illustrations and details:

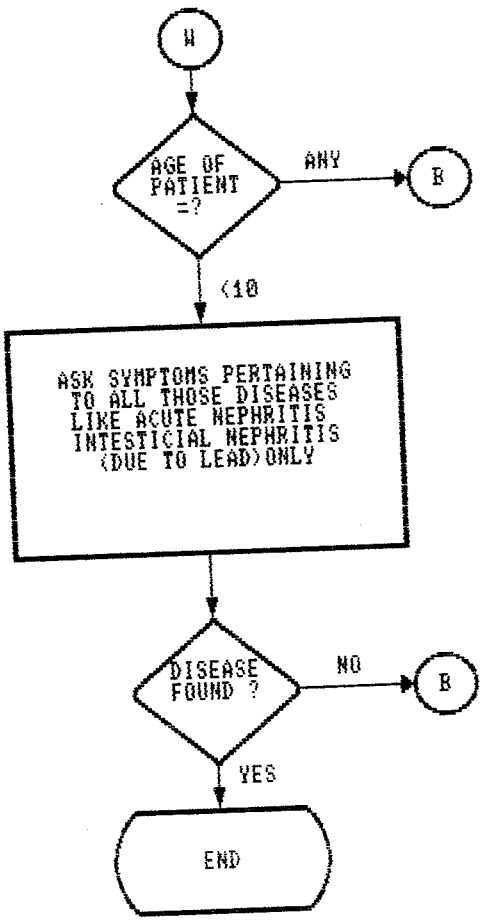
The working of the whole software, at various levels and in the varying situations are explained or illustrated in detail in the flow diagrams/charts that follow in the next few pages.

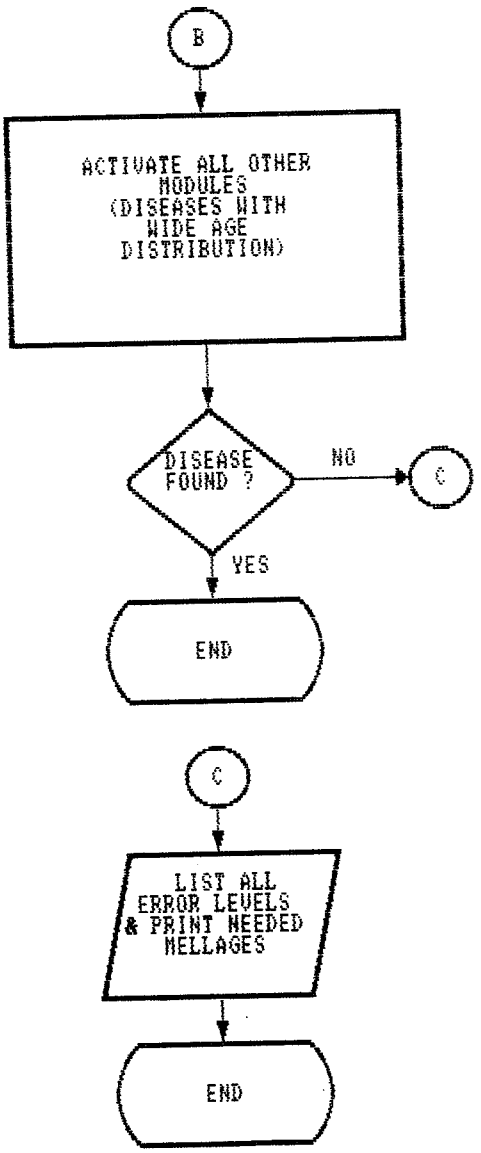
SYSTEM FLOW CHART

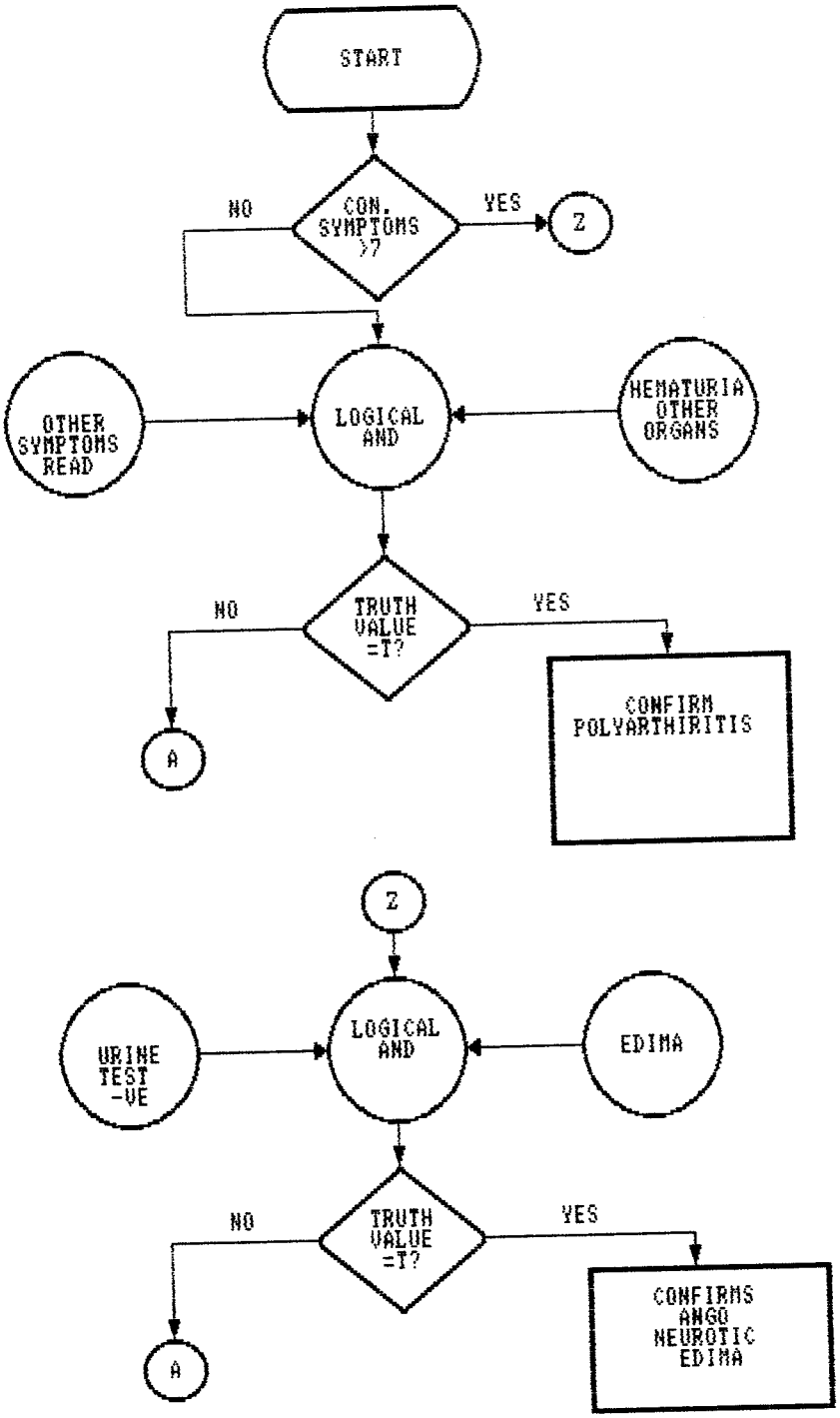


SYSTEM WORKING FLOW CHART




H
AGE OF PATIENT =?
ANY
B
<10
ASK SYMPTOMS PERTAINING TO ALL THOSE DISEASES LIKE ACUTE NEPHRITIS INTESTICIAL NEPHRITIS (DUE TO LEAD) ONLY
DISEASE FOUND ?
NO
B
YES
END

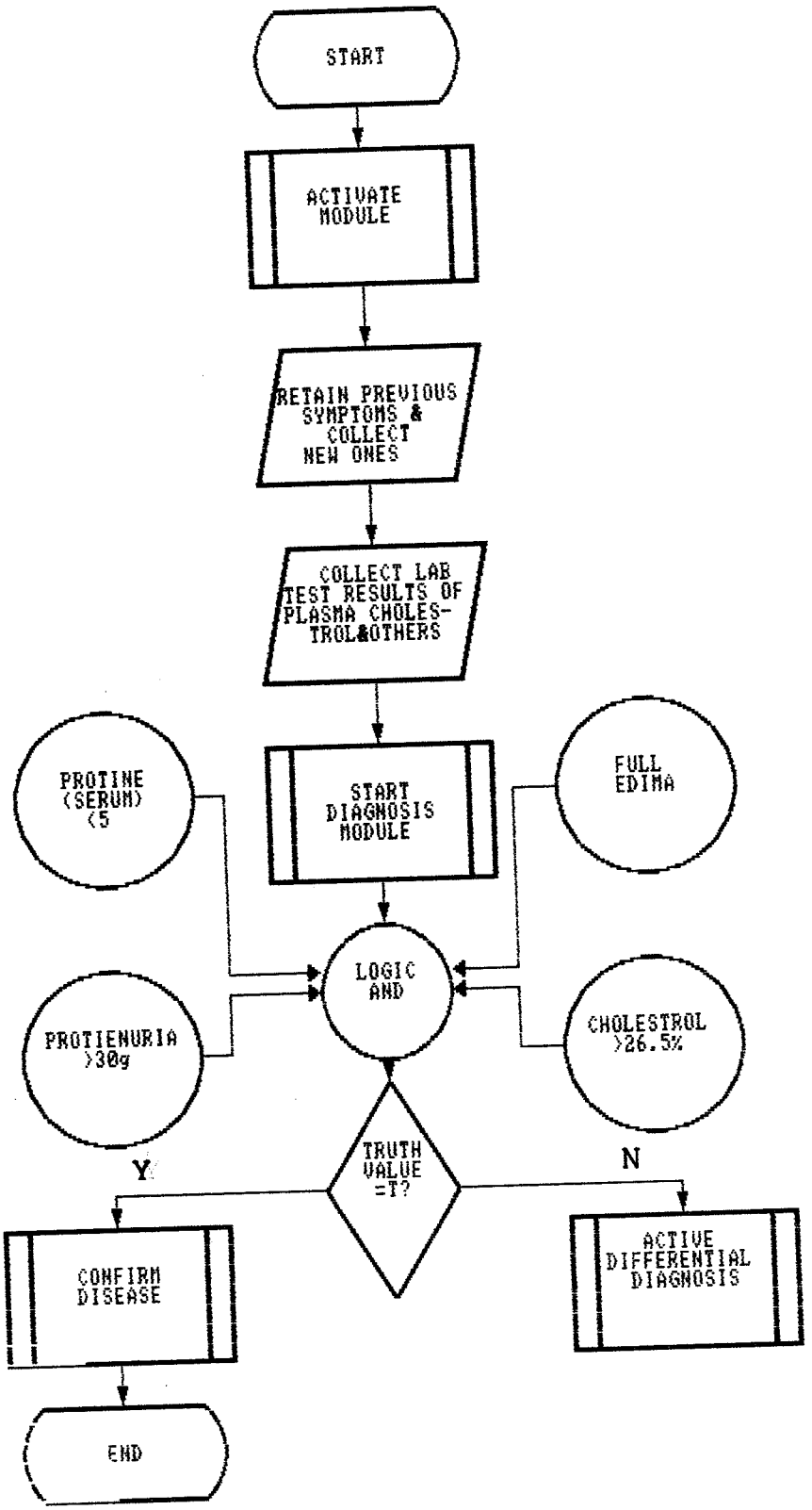

B
ACTIVATE ALL OTHER MODULES (DISEASES WITH WIDE AGE DISTRIBUTION)
DISEASE FOUND ?
NO
C
YES
END
C
LIST ALL ERROR LEVELS & PRINT NEEDED MELLAGES
END



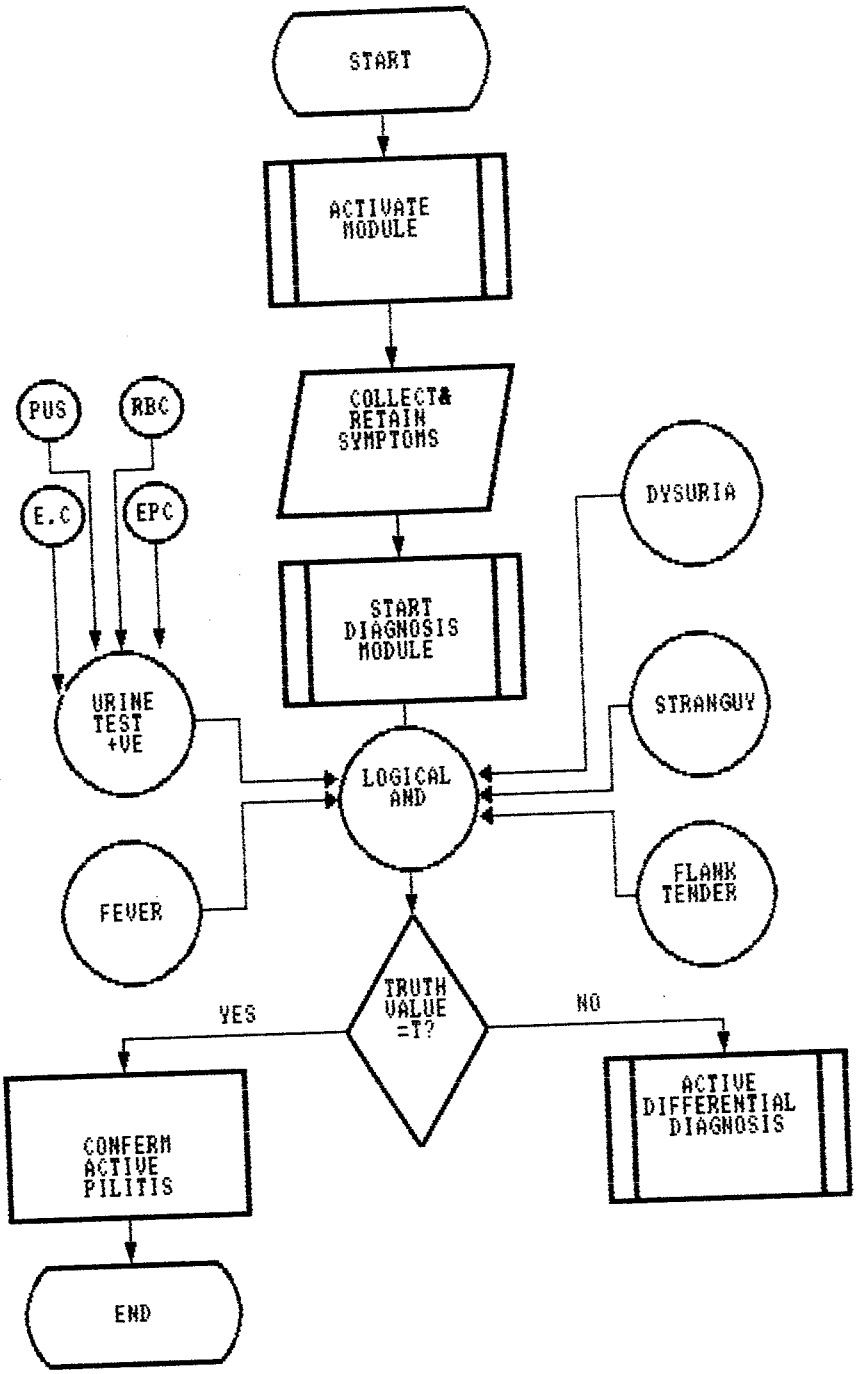
* *Sample differential diagnosis of acute nephritis*

Note : 'A' refers to acute nephritis flow chart.

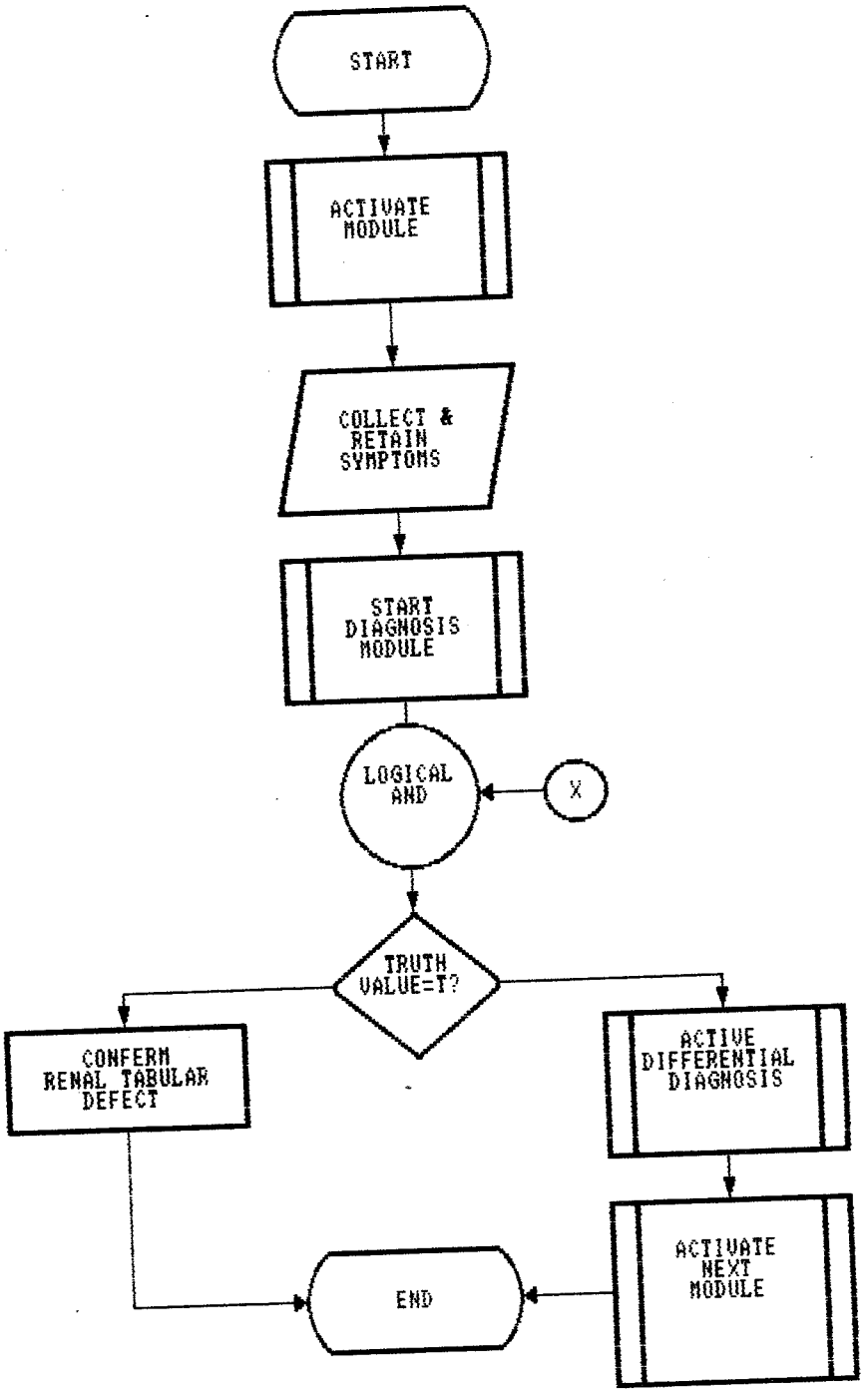
MEMBRANEOUS GLOMERULO NEPHRITIS

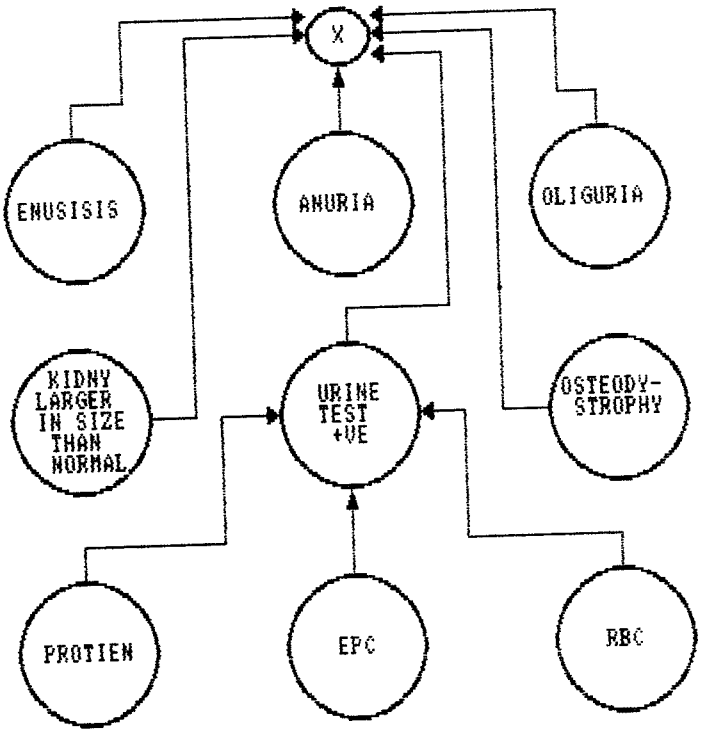


URINARY TRACT INFECTION



RENAL TUBULE DEFECT




X
ENUSISIS
ANURIA
OLIGURIA
KIDNY LARGER IN SIZE THAN NORMAL
URINE TEST +VE
OSTEODY-STROPHY
PROTIEN
EPC
RBC

CHAPTER - 5

CONCLUSION

In this stage of completion of development we would like to conclude by stating that with the knowledge base of a different organ of the human body this program can be modified to run. Thus, for instance, if we consider the knowledge base of symptomatology and diagnosis of the heart diseases, the knowledge engineer with the help of a cardiac specialist will easily be able to modify the diagnosis schedulings and corresponding changes. We would also like to appreciate the power of LISP which has helped us a lot to represent knowledge with the minimum memory requirements than any other A.I languages.

CHAPTER - 6

FUTURE DEVELOPMENTS

This nephrotic disease diagnosing software is very flexible so as to be used for diagnosing other diseases also, by making use of a different data base. Further A.I techniques, when made use of in the future on the same software will help in reducing the run-time, the memory requirements and may be a substancial increase in the computing speed henceforth.

Hence due to the possibility of moulding a more complex disease diagnosis software development, we like to recommend the same for other knowledge engineers to make use of and do the necessary changes for an expert system in a different field. For instance, error diagnosis/fault detector for personnel computers.

CHAPTER - 7

REFERENCES

1. "How to solve it in LISP" by patrick J. Hall, Sigma Press, England.
2. "Artificial intelligence" by Elaine Rich, McGraw Hill, Inc, Singapore.
3. "A guide to Expert systems" by Donald A. Waterman, Addison - Wesley, U.S.
4. "LISP" by winston and Horn, Addison wesley, Narosa.
5. "Common LISP - the language" by Guy L. Steele JR. Digital Press.
6. "Common LISP" by wade L. Hennessey, Mc Graw Hill, Inc, Singapore.
7. "Let's talk LISP" by Laurent siklossy, Prentice Hall, INc, N.J.
8. "Price's textbook of the practice of medicine", tenth edition by Sir Ronala Bodley Scott, London-Oxford University Press, 1966.
9. "The principles and practice of medicine" by Sir Stanley Davidson, ELBS. (seventh edition) 1965.

10. "Harrison's principles of internal medicine"- Tenth edition, Mc. Graw Hill Inc, N.Y.

11. "Hutchison's clinical methods by Donald Hunter and R.R. Bomford" - 14th edition. Bailliere, Tindall & Cassell, London.

12. "A short text book of medicine" by Dr. K.V. Krishnadas.

CHAPTER - 8

1. Hutchisons Clinical Methods
by Donald Hunter and R.R. Bomford
(Bailliere, Tindall & Cassell)
- Plate 2 - Facies
- Plate 9 - Viscera of Thorax and Abdomen, As seen from behind in the Cadaver.

2. Know your Body - A Reader's Digest guide.
- Page No.142, Urinary Tract : Kidney

3. Lederle Laboratories Division
30 Rockfeller Plaza, New York 20, N.Y.
(Publicity of Aureomycin).
- Anatomy of the kidney (Posterior Aspect).

CHAPTER - 9

A. COMMON LISP - THE LANGUAGE

(Courtesy digital Press, M.A, U.S.A)

Top level Forms :

1. defun

(defun name lambda-list [declaration/ doc-string]* [form]*) = name.

This macro is the most common way to define a named function. It makes name the global name of the function specified by the lambda - expression.

2. equal

(equal object 1 object 2) = boolean.

This function is a predicate that is true if object 1 and object 2 are of identical type and structure. In most cases if they have the some printed representation it's true. Numbers and characters are equal if they are T in equal.

Symbols are equal if they are eq.

3. and

(and object 1 object 2)

Thif form serves as a logical operator and control structure.

4. Or

(Or object 1 object 2)

This form serves as a logical operator and if any form i returns a non-nil value or returns that value without evaluating remaining forms.

5. Set f

(Setf [place new value]*)

= last-new-value-form-result

This macro produces a form that, when evaluated, updates the value at place to new-value. The place arguement must be a form (such as a variable or a function-call) that access some LISP object when evaluated. The new-value arguement can be any form where value can legally be assigned to the location designated by place.

6. Defstruct

(defstruct [Name/(Name/(Name [option]*)]

[Doc-string]*) = name

This macro defines a structured data type similar to records in pascal. It also defines facilities for creating instances of the newly defined structure and accessors for the slots in the structure. A simple call to defstruct specifies the name of the structure and of the slots within it.

CHAPTER - 10

B. SYSTEM / HARDWARE & SOFTWARE USED.

* OASYS III workstation :
  - AT 486 with a hard disk capacity of 100 MB

  - VGA supersync color monitor.
  - Logitech MOUSE MAN high resolution mouse connected to COM2.
  - 80387 coprocessor support.

* MS DOS (V.5).
* GOLDEN COMMON LISP (V.4.1).
* M.S WINDOWS 3.0 environment running in 386 enhanced mode / standard mode.