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A FRAMEWORK FOR THE APPLICATION OF KNOWLEDGE TECHNOLOGY TO THE MANAGEMENT OF DISEASES.

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ABSTRACT

Medical diagnosis and therapy constitute a network of inter-related processes. The conventional method of medical diagnosis and therapy of diseases involve the state space search of medical knowledge of diseases and patient history, which could be combinatorial explosive. This paper presents the report of the experimental study of an intelligent, interactive, user friendly knowledge based system, which does a stepwise analysis of the patient's complaints, filtering the cognitive and emotional elements to be able to make inferences. It applies both forward and backward chaining in making inferences concerning the management of the diseases. A case study of the system is carried out using some tropical diseases. It is believed that the system will serve as a good contribution towards the much desired tropical medical informatics.

Keywords: Medical Diagnosis, Knowledge Technology, Inference Engine, Tropical Diseases

INTRODUCTION

Over the years, the computer has served as an aid to decision making. This is due to its efficiency in carrying out data processing, statistical and mathematical computations. However, in fields like medicine, industry, management, law, etc, important problems exist, which do not lend them to routine data processing. Solving such problems is still critically dependent on human expertise and skills, such as identifying and relating key factors, weighing evidences, evaluating alternatives, predicting outcomes and making complex decisions (Akinyokun, 1998). Medical diagnosis and therapy of tropical preventable diseases involve the state space search of medical knowledge of tropical diseases, patient history, drugs and other cognitive and emotional variables. Akinyokun (1996) posits that the mathematical algorithmic procedure for the state space search is generally combinatorial and becomes explosive when the variables are numerous. In most tropical countries most of which are developing, medical personnel and facilities are not adequate for effective tackling of these diseases. In the rural area, medical attention is grossly inadequate (Iseyemi, 2000). This research seeks to develop a knowledge based system for diagnosis, and therapy of tropical diseases. The system is able to achieve the following:

a. Assist the medical expert in the tedious and complicated task of diagnosing and providing treatment for tropical diseases.
b. Provide a scheme that will assist medical personnel especially in rural areas, where there are shortage of doctors, in the process of offering primary health care to the people.

This system is futuristic in nature as it is envisaged that in a couple of years to come most rural areas especially in Nigeria will have good access to the computer which is fast becoming a house hold property. Many local government councils are purchasing computers for their organs including the local health centers and community health departments. But there is still acute shortage of doctors in these centers. It is therefore expected that if commercially developed the proposed system will assist other medical personnel in attending to patients and also assist the doctor by making his task easy and enabling him to attend to as many patients as possible.

THE CONVENTIONAL APPROACH TO THE DIAGNOSIS, AND THERAPY OF TROPICAL DISEASES

Diseases that are conventionally referred to as tropical diseases are by no means confined to the tropics but are prevalent in the tropics. The principles of diagnosis and therapy may be the same the world over. In the tropics, multiple pathologies and diagnosis are the rule rather than the exception and treatment may be modified in the light of background factors (Iseyemi, 2000).

The Nigerian National Basic Health Services Scheme (NNBHSS) is discussed in [Akinyokun and Adeniyi, 1991]. The scheme contains standing orders which define how patients should be cared for. The standing orders are high-level abstraction of the combined structured and experiential knowledge of a team of medical doctors and nurses in the management of tropical diseases. The emphasis is on health maintenance and prevention of diseases. No attempt is made in the standing orders to provide comprehensive treatment for all disease and possibilities. In practice, an experienced physician may have valid medical reasons for rejecting the treatment set out in the standing orders because of peculiarities such as patient history, drug contra-indication and other environmental situations. In such circumstances the doctor applies his experiential knowledge in the domain of health care and delivery.

The conventional approach to medical diagnosis is discussed in [Jay and Stein 1993, Elefin, 2001] and modeled in Figure2. It consists of the following parts: the interrogation of the patient, clinical examinations, further investigations. Diagnosis is the well-balanced

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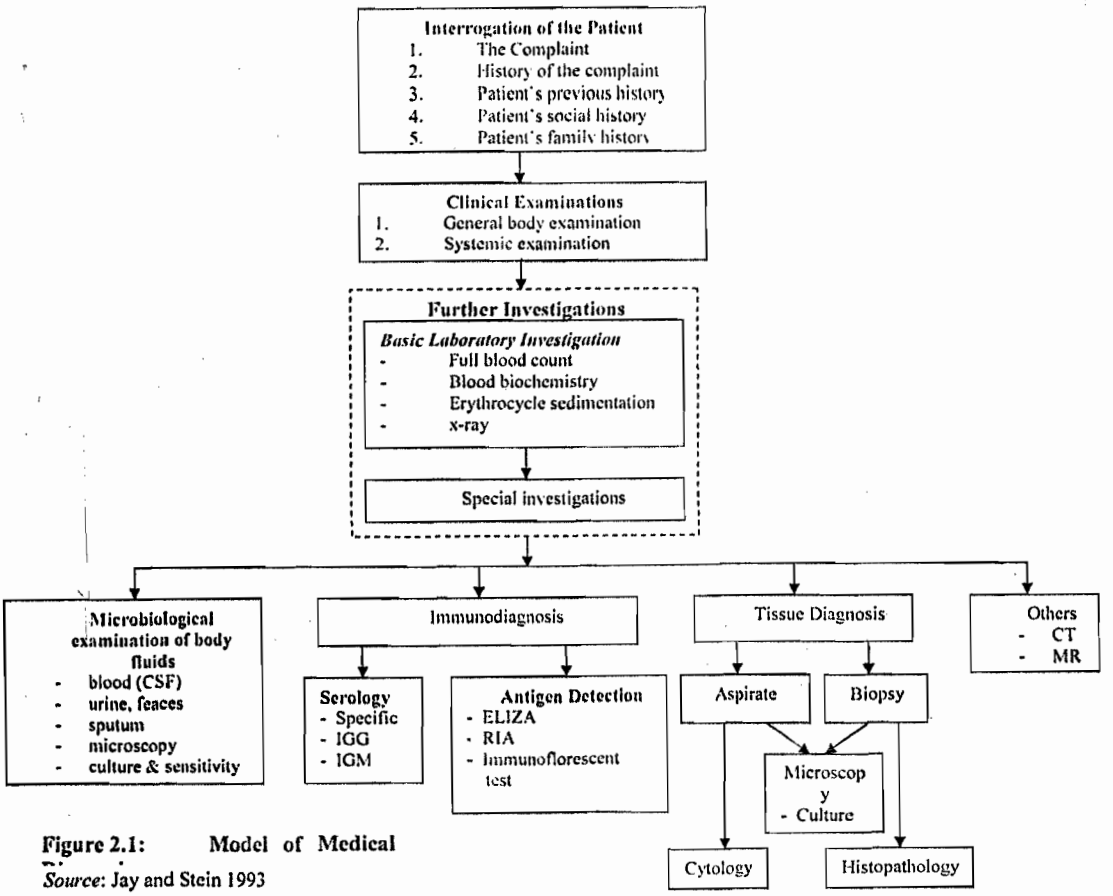

Figure 2.1: Model of Medical

Source: Jay and Stein 1993

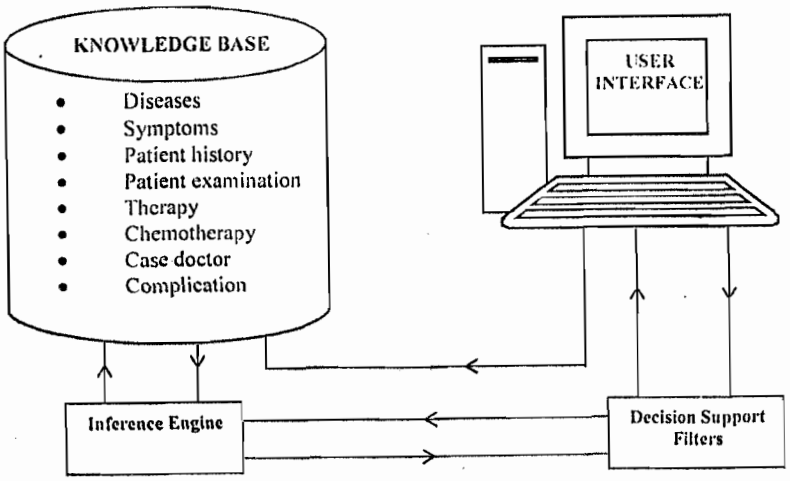

Figure 3: The Architecture of MEPA System

judgment of all the facts relating to the ailment. To take a good history requires as much or more skill than the subsequent physical examination. Accuracy and patience are usually well rewarded by the diagnostic value of the data obtained. The individual physician, in the course of practice, usually develops a particular scheme of questions, which to him seem most appropriate. The general principles involve the complaint, the chief or cardinal symptom, history of the present complaint, the patient's previous history, the social history and the family history (Jay and Stein 1993). The history of the patient gives a clue to the part of the body affected. The interrogation may be followed by clinical examination. The clinical examination is in two phases: the general body examination and systemic examination which involves the examination of the respiratory system the digestive system, the genito-urinary system and the sense organs. Where clinical examination does not give the full clue concerning the diseases, further investigation is carried out (Akinyokun

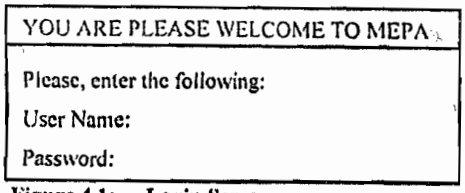

Figure 4.1: Login Screen

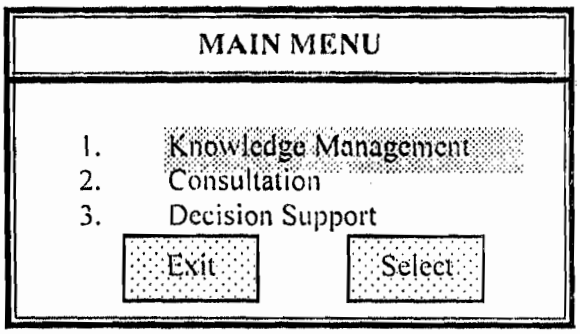

Figure 4.2: Main Menu

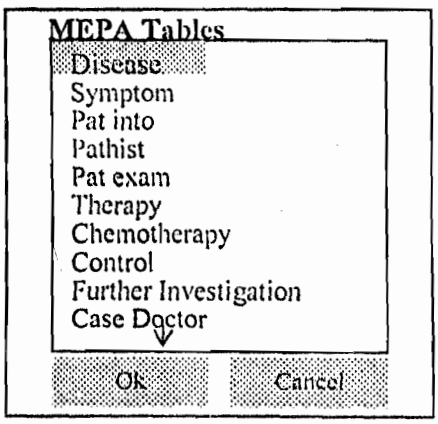

Figure 4.3: Tables Submenu

and Adeniyi, 1991). It consists of the following:

a. Basic laboratory investigations such as full blood count, blood biochemistry, erythrocycle sedimentations, x-ray.
b. Special investigations, which could include microbiological examination of body fluids immunodiagnosis, tissue diagnosis (aspirate and biopsy).

Conventionally, treatment of the diseases follows after diagnosis and is dependent on the results of the diagnosis. The following modes of treatment are adopted for tropical diseases: chemotherapy, conservative/palliative management, surgical intervention, immunotherapy, radiotherapy and physiotherapy.

THE DESIGN OF THE KNOWLEDGE BASED SYSTEM

The computer aided (knowledge based) system as conceptualized in this study, involves three principal actors, namely; the medical practitioners, the patient and the computer system. The proposed computer based system, christened "Medical Practitioners' Assistant (MEPA)" has an architecture presented in Figure 3, which consists of the following main subsystems;

a. The knowledge base
b. Inference engine
c. Decision support filter

KNOWLEDGE BASE

Knowledge is a key factor in the performance of intelligent systems. The knowledge base is composed of quantitative (structured) and qualitative (unstructured) knowledge of medical diagnosis and therapy (Akinyokun and Adniyi, 1991). The structured knowledge is concerned with facts, rules and events of tropical medicine, which are commonly agreed upon by experts in the field of medicine. The unstructured knowledge is

AGGREGATE WEIGHTING FACTORS

TABLE A: SYMPTOMS ANALYSIS

	Symptom	MAL	TYP	RAB	MEA	LEP	PER	YEF	HEP	DIP	TUB	POL	TET	GON	BDY	ADY	ONC	HEL	COL	TPA	GAS
1	Weight loss	0.11	0.19	0.07	0.18	0.02	0.09	0.09	0.09	0.08	0.48	0.03	0.04	0.05	0.10	0.22	0.07	0.28	0.37	0.03	0.32
2	Excess weight gain	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.03	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.00
3	Poor sleep	0.17	0.19	0.22	0.19	0.05	0.23	0.26	0.28	0.13	0.15	0.16	0.43	0.04	0.08	0.09	0.20	0.11	0.18	0.08	0.2
4	Excess sleep	0.08	0.01	0.13	0.04	0.06	0.01	0.01	0.04	0.01	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.42	0.00
5	Lack of energy	0.36	0.39	0.06	0.35	0.12	0.10	0.19	0.35	0.09	0.29	0.17	0.09	0.02	0.18	0.16	0.05	0.10	0.36	0.20	0.34
6	Abdominal pain	0.27	0.34	0.03	0.03	0.04	0.03	0.05	0.22	0.05	0.19	0.08	0.04	0.03	0.26	0.42	0.01	0.48	0.28	0.02	0.22
7	Loss of appetite	0.36	0.45	0.31	0.40	0.03	0.18	0.31	0.37	0.14	0.11	0.15	0.15	0.01	0.15	0.22	0.05	0.23	0.13	0.01	0.1
8	Nausea	0.28	0.26	0.24	0.25	0.10	0.16	0.16	0.22	0.09	0.04	0.20	0.15	0.00	0.08	0.12	0.00	0.38	0.21	0.00	0.08
9	Vomiting	0.21	0.25	0.09	0.16	0.06	0.29	0.15	0.21	0.16	0.06	0.11	0.06	0.00	0.11	0.14	0.00	0.26	0.43	0.02	0.36
10	Flatulence	0.07	0.12	0.02	0.05	0.03	0.02	0.07	0.07	0.04	0.04	0.08	0.02	0.00	0.20	0.12	0.00	0.12	0.24	0.00	0.1
11	Water brash	0.08	0.15	0.04	0.05	0.02	0.03	0.08	0.06	0.07	0.03	0.02	0.03	0.00	0.08	0.05	0.00	0.28	0.08	0.00	0.04
12	Heart burn	0.07	0.05	0.02	0.04	0.03	0.06	0.04	0.03	0.05	0.04	0.03	0.02	0.00	0.05	0.01	0.00	0.12	0.01	0.00	0.02
13	Dysphasia	0.05	0.06	0.30	0.09	0.10	0.06	0.04	0.02	0.10	0.04	0.06	0.29	0.02	0.06	0.01	0.00	0.08	0.00	0.10	0.00
14	Diarrhoea	0.17	0.25	0.10	0.16	0.03	0.05	0.12	0.04	0.06	0.03	0.10	0.02	0.01	0.42	0.40	0.00	0.12	0.76	0.00	0.04
15	Constipation	0.06	0.28	0.03	0.03	0.04	0.02	0.05	0.08	0.04	0.03	0.11	0.06	0.00	0.09	0.04	0.00	0.04	0.00	0.00	0.00
16	Dysphonea	0.13	0.12	0.29	0.39	0.20	0.28	0.11	0.12	0.44	0.27	0.22	0.34	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
17	Chest tightness	0.07	0.05	0.14	0.25	0.05	0.16	0.04	0.08	0.25	0.22	0.26	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	Cough	0.05	0.03	0.07	0.45	0.01	0.43	0.04	0.03	0.34	0.51	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	Leg swelling	0.02	0.03	0.02	0.00	0.02	0.01	0.00	0.01	0.01	0.03	0.03	0.00	0.02	0.02	0.10	0.00	0.12	0.01	0.02	0.01
20	Chest pain	0.03	0.00	0.10	0.20	0.00	0.21	0.11	0.02	0.20	0.22	0.24	0.04	0.00	0.00	0.00	0.00	0.02	0.00	0.02	0.00
21	Fever	0.45	0.32	0.17	0.34	0.06	0.19	0.07	0.39	0.28	0.34	0.39	0.15	0.06	0.22	0.36	0.18	0.04	0.20	0.01	0.00
22	Headache	0.42	0.42	0.22	0.22	0.05	0.04	0.04	0.18	0.11	0.03	0.04	0.05	0.02	0.09	0.12	0.00	0.02	0.02	0.04	0.00
23	Bleeding	0.00	0.07	0.04	0.03	0.02	0.03	0.04	0.21	0.03	0.16	0.02	0.00	0.03	0.21	0.30	0.01	0.15	0.02	0.03	0.00
24	Tiredness	0.30	0.37	0.05	0.19	0.19	0.12	0.21	0.33	0.06	0.28	0.22	0.18	0.01	0.11	0.14	0.01	0.14	0.18	0.02	0.02
25	Body weakness	0.26	0.26	0.19	0.20	0.11	0.06	0.20	0.23	0.11	0.23	0.34	0.05	0.01	0.18	0.2	0.00	0.12	0.12	0.03	0.20
26	Haemopthis	0.00	0.00	0.04	0.12	0.00	0.00	0.01	0.00	0.10	0.32	0.00	0.00	0.01	0.00	0.00	0.00	0.06	0.00	0.00	0.01
27	Persistent night sweat	0.10	0.14	0.00	0.00	0.00	0.02	0.01	0.00	0.09	0.34	0.02	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00

TABLE B: VARIOUS DIAGNOSIS STEPS AND THEIR WEIGHTING FACTOR

BASIC LABORATORY INVESTIGATION																			
DIAGNOSIS	MAL	TYP	RAB	MEA	LEP	TET	PER	YEF	HEP	DIP	TUB	POL	GON	BDY	ADY	ONC	HEL	COL	TPA	GAS
Complete Blood Count and Blood Electrolyte and Urea	0 65	0.76	0.37	0 31	0 28	0 35	0.31	0 26	0 38	0 26	0 33	0 26	0 08	0.10	0.06	0 01	0 20	0 02	0 08	0 3
Eritrocycle sedimentation	0 05	0 09	0 00	0 06	0 07	0 20	0 05	0 04	0 16	0 20	0 21	0.14	0 01	0 02	0 02	0 02	0 04	0 01	0 02	0 01
X-ray	0 00	0 00	0 00	0 10	0 22	0 02	0 22	0 02	0 28	0 02	0 32	0 02	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00
Urinalysis	0 04	0 05	0 00	0 08	0 00	0 06	0 02	0 09	0 00	0 06	0 02	0 07	0 20	0 01	0 01	0 00	0 00	0 00	0 00	0 01

SPECIFIC INVISTIGATION																			
DIAGNOSIS	MAL	TYP	RAB	MEA	LEP	TET	PER	YEF	HEP	DIP	TUB	POL	GON	BDY	ADY	ONC	HEL	COL	TPA	GAS
MICROBIOLOGY EXAMINATION OF BODY FLUID																				
Urine	0.05	0.36	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0 00	0.00	0.00	0.02	0.03	0.01	0.01	0 01	0.00	0.01	0.01
Blood	0.59	0.55	0.09	0.16	0 10	0.09	0.26	0.27	0.16	0.15	0.15	0 20	0.04	0.10	0.03	0.42	0.24	0.01	0.34	0.04
Spetum	0.00	0.00	0.00	0.14	0.00	0.00	0.30	0.00	0.17	0.00	0.29	0.00	0.01	0.00	0.00	0 01	0 12	0 00	0 02	0 00
CSF	0.10	0.00	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.01	0.00	0.06	0.00	0.34	0.00
Faeces	0.00	0 27	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0 32	0.44	0.00	0.52	0.28	0 01	0.20
IMMUNODIAGNOSIS																				
Serology	0.00	0.04	0.00	0.01	0.00	0.00	0.02	0.01	0.01	0.01	0.02	0.01	0.04	0.02	0.02	0.01	0.02	0.02	0.00	0.20
Specific	0.00	0.15	0.00	0.14	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0 01	0.01	0.01	0 01	0.00	0.00	0.08
IGG	0.06	0.14	0.10	0 00	0.03	0.04	0.13	0.03	0.12	0.05	0.15	0.03	0.02	0.00	0.00	0 00	0 00	0 00	0.00	0.24
IGM	0.00	0.01	0.00	0.00	0.03	0.04	0.03	0.15	0.01	0.05	0.01	0.03	0.01	0.00	0.00	0 01	0 00	0 00	0 00	0 00
Antigen Detection	0.05	0.14	0.03	0.08	0.06	0.09	0.01	0.13	0.01	0.02	0.23	0.03	0.00	0.00	0.00	0.00	0 02	0.00	0.00	0.00
Eliza	0.03	0.00	0.03	0.00	0.00	0.03	0.03	0.13	0.02	0.14	0.03	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Radio Immunodiagnosis	0.00	0.00	0.08	0.00	0.00	0.03	0.00	0.15	0.00	0.16	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Immune Florescent Test	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.03	0.00	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TISSU DIAGNOSIS																				
Aspirate	0.00	0.04	0.00	0.02	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.12	0.00	0.00	0.00	0.00	0.00
Cytology	0.00	0.07	0.05	0 01	0.00	0.00	0.00	0.19	0.00	0.18	0.00	0.15	0.01	0.00	0.02	0.00	0.00	0.01	0.01	0.01
Mycroscopy	0.18	0.20	0.10	0.05	0.00	0.00	0.00	0.15	0.00	0.19	0.00	0.19	0.40	0.24	0.21	0.20	0.05	0.22	0.04	0 15
culture	0.00	0.21	0.07	0.10	0.00	0.09	0.06	0.00	0.11	0.00	0.11	0.07	0.68	0.18	0.38	0.00	0.00	0.22	0.02	0.06
DNA	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Histopathology	0.09	0.00	0.05	0.00	0.14	0.00	0.00	0.06	0.00	0.06	0.00	0.07	0.00	0.00	0.19	0.20	0 00	0 05	0 12	0 00
OTHERS																				
Imaging	0.00	0.00	0.00	0.00	0.00	0 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CI	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MRI	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Angiography	0.00	0.00	0.00	0.00	0.00	0.00	0 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0 00	0.00	0 00	0.00

that which is acquired by medical experts by experience. It is heuristic knowledge or that which is acquired by good practice, guesses and judgment (Ermine 1995).

The knowledge base of MEPA is composed of a network of semantically related structured (static) and experiential (dynamic) medical knowledge of tropical preventable diseases. For the purpose of this study, twenty tropical diseases are considered. They include: Malaria (MAL), Typhoid (TYP), Rabies (RAB), Measles (MEA), Leprosy (LEP), Pertusis (PER), Yellow fever (YEF), Viral Hepatitis(HEP), Diphtheria(DIP), Tuberculosis(TUB), Poliomyelitis(POL),Tetanus (TET), Gonorrhea(GON), Bacillary Dysentery(BDY), Amoeba Dysentery(ADY), Onchoceriasis (ONC), Helminthiasis (HEL), Cholera (COL), Thypanosomiasis (TPA) and Gastroenteritis (GAS). The knowledge base is conceptualized as a semantic network of relations. A relation is a two-dimensional table containing tuples (records) on the row and attributes (fields) on the column. The general form of a relation is given by R = $[a_1, a_2, a_3, \ldots, a_k]$ where R represents the name of the relation and the set $\{a_1, a_2, a_3, \ldots, a_k\}$ represents the attributes of the relation R [Codd, 1970].

The set of relations of that are developed in this study for the management of tropical preventable diseases are as follows:

a. DISEASE [disease – number, disease-name, nature, mode-of-infection, agent-of-infection]
b. SYMPTOM [disease-number, symptom number, duration, intensity.]
c. PATINFO [Patient-number, Patient name, Date of birth, Residential address, Tel-no, Next-of-kin-name, Next-of-kin-address, Next-of-kin-phone, Date-of-registration, Special-xteristics, Disease-NUMBER, date-history-is-taken, Time-history-is-taken, Time-exam-is-taken, Diagnosis-number, Diagnosis-Desc]
d. PATEXAM [Patient-number, Disease-number, Date-exam-is-taken, Time-exam-is-taken, exam-01, exams-02, ..., exam-m]
e. THERAPY [Disease-number, Treatment]
f. CHEMOTHERAPY [Disease-number, Drug-number, Adult-dosage, Children dosage, Injection, Side-effect]
g. CONTROL [Disease-number, Patient-number, Control measures]
h. FURTHER INVESTIGATION [Disease-number, Investigation Desc, result]
i. CASE DOCTOR [Patient-number, Medical-doctor's-name, dept, Date-of-consultation, Diagnosed-disease, Therapy, Chemotherapy]

The unstructured knowledge for MEPA was obtained through the administration of questionnaires and conducting of interviews on thirty doctors in Nigeria, who are specialists in tropical diseases. Through the aid of the instrument, weighting factors were attached to various symptoms, diagnosis steps, and treatments relating to tropical diseases. The weighting factor represents the heuristic elements of the knowledge base that function on the principles of plausibility calculus [Ermine, 1995]. The weighting factor is given as w where $0 \leq w \leq 1$ for each variable concerning a given disease. Tables A – D present two dimensional representations of the weighting factors for symptoms, diagnosis steps, modes of treatment, and chemotherapy respectively.

INFERENCE ENGINE

The Inference Engine is concerned with the adoption of an appropriate line of reasoning, leading to the solution of a given case situation or the formulation of a body of consultative advice on a given medical phenomenon (Ermine 1995). The major inference technique adopted in this study is a forward chaining type, in which some conclusions are drawn, based on available facts obtained through the combinatorial analysis of corresponding medical decision variables. The system can also apply backward chaining as a minor technique, especially where the patient is not able to effectively communicate the symptoms to the medical practitioner. In that case the medical practitioner supplies the name of suspected diseases and works through a stepwise factor analysis of symptoms to arrive at a body of conclusions, which are then cognitively and emotionally filtered to be able to commence appropriate treatment.

In the main strategy, the medical practitioner supplies the system with the symptom obtained from the patient in question (in an interactive mode). This is accompanied with associated degrees of intensity, which are rated on a Likert scale of 1 – 5, where lower part of the scale represents the case of occasional, not intensive situation while the upper part of the scale represents a frequent, very intensive situation. The system then sets up a four dimensional table of diseases, symptoms, weighting factors and intensities, which eventually leads to the identification of the suspected disease(s). The algorithm for such identification is proposed as follows:

1. List the symptoms of the patient complained of where the number of symptoms = n
2. Loop for i = 1 to n
3. Search for the disease that has the symptom and mark X at the appropriate location of the empty decision matrix
4. Multiply the symptom by the intensity factor and the associated plausibility (weighting) factor to get the confidence rating as follows

$$c = 0 \leq \frac{\sum xy}{5} \leq 1$$

where x = plausibility factor ($0 \leq x \leq 1.0$)
y = intensity level ($y = 1, 2, 3, 4, 5$)
c = confidence rating ($0 \leq c \leq 1.0$)

5. endloop
6. Sum the confidence ratings for the symptoms on every disease in the database to obtain the aggregate symptom factors as follows:

$$a_j = \sum_{i=1}^{n} \sum_{j=1}^{k} cij$$

where n is number of complained symptoms and k is number of diseases in the knowledge base

7. Rank the aggregate symptom factors according to disease
8. Determine the probable diseases by choosing the first four diseases in the ranking
9. Apply decision support filters on the results to determine the eventual disease

The inference procedure is supported by a production rule mechanism (Uzoka 1998). Example of production rules supported by MEPA is given below:

If {fever-strong, headache-strong, appetite-loss, body weakness-average, abdominal pain-yes}
then {malaria or typhoid fever or yellow fever or measles} suspected

DECISION SUPPORT FILTERS (DSF)

The DSF contains the cognitive filter and emotional filter. The cognitive filter carries out deductive and inductive reasoning on the information content of the various alternative suspected diseases while the emotional filter carries out inductive and deductive reasoning on the information context of the suspected diseases (Akinyokun and Uzoka 2000). The DSF helps the medical practitioner to form preferences, make judgments and take decisions. Decision making process has three components, namely; People, Information Technology (IT) and Preference Technology

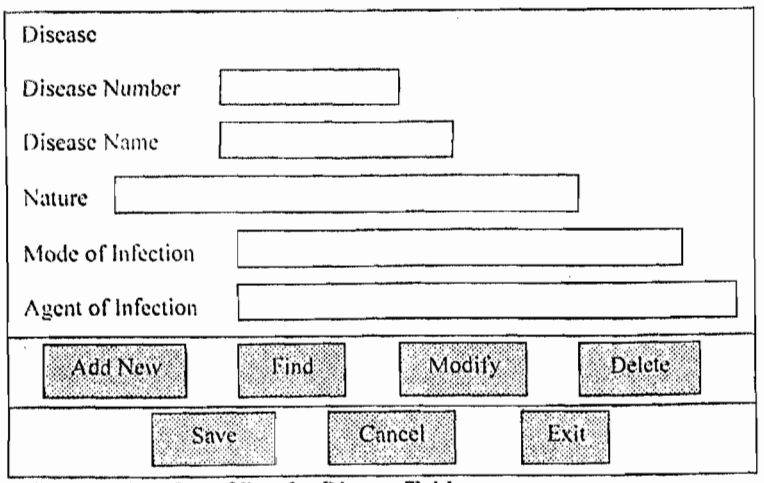

Figure 4.4: Form View for Disease Table

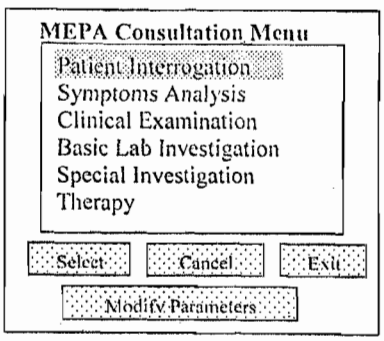

Figure 4.5: Inference Engine Submenu

TABLE C MODES OF TREATMENT AND THEIR WEIGHTING FACTORS

S/N	TREATMENT	MAL	TYP	RAB	MEA	LEP	TET	PER	YEF	HEP	DIP	TUB	POL	GON	BDY	ADY	ONC	HEL	COL	TPA	GAS
1	Chemotherapy	0.73	0.69	0.37	0.31	0.62	0.44	0.69	0.48	0.33	0.57	0.64	0.23	0.6	0.3	0.48	0.53	0.46	0.28	0.4	0.12
2	Pakkuatuve and Conservative Management	0.10	0.03	0.63	0.31	0.20	0.00	0.09	0.22	0.46	0.16	0.10	0.30	0.01	0.02	0.03	0.02	0.02	0.15	0.02	0.46
3	Surgical intervention	0.00	0.20	0.00	0.05	0.05	0.13	0.00	0.00	0.00	0.00	0.20	0.15	0.2	0.00	0.32	0.24	0.01	0.02	0.01	0.02
4	Immunotherapy	0.10	0.09	0.31	0.24	0.00	0.00	0.20	0.20	0.34	0.20	0.22	0.23	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00
5	Radiotherapy	0.00	0.00	0.00	0.00	0.14	0.02	0.00	0.00	0.00	0.00	0.00	0.09	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	Physiotherapy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.31	0.05	0.00	0.00	0.02	0.00	0.02	0.00	0.11

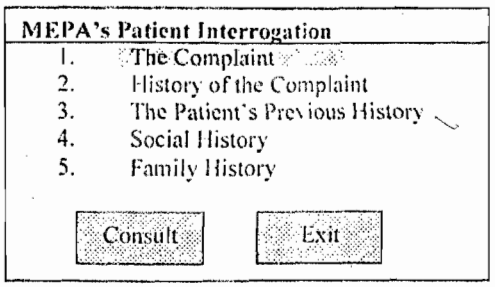

Figure 4.6: The Interrogation Submenu

(Emotional and Cognitive Filters). The people, involved are the medical practitioners. The IT component consists of the computing system that handles the capture, storage, processing, analysis of relevant information and providing software modeling assistance to determine the consequences of pursuing different alternatives [Akinyokun and Anyiam, 2001]. The preference technology helps to clarify both the objective and subjective value judgments made when evaluating the possible consequence of alternative decisions.

The DSF helps the medical practitioner to translate a fuzzy problem into a more structured and manageable one. This is achieved through the dialogue sessions provided by the discussion module. For instance, a patient may be diagnosed to be suffering from malaria, but further dialogue may reveal that the patient may be suffering from stress and fatigue or some psychological phenomena occasioned by excessive work, poor living conditions, unfavourable events or some other factors (Akinyokun and Adeniyi, 1991).

CASE STUDY AND RESULTS

MEPA is developed in Microsoft Access and Visual Basic environment. It is implemented in a distributed environment that has Windows Millennium Edition (as the distributed operating system). The medical personnel views the knowledge base component of the package in a top down manner and gains access to it by supplying a valid user name and password, both of which serve as the access right and control mechanism. If access right is granted; the system presents the scenario of easy to understand menus and submenus. The menus and submenus contain valid transactions and inferences in the management of tropical diseases. An inference procedure is interactive in nature and guides the medical personnel intelligently but always leaving the final decision to the medical personnel. The system supports four major dialogue sessions.

MEPA'S DIALOGUE AND MENU SESSIONS

The first dialogue session takes the medical personnel through the login procedure. On the windows desktop, the icon "MEPA" is double clicked. The system presents an opening banner, followed by the login screen depicted in Figure 4.1. The user name and password are entered. Subject to verification and validation, authorization is granted and the system's main menu, depicted in Figure 4.2 is displayed on the screen. On clicking on "exit", the user is taken out of the system, but on the clicking on "select", the user is allowed access to the highlighted menu option.

MEPA REPORT MODULE FOR PATIENT DIAGNOSIS

Patient Name: Kunle Ajayi Patient No: 0143502

Patient Age: 35 Date of First Treatment: 04 – 01 – 2002

Suspected Diseases: Malaria, Typhoid Fever, Yellow Fever, Measles

Patient Complaints (Symptons): Loss of appetite (S1)
Fever (S2)
Headache (S3)
Nausea (S4)
Body weakness (S5)
Abdominal pain (S6)

Disease	S1			S2			S3			S4			S5			S6			
	W	C	T	W	C	T	W	C	T	W	C	T	W	C	T	W	C	T	AGGR
Malaria	0.36	4	1.44	0.45	5	2.25	0.42	4	1.68	0.28	3	0.84	0.26	4	1.04	0.27	3	0.81	8.06
Typhoid	0.45	4	1.80	0.32	5	1.60	0.42	4	1.68	0.26	3	0.78	0.26	4	1.04	0.34	3	1.02	7.92
Yellow fever	0.31	4	0.24	0.07	5	0.35	0.04	4	0.16	0.16	3	0.48	0.20	4	0.80	0.06	3	0.18	3.21
Measles	0.40	4	1.6	0.34	5	1.7	0.22	4	0.88	0.25	3	0.75	0.20	4	0.8	0.03	3	0.09	5.82

Key W = Weighting factor
C = Confidence level
T = Total scalling

Save View Print Cancel Exit

Figure 4.7: Transcript of MEPA's Diagnosis Report

TABLE D: CHEMOTHERAPY AND CORRESPONDING WEIGHTING FACTORS

S/N	DRUGS	MAL	TYP	RAB	MEA	LEP	TET	PER	YEF	HEP	DIP	TUB	POL	GON	BDY	ADY	ONC	HEL	COL	TPA	GAS
1	Antiparasites	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.42	0.34	0.02	0.3	0.02
2	Antiprotozoans	0.40	0.00	0.00	0.10	0.14	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.01	0.02	0.01	0.00	0.01
3	Antibiotics	0.11	0.50	0.46	0.49	0.09	0.16	0.13	0.18	0.18	0.21	0.32	0.18	0.56	0.32	0.48	0.1	0.04	0.20	0.01	
4	Cytotoxic agent	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.02	0.16
5	Antifungi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.04
6	Chloroquine	0.71	0.00	0.00	0.03	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
7	Sulfadoxine	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3	0.25	0.02	0.00	0.00	0.12	0.00	0.20
8	Pyrimethamine	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0	0	0	0
9	Helofantrine	0.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	Quinine	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	Palluther	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12	Oxiocycline	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.02	0.02	0.00	0.00	0.10	0.00	0.0
13	Anioxilin	0.00	0.35	0.00	0.05	0.00	0.08	0.17	0.09	0.17	0.05	0.05	0.05	0.36	0.10	0.10	0.00	0.00	0.00	0.00	0.0
14	Cotrimoxacole	0.00	0.35	0.00	0.00	0.00	0.06	0.04	0.00	0.00	0.07	0.03	0.05	0.32	0.36	0.12	0.00	0.00	0.16	0.00	0.3
15	Refloxacine	0.00	0.20	0.00	0.00	0.00	0.07	0.04	0.00	0.00	0.05	0.02	0.03	0.08	0.02	0.0	0.00	0.00	0.00	0.00	0.0
16	Eprofloxaine	0.00	0.30	0.00	0.00	0.00	0.09	0.04	0.00	0.00	0.06	0.00	0.00	0.01	0.00	0.0	0.00	0.00	0.00	0.00	0.0
17	Anti-rabies vcc	0.00	0.00	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.0
18	Antirabies immunoglobulin	0.00	0.00	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.0
19	Isoniazid	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.01	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.0
20	Rifampicin	0.00	0.00	0.00	0.05	0.12	0.00	0.00	0.00	0.00	0.00	0.39	0.03	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.0
21	Ethanbutol	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.07	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.0
22	Pyrazinamide	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.02	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.0
23	Thiacetazone	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.0
24	BCG	0.00	0.00	0.00	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.0
25	Cycloserine	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.01	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.0
26	Leprosy vcc	0.00	0.00	0.00	0.05	0.29	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0	0.0	0.0
27	Clofascamine	0.00	0.00	0.00	0.02	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0	0.0	0.0
28	Yellow-fever vcc	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.38	0.09	0.11	0.08	0.00	0.00	0.00	0.0	0.00	0.00	0.0	0.0	0.0
29	DPT	0.00	0.00	0.00	0.00	0.00	0.33	0.29	0.07	0.20	0.28	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0	0.0	0.0
30	Oral polio vcc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.00	0.00	0.0	0.00	0.00	0.0	0.0	0.0
31	Inactivated polio vcc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.0	0.00	0.00	0.0	0.0	0.0
32	Attenuated polio vcc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.0	0.00	0.00	0.0	0.0	0.0
33	Clindamycin	0.00	0.00	0.09	0.09	0.00	0.15	0.15	0.00	0.00	0.15	0.00	0.15	0.01	0.00	0.22	0.00	0.00	0.0	0.0	0.0
34	Tetanus toxoid	0.00	0.18	0.10	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.10	0.00	0.0	0.0	0.0
35	Xtal penicillin	0.00	0.09	0.09	0.16	0.03	0.07	0.07	0.06	0.11	0.08	0.00	0.02	0.20	0.01	0.01	0.01	0.00	0.0	0.0	0.0
36	Cephelosponnes	0.00	0.02	0.17	0.16	0.03	0.08	0.08	0.04	0.06	0.21	0.00	0.00	0.42	0.02	0.04	0.00	0.00	0.2	0.0	0.0
37	Diazepam	0.00	0.00	0.10	0.00	0.02	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.01	0.00	0.04	0.00	0.0	0.0	0.0
38	Chlorpromazine	0.00	0.00	0.13	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.0	0.0	0.0
39	Anti-tetanus	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.0	0.0	0.1
40	Serum Immunoglobin	0.00	0.00	0.11	0.00	0.05	0.18	0.18	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.02
41	Hepatitis B vcc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0
42	Engerix B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0
43	Vitamin B complex	0.19	0.18	0.11	0.07	0.14	0.11	0.11	0.11	0.24	0.09	0.14	0.16	0.12	0.20	0.10	0.01	0.01	0.2	0.0	0.04
44	Antiviral lamivindine	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.25	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00
45	Combivir	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.17	0.00	0.00	0.04	0.02	0.00	0.00	0.00	0.00	0.0	0.0	0.0

The second dialogue session commences when the "knowledge management" option is selected from the main menu. Knowledge management can only be carried out by an authorized medical personnel; hence, the access right of the medical personnel has to be verified and validated. If access is granted, a combo list of the tables in the knowledge base is displayed on the screen as shown in Figure 4.3. On selecting the appropriate table, the relevant form view is displayed. Presented in figure 4.4 is a form view for the DISEASE table. The form view gives the medical personnel the opportunity of carrying out the following:

a. Inserting a new record
b. Finding an existing record
c. Deleting an existing record
d. Modifying an existing record

The third dialogue session begins when the option "Consultation" is selected in Figure 4.2. The access right of the medical personnel making the selection has to be verified and validated. If access is granted a combo list of diagnostic and inference activities of MEPA is shown as presented in Figure 4.5. The 'Select' option allows the user to select a highlighted activity. The "modify parameters" on the other hand, allows an authorized medical practitioner to modify the parameters involved in the inference (as contained in Tables A – D). Suppose the option "Patient Interrogation" is selected in Figure 4.5, an inference module is activated, which produces a list of interrogation elements, which allows for a stepwise analysis of the complaint variables needed for the diagnosis of the patient. Figure 4.6 presents such elements.

Any option chosen, presents an interactive screen which allows the doctor to chain forward through the symptoms or to chain backwards through a suspected disease to be able to decide on a suspected disease or to move to the next inference which could involve clinical examination or some further investigations. The inference engine produces a report required for the therapy of the disease. The medical practitioner may decide to report to the screen for the purpose of viewing, patient's file for future reference, or printer for hard copy

Chemotherapy Report

Patient's Name: Kunle Ajayi [0143502]

Disease Name: Malaria
Report Date: 20/01/2002

Drug Name	Adult Dosage	Children Dosage	Injection	Side Effects
Chloroquine	Tablets: 600mg initial dose 300mg after 6 to 8 hrs	Tablet: 10mg/kg initial dose 5mg/kg after 6 to 8 hours for 2 days	Adult: 200mg every 12 hours for 3 – 4 doses	Headache Skin reaction Vomiting Gastro-intestinal Disturbances
Paracetamol	Tablets: 2 tablets three times a day			
Alternative Active Drug: Quinine	Tablet: 600mg initial dose every 8 hrs for seven days	10 mg/kg every 8 hrs for 2 days		Cinchonism, headache Abdominal pain Flushed skin

Figure 4.8: MEPA's Therapy Report

production. The transcript of such a report generated by MEPA is shown in Figure 4.7.

The doctor may conduct basic laboratory investigation or specific investigation to further pin-point the exact disease. The results of the sympton analysis and laboratory investigations are fed into the decision support filter in (Figure 4.2) which forms the fourth dialogue session.

The decision support filters take as input, the results of the interrogation and investigation processes and carries out deductive and inductive reasoning on the information content and context of the knowledge base to be able to take the final decision regarding the particular disease in question. The final decision takes the medical practitioner to the therapy module submodule of Figure 4.5. This produces a final therapy report, based on the disease eventually arrived at. A transcript of such a therapy report for malaria is shown in Figure 4.8. MEPA has a therapy dialogue whose results also assists the system in deciding on the drug prescriptions. Such dialogues could include the following

What drug(s) are you recently placed on?
Are you pregnant (Y/N)?
Do you have ulcer (Y/N)?
What drug(s) do you react to?

CONCLUSION AND RECOMMENDATIONS

This work has shown clearly the role of computer system as an intermediary between patient and medical practitioner. The medical practitioner has to examine his/her patient as in the orthodox approach, perhaps, even more thoroughly as he would aim for precision in the management of the disease. Also the computer aided system facilitates fast and accurate information retrieval, which may help to reduce the problem of manual walkthrough of voluminous medical textbooks and manuals. There are also the prospects of standardized and high intelligent differential diagnosis and therapy procedures. Furthermore, the system plays important role in the self-education and medical diagnosis and therapy by doctors, nurses, clinical students, and other relevant medical personnel. The design considerations for the system presented is built on the conviction that the quickest and effective way to carry out medical diagnosis and therapy is to employ the services of a doctor assisted by a computer knowledge base system. Finally, the major contribution of the system is that it enhances the doctors' performances for quick and effective diagnosis and therapy of tropical preventable disease.

It is noted that this paper presents a framework whose commercial implementation can be worked upon to be able to meet the needs of the rural areas in the tropics where computers are almost non existent and electricity supply is epileptic, with the explosion in IT activities in developing countries, it is expected that in a couple of years to come, the practical realization of the utility of this framework would be achieved, even in the rural tropical communities.

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