MEDICAL DECISION SUPPORT SYSTEM USING ANALYTIC HIERACHY PROCESS: A CASE STUDY OF MALARIA DIAGNOSIS

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Outline

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Motivation

- Malaria attack is so prevalent, especially in the tropics.
- Malaria is a major source of morbidity and mortality in most African countries
- High incidence among children less than 5 years old
- Roll back malaria has not succeeded in eradicating malaria

Motivation

- research has been intensified in the past decade to facilitate finding more appropriate means of malaria diagnosis, treatment and control

- A number of MDSS have been proposed for the management of diseases

- AHP has been identified to be efficient in handling hierarchically structured decision variables

- An attempt is made at utilizing AHP in modeling the diagnosis of malaria

Objectives

OBJECTIVES

- Propose a model for the qualitative evaluation of malaria symptoms using the classical method of the Analytic Hierarchy Process (AHP)

- Demonstrate the functionality of the model using some sample data from malaria patients.

Conventional Method of Malaria Diagnosis

■ Patient interrogations.

■ Basic laboratory investigations

■ Special investigations
  – Microbiological examination of body fluids
  – Immunodiagnosis
  – Tissue diagnosis

Methodology

- Interact with medical doctors on symptoms of malaria, the possible grouping of the symptoms, and the pairwise comparison of the symptoms .

- Design of a computer oriented model using the analytical hierarchy process powered inference mechanism.

- The major components of the model are:
  - ✓ Knowledge base
  - ✓ Decision support base (Powered by AHP)
  - ✓ User interface

Knowledge Components

- Patient information

- Patient characteristics

- Medical history

- Patient examination

- Chemotherapy

- Symptom intensity

The Algorithm of the AHP Process

- Identify all decision alternatives.
- Identify all the criteria for evaluation.
- Develop the hierarchy of criteria for prioritizations.
- Establish a priority model by identifying the relative importance of criteria through pairwise comparison (PWC) which is done from the top level of the hierarchy to the bottom level.
- Assess each decision alternative in terms of the lowest level sub-criteria in each criterion.
- Determine the priority order (ranking).

Hierarchy of Basic Malaria Diagnosis Criteria

LEVEL 1 (GOAL)	LEVEL 2 (CRITERIA)	LEVEL 3 (VARIABLES)
MALARIA DIAGNOSIS	FEVER (FVR)	Fever (FVR), Sweating (EXT), Shivering (SHV)
	ACHES (ACH)	Headache (HDC), Muscle ache (MSH), Backache (BKH), Joint Pain (JTP)
	CENTRAL NERVOUS SYSTEM (CNS)	Chills (CHL), Nausea (NSA), Delirium (DRM), Tiredness (TRD), Excessive Sleeping (EXP), Dizziness (DZN)
	GASTRO INTESTINAL TRACT (GIT)	Vomiting (VMT), Diarrhea (DRH), Dehydration (DRT), Stomach discomfort (SMC)
	RESPIRATORY SYSTEM (RSS)	Abnormal Breathing (ABT), Coughing (CUG)
	GENERAL MALAISE (GML)	Loss of Appetite (LOA), Yellowish Eyes (YOE), State of Unwell (SUW)

Level 2 Pairwise Comparison Matrix

	FVR	ACH	CNS	GIT	RSS	GML
FVR	1	5	7	7	8	6
ACH	1/5	1	7	6	7	5
CNS	1/7	1/7	1	1	3	1/5
GIT	1/7	1/6	1	1	6	¼
RSS	1/8	1/7	1/3	1/6	1	1/5
GML	1/6	1/5	5	4	5	1

AHP Malaria Diagnosis Model

The application of AHP to the 2nd and 3rd level PWC gives the following Aggregate Diagnostic Factor Index (ADFI)

$$ADFI = 0.0540FVR + 0.0031EXT + 0.0160SHV + 0.0226HDC + 0.0066MSH + 0.0050BKH + 0.0064JTP + 0.0043CHL + 0.0030NSA + 0.0010DRM + 0.0050TRD + 0.0004EXP + 0.0018DZN + 0.0024VMT + 0.0057DRH + 0.0041DRT + 0.0010SMC + 0.0003ABT + 0.0007CUG + 0.0131LOA + 0.0010YOE + 0.0077GML$$

Utilizing the value of perfect information, a value judgment could be made about the intensity of malaria attack

Uniform Rating	ADF1 Range	Malaria Intensity
1.	0.00000 – 0.16524	Very low
2.	0.16525 – 0.33047	Low
3.	0.33047 – 0.49571	Moderate
4.	0.49572 – 0.66095	High
5.	0.66096 – 0.82618	Very high

Results for some of the diagnosed patients

Patient number	ADFI	Malaria Intensity
9200195	0.610783	High
9000087	0.361289	Moderate
2201421	0.49842	High
9100182	0.60113	High
8700008	0.461251	Moderate
2301694	0.479785	Moderate
2101387	0.456735	Moderate
8900021	0.364672	Moderate
9300201	0.606026	High
2401756	0.431987	Moderate
2401903	0.563012	High
2201450	0.383277	Moderate
2201203	0.259022	Low
9500490	0.495637	Moderate
9900779	0.666986	Very High
9100176	0.692396	Very High
9000090	0.462334	Moderate
9300199	0.60621	High
3001561	0.687848	High
8600003	0.58669	High
3301696	0.539512	High
9300199	0.615758	High
8900033	0.453646	Moderate

Analysis

- **Most of the patients diagnosed had either moderate or high intensity of malaria attack.**

- **This could be attributed to people's predisposition to go for medical attention only when malaria symptoms have become very discomforting. Majority even attempt self medication**

- **The intensity of malaria attack is influenced more by the variables that have high values on the eigenvector; such as**
  - ➢ **fever (0.0540)**
  - ➢ **headache (0.0226)**
  - ➢ **shivering (0.0160)**

- **These variables also belong to the level 2 criteria that have high ratings on the Level 2 eigenvector; namely, fever and aches which are very common symptoms of malaria.**

- **Evidence from the results show that malaria has reasonably low effect on the respiratory and gastro intestinal tract systems.**

Conclusion

- Medical diagnosis is a complex process that requires the combinatorial analysis of decision variables

- Malaria diagnosis provides one such situation where qualitative variables could be hierarchically structured to determine the basic diagnosis.

- The AHP based system provides a useful tool for carrying out diagnosis of malaria, based on patient interrogation and clinical examinations.

- This study has proposed a model for structuring of malaria diagnostic decision variables.

- The evaluation of the system shows a percentage confidence level of about 7% over the manual method of malaria diagnosis.

- However, it is proposed that the model be subjected to clinical acceptability as a basis for the development of full scale Malaria Diagnosis Decision Support System

Future Study

- It is expected that future study could consider the application of factor analysis in the classification and evaluation of relative importance of the symptoms in the process of malaria diagnosis

- A clinical evaluation of the proposed system would assist in carrying out a careful improvement of the model in order to eventually actualize an operational decision support system for

APPRECIATION