# A Conceptual Approach to Development of Predictive Medical Diagnostic System for Malaria and Asthma

**Okumbor N. Anthony**
Department of Computer Science
Delta State Polytechnic, Otefe-Oghara
Delta State, Nigeria
Aokumbor@yahoo.com

***Abstract***
*This paper conceptualizes computer solution to the diagnosis and treatment of Malaria and Asthma diseases. The choice of these two diseases is because they are common and most widely spread in our locality. The open problems are addressed and a perspective for the realization of automated diagnosis of malaria and asthma is provided. To examine the existing system, the Structured System Analysis and Design (SSADM) methodology was employed. The purpose of the design was to build a new system that will solve the problem of the existing system. Hence, the programming language used for the design of this work is Visual basic 6.0 for the frontend and MS Access for the backend database because of enhance interaction and friendliness. The solution designed will provide diagnostic support, the efficiency of alternative therapeutic schemes and promote better patient care by enhancing collaboration between physicians and pharmacists. The medical diagnostic system developed no doubt would enhance medical practice within the medical profession when adopted and implemented.*

***Keywords:*** *Asthma; Diagnostic; Malaria; Medicine; Patient; Prognosis; Therapy; SSADM.*

## 1.0. Introduction

Disease is an unhealthy condition in a human being, it is illness of the body of the mind caused by infection or internal disorder. The process of attempting to determine or identify a disease or disorder is termed diagnosis. A diagnosis in the sense of diagnostic procedure can be regarded as an attempt at classifying an individual's health condition into separate and distinct categories that allow medical decisions about treatment and prognosis to be made.

Therefore, computerized predictive medical diagnostic system is more essential in medical care services than any other area of human life. Today small computer containing an electrocardiograph system can be wheeled to a patient's bedside to record and interpret an electrocardiogram (ECG). The electrocardiogram is a graph of electrical pulse that causes the patient's heart to beat. With the help of such report doctors can quickly detect many of the abnormalities of heart disease; thus proper drugs for treatment could then be prescribed. Another small computer known as blood cell separator can also be used to accept blood directly from doctor or patients. In this work, the approach is to conceptualize the development of a system that does diagnosis of Malaria and Asthma.

## 1.1 Background

Malaria is a serious infectious disease caused by a peripheral blood parasite of the genus *Plasmodium*. According to the World Health Organization (WHO), it causes more than one million deaths arising from approximately 300–500 million infections every year (Korenromp et al, 2005). Though techniques abound of the disease diagnosis, however, Hanscheid (2003) noted that manual microscopy for the examination of blood smears is currently the gold standard for malaria diagnosis. According to Kettelhut et al, (2003) diagnosis using a

microscope requires special training and considerable expertise. It has been shown in several field studies that manual microscopy is not a reliable screening method when performed by non-experts due to lack of training especially in the rural areas where malaria is endemic (Coleman et al, 2002, Bates et al, 2004, Mitiku et al, 2004). On the other hand, Asthma is a common disease in this part of the world. It is a chest illness that causes difficulty in breathing. The symptoms are cough, difficulty in breathing and sneezing.
To diagnose these diseases an automated system aims at performing this task without human intervention and to provide an objective, reliable, and efficient tool to do so. An automated diagnosis system can be conceptualized by understanding the diagnostic expertise and representing it by specifically tailored pattern recognition algorithms, image processing and analysis. This study provides an overview of computer predictive studies of malaria and asthma diagnosis and intends to fill a gap in this area by doing so.

## 1.2. Statement of Problem

Disease diagnosis and treatment is the major work of physicians. Most of the time, diagnosis is wrongly done leading to error in drug prescription and complications in the patient's health. It has also been noticed that much time is spent in interview and physical examination of patients before treatment commences. In order to overcome this issue, the predictive diagnosis of malaria and asthma shall address these problems by effectively providing quality diagnosis.

## 1.3. Aim and Objectives

The aim of the work is to conceptualize a predictive diagnosis and treatment for malaria and asthma. The objectives are as follows:

- To develop modern interactive diagnostic software that will aid clinicians in diagnostic procedures offer prescription of medication.
- To examine the existing system of diagnosing disease in Delta State University Teaching Hospital (DESUTH) Oghara.
- To review existing literature and expose new ground where the system can be implemented.

**1.4. Scope:** Despite the seemingly broad of the study of disease, this study is centered on the design of computerized system for medical diagnosis and prescribe treatment of asthma and malaria patients. The choice of these two diseases is because they are common and most widely spread in our locality.

**1.5. Significance:** The significance of this work is that in its ability to: Promote better patient care by enhancing collaboration between physicians and pharmacists. Reduce the potential for harmful drug interactions, prescription errors and adverse drug reactions. And provide diagnostic support and the efficiency of alternative therapeutic schemes.

**1.6. Limitation of Study:** In the course of this study, a major constraint experienced was that of the inevitability of human error and bias as some information were obtained via interpersonal interactions, interviews and research, making some inconsistent with existing realities. Others include time factor and insufficient finance. However great pains were taken to ensure that these limitations are at their very minimum and less impactful on the outcome of the work.

## 2.0. Literature Review

According to Churchill (1995) the choice to model the behavior of a computer expert in medicine on the expertise of human consultants is by no means logically necessary. If we could understand the functioning in health and in disease of the human body in sufficient depth to model the detailed disease processes which disturb health, then, at least in principle, we could perform diagnosis by fitting our model to the actually observable characteristics of the patient at hand. Nevertheless, most of what we know about the practice of medicine we know from interrogating the best human practitioners; therefore, the techniques we tend to build into our programs mimic those used by our clinician informants (Hawkinson, 1980).

Relying on the knowledge of human experts as postulated by David (1985) to build expert computer programs is actually helpful for several additional reasons: first, the decisions and recommendations of a program can be explained to its users and evaluators in terms which are familiar to the experts. Second, because we hope to duplicate the expertise of human specialists, we can measure the extent to which our goal is achieved by a direct comparison of the program's behavior to that of the experts. However, it is important to note that the right to adequate healthcare, at anytime and anywhere, to anyone, is one of the main goals of modern society, hence the diagnosis and treatment of the diseases malaria and asthma is the focus in this study.

**2.1. Malaria:** According to World Health Organization (WHO, 2019), malaria is a potential medical emergency and should be treated because delays in diagnosis and treatment are leading causes of death in many countries. As noted earlier, the disease is caused by a peripheral blood parasite of the genus *Plasmodium*. The signs and symptoms of malaria include fever, headache, weakness, myalgia, chills, dizziness, abdominal pain, diarrhea, anorexia, and pruritus (Looareesuwan, 1999). Nowadays, the gold standard method for malaria detection is examined by expert laboratorists. It requires well-trained laboratory personnel, it is time consuming, and is an unautomated protocol. In routine laboratory tests, a complete blood count (CBC) is almost always requested without exception as part of the routine investigation in febrile patients. In previously published research, there were some reports using routine automated hematology analyzers for presumptive diagnosis of malaria infection. Most studies are those regarding abnormal depolarizing patterns of the Cell-Dyn hematology analyzer (Abbott Diagnostics, Santa Clara, CA) (Hanscheid et al, 2001). Maladiag Software was developed to predict malaria infection in suspected malaria patients. The demographic data of patients, examination for malaria parasites, and complete blood count (CBC) profiles were analyzed (Kotepui, et al, 2015).

However, a clinical diagnosis of malaria from symptoms of malaria patients is still inaccurate because of the non-specific symptoms similar to viral or bacterial infections, and other febrile illnesses which may impair diagnostic specificity (Mwangi et al, 2005 and Reyburn et al, 2004). To gain a more precise diagnosis, malaria is diagnosed using microscopic diagnosis by the gold standard method which is the staining of thin and thick peripheral blood smears (Ngasala et al, 2008) and other techniques such as the quantitative buffy coat (QBC) method (Bhandari et al, 2008). The rapid diagnostic test (RDT) is another method that detects malaria antigens in a small amount of blood by immunochromatographic assay impregnated on a test strip (Wongsrichanalai, 2007). The RDT dipstick was a commercially available and frequently uses routine diagnostic tool such as OptiMAL (Tagbor et al, 2008 and Zerpa et.al, 2008) and others. Molecular diagnostic methods, such as polymerase chain reaction (PCR) was also used with higher sensitivity when compared to the blood film examination (Vo et al, 2007). Some advantages and disadvantages of these methods related to accuracy, precision, sensitivity, specificity, time consumed, cost-effectiveness, and the need for skilled microscopists have been described.

**2.2. Asthma** is a heterogeneous disease of the lower respiratory tract that is affecting millions of people worldwide. It is characterized by airway hyper-responsiveness and airway inflammation with variable airflow obstruction. The symptoms of asthma can be nonspecific and varied, making the diagnosis difficult. Patients often present with wheezing, shortness of breath, and cough that occur more frequently during the night and early morning (Buist, 2013). Symptoms are often episodic and can be caused by various triggers, such as irritants, specific allergens, and exercise. Wheezing is the single most sensitive and prevalent symptom for the diagnosis of asthma (Neukirch et al, 1995 and Sistek et al, 2001). Respiratory symptoms that vary over time and in intensity, that are worse at night or in the morning, and that have specific triggers are associated with a higher likelihood of an asthma diagnosis. (Global Initiative for Asthma, 2018). On the other hand, the presence of chronic sputum production, chest pain, and isolated cough with no other respiratory symptoms decrease the probability of asthma. It is diagnosed clinically, but no single gold standard test is available; therefore, a thorough history and physical examination along with spirometry are important for the diagnosis of asthma. The goal of asthma treatment is symptom control and prevention of future exacerbations (Global Initiative, 2018). It involves an understanding of the heterogeneous pathophysiology and phenotypes of asthma and an individualized treatment plan.

It is predicted that by the 2020, chronic respiratory diseases will become the world's biggest cause of mortality (Murray and Lopez, 1997). Management of chronic respiratory diseases demands correct and on-time diagnosis, responses, and therapy. Following guidelines by the Global Initiative for Chronic Obstructive Lung Disease (GOLD) and Global Initiative for Asthma (GINA) (Global Initiative, 2018). Asthma is diagnosed using information acquired from static and dynamic assessments of patients. According to (Badnjevic et al, 2013), static assessment provides basic information regarding patient symptoms, while dynamic assessment refers to the testing of patients' lung capacity and function by performing functional spirometry (SPIR) and/or impulse oscillometry (IOS). However, diagnosis performed with multiple parameters can be achieved by utilizing computer-based methods in medical diagnosis. Hence, this study conceptualizes the idea to develop diagnosis software for assisting in the diagnosis and recommend treatment of malaria and asthma infection in suspected patients.

### 3.0. System Analysis and Methodology

The method adopted is the Structured System Analysis and Design (SSADM), which is an accepted Software Engineering principle for designing software.

Five domain expert were randomly selected and a medical laboratory scientist based on consent from a University Teaching hospital in Delta State of Nigeria. The choice of these medical personnel for the work was not necessary by any known statistical sampling method. Standardized statistical methods could not be used because of the unwillingness of some of the domain experts to freely take part in the work due to high level of ignorance on the part of our medical personnel on the potential of computer technology in enhancing medical practice.

The domain expert used in the study were those who gave their consent to participate in the study. The requirement elicitation was from the domain experts through the study of relevant documents, interview, observation and structured questionnaires. The instrument was developed and subjected to known standard reliability and validity test before being used for the study.

### 3.1.Analysis of The Existing System

The most difficulty experienced by doctors is the matter that arises when more than one disease has a very close and similar symptom like Typhoid and malaria. Most doctors stick to the methodology of general assumption about a suspected disease, then gradually build assumption removing or adding some fact that help in diagnosing a disease accurately. Sometimes, to diagnose a disease, a physician is usually based on the clinical history and physical examination of the patient, visual inspection of medical images, as well as the results of laboratory test. But in some cases confirmation of the diagnosis is difficult because it requires specialization and experience, or even the application of interventional methodologies like biopsy. Moreover, diagnosis of a disease is the balancing of probabilities based on the presence and absence of a specific symptom and sign and the application of scientific method. Therefore, to attain an optimal diagnosis of a particular disease, it is required of a medical doctor to have a large information reserve and the ability to draw inference correctly with the information he has acquired. The problems of the existing system are:

- *The level of familiarity with the doctor and patient*. When a patient is not familiar with the doctor he or she might not have confidence to reveal some secret information to the doctor e.g. case of sexually transmitted disease.
- *How much background information the doctor possesses.* The background knowledge of a medical doctor goes a long way to determine how effective he or she would be in diagnosing a disease.
- *The patient state of mind reveals the correct information needed for the diagnosis* for example after the doctor has diagnose he/or she should know how to reveal it to the patient.

In the light of the above stated problems, this study is out to design computerized system for medical diagnosis and treatment of asthma and malaria patients, a tool for medical diagnosis to overcome the above stated problems.

### 3.2. The Proposed System

The proposed system deals with the design and implementation of a predictive tool for medical diagnosis. The system will represent the knowledge of an expert is the diagnosing Malaria and Asthma diseases. The justification of this new system is that it will facilitate the process of diagnosing diseases, and prescribing drugs for the diagnosed disease. It is very easy to use, and it provide information security and reduce manual work.

Of course the advantages are enormous as it will: ensure data integrity and accuracy; minimize manual diagnosis; provide greater efficiency and better service; user friendliness and interactive with minimum time required. However, a disadvantage is that it will require the knowledge of a computer literate for easy operation.

## 4.0 System Design

In this stage the conceptual system is being put into design and built. The purpose is to build a new system that will solve the problem of the existing system. The design is able to achieve accurate diagnosis of patients and save time and resources during medical checkup. The diseases focus on in this system are Asthma and Malaria. The system also prescribes drugs after careful and correct diagnosis has been made. It plays intelligence by checking through a frame of disease symptoms and pick out finite number of symptoms and then give the medical report only if the exact symptom of the disease is selected. The main objective of the system is: to diagnose disease, prescribe drugs and ensure the safe health of patients

**Control Center:** The following are the control center for the system: Patient Registration; Consultation; Disease Prediction; and Drug Prescription

**4.1 Input and Output (Data Base Specification)**

This system is database dependent and the database is used to save patients' medical record. The database is made up of different tables which in turn comprises of different fields. The database for this application is built with Microsoft Access and it serves as the backend. The database design for this work are shown below;

**Table 4.1: Patient Registration Database**

| **Field** | **Type** | **Size** | **Null** | **Default** | **Extra** |
|---|---|---|---|---|---|
| S/N | bigint | 20 | No | | auto_increment |
| CardNo | varchar | 20 | Yes | Null | Null |
| Surname | varchar | 20 | Yes | Null | Null |
| Othernames | varchar | 20 | Yes | Null | Null |
| Sex | varchar | 20 | Yes | Null | Null |
| Age | varchar | 3 | Yes | Null | Null |
| Address | varchar | 20 | Yes | Null | Null |
| PhoneNo | varchar | 20 | Yes | Null | Null |
| Next_of_Kin | varchar | 20 | Yes | Null | Null |
| Next_of_Kin_Address | varchar | 20 | Yes | Null | Null |
| Next_of_Kin_PhoneNo | varchar | 20 | Yes | Null | Null |
| Relationship | varchar | 20 | Yes | Null | Null |
| Date | varchar | 20 | Yes | Null | Null |

All patient data are save in the Table 4.1, showing the field, type and their size/or length.

**Table 4.2: Consultation Information Database**

| **Field** | **Type** | **Size** | **Null** | **Default** | **Extra** |
|---|---|---|---|---|---|
| S/N | bigint | 20 | No | | auto_increment |
| CardNo | varchar | 20 | Yes | Null | Null |
| Disease | varchar | 20 | Yes | Null | Null |
| Symptom1 | varchar | 20 | Yes | Null | Null |
| Symptom2 | varchar | 20 | Yes | Null | Null |
| Symptom3 | varchar | 30 | Yes | Null | Null |
| Symptom4 | varchar | 20 | Yes | Null | Null |
| Symptom5 | varchar | 20 | Yes | Null | Null |
| Drug1 | varchar | 20 | Yes | Null | Null |
| Drug2 | varchar | 20 | Yes | Null | Null |
| Drug3 | varchar | 20 | Yes | Null | Null |
| Drug4 | varchar | 20 | Yes | Null | Null |
| Drug5 | varchar | 20 | Yes | Null | Null |
| Date | varchar | 20 | Yes | Null | Null |

The consultation information is save in the Table 4.2, it includes; the field, data type and length of characters.

**Table 4.3: Disease Information Database**

| Field | Type | Size | Null | Default | Extra |
|---|---|---|---|---|---|
| S/N | bigint | 20 | No | | auto_increment |
| CardNo | varchar | 20 | Yes | Null | Null |
| Disease | varchar | 20 | Yes | Null | Null |
| Symptom1 | varchar | 20 | Yes | Null | Null |
| Symptom2 | varchar | 20 | Yes | Null | Null |
| Symptom3 | varchar | 30 | Yes | Null | Null |
| Symptom4 | varchar | 20 | Yes | Null | Null |
| Symptom5 | varchar | 20 | Yes | Null | Null |

All disease data are save in the Table 4.3. It also includes; the field, data type and length of characters.

**Table 4.4: Drug Information Database**

| Field | Type | Size | Null | Default | Extra |
|---|---|---|---|---|---|
| S/N | bigint | 20 | No | | auto_increment |
| CardNo | varchar | 20 | Yes | Null | Null |
| Drug1 | varchar | 20 | Yes | Null | Null |
| Drug2 | varchar | 20 | Yes | Null | Null |
| Drug3 | varchar | 20 | Yes | Null | Null |
| Drug4 | varchar | 20 | Yes | Null | Null |
| Drug5 | varchar | 20 | Yes | Null | Null |

All drug data are save in the Table 4.4, it also includes the field, type and size of characters.

## 4.2 Program Module Specification

In order for the new system to meet its goal, the programming language tagged Visual Basic 6.0 is use for the design of the interface. The system is event driven and modular type program, as it is principally divided into three modules. The program has been so designed that the modules are independent of each other.

The first is the registration module: it inputs patients name, address, age, sex, date of birth and registration number. The second module is the consultation with the doctor: here the doctor checks symptoms from the answer that the patients gives and entered into the computer system. The symptoms are displayed to the user during the execution of the program; a message box is displayed to the user to notify if the diagnosis is successful, and in the third module the drugs are displayed through the message.

**4.3 Input Format:** An acceptable, understandable and cost effective input layout was designed to make it easy to achieve the highest positive level of accuracy, the input data are interactive, that is when data are entered, and the compiler runs through the code to see what the user requested for the displays requests immediately on the screen. In this work we have input for patient information and input for the consultation that capture symptoms of disease as shown in Table 4.1 and Table 4.2.

**4.4 Output Format:** The output required of a system depends largely on both the input design and also the output design, since the output is the system to the user. It is therefore, important that the programmer takes proper care when designing the input/output interface. In this program we have two outputs, namely: Report and the Treatment platform. The report shows successful diagnosis has been out but when a diagnosis is not feasible; no medical report is produce. However, one will be notified when diagnosis is not successive. The medical report contains the following: patient's information, patient observed; disease dispose; and drugs prescribed.

### 4.5 System Flow Diagram

A flowchart is a type of diagram that represent an algorithm or process, showing the steps as boxes of various kind and their order by connecting theses with arrows. This diagrammatic representation can give a step by step solution to a given problem. These flow diagram shows the main menu module in Figure 4.1, registration flowchart in Figure 4.2 and consultation flowchart in Figure 4.3.

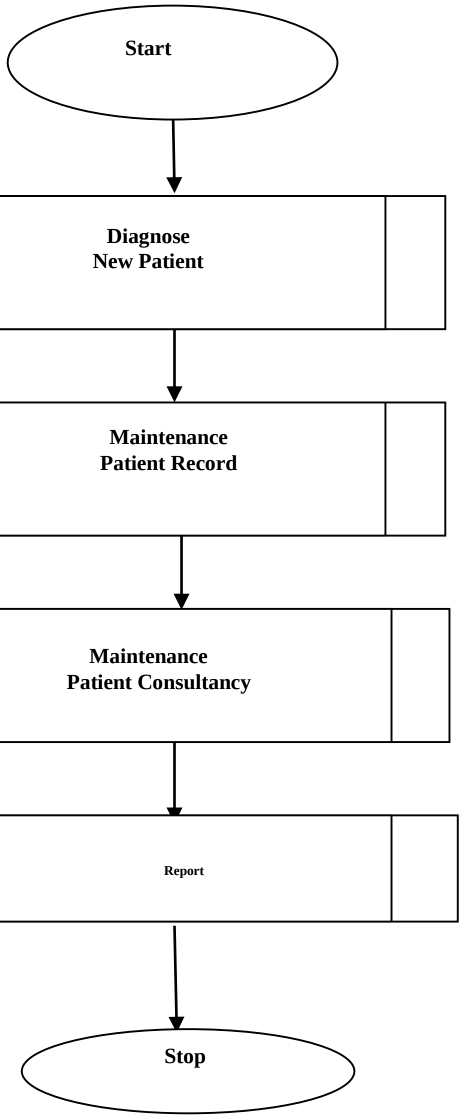


**Fig 4.1.** Main Menu Module.

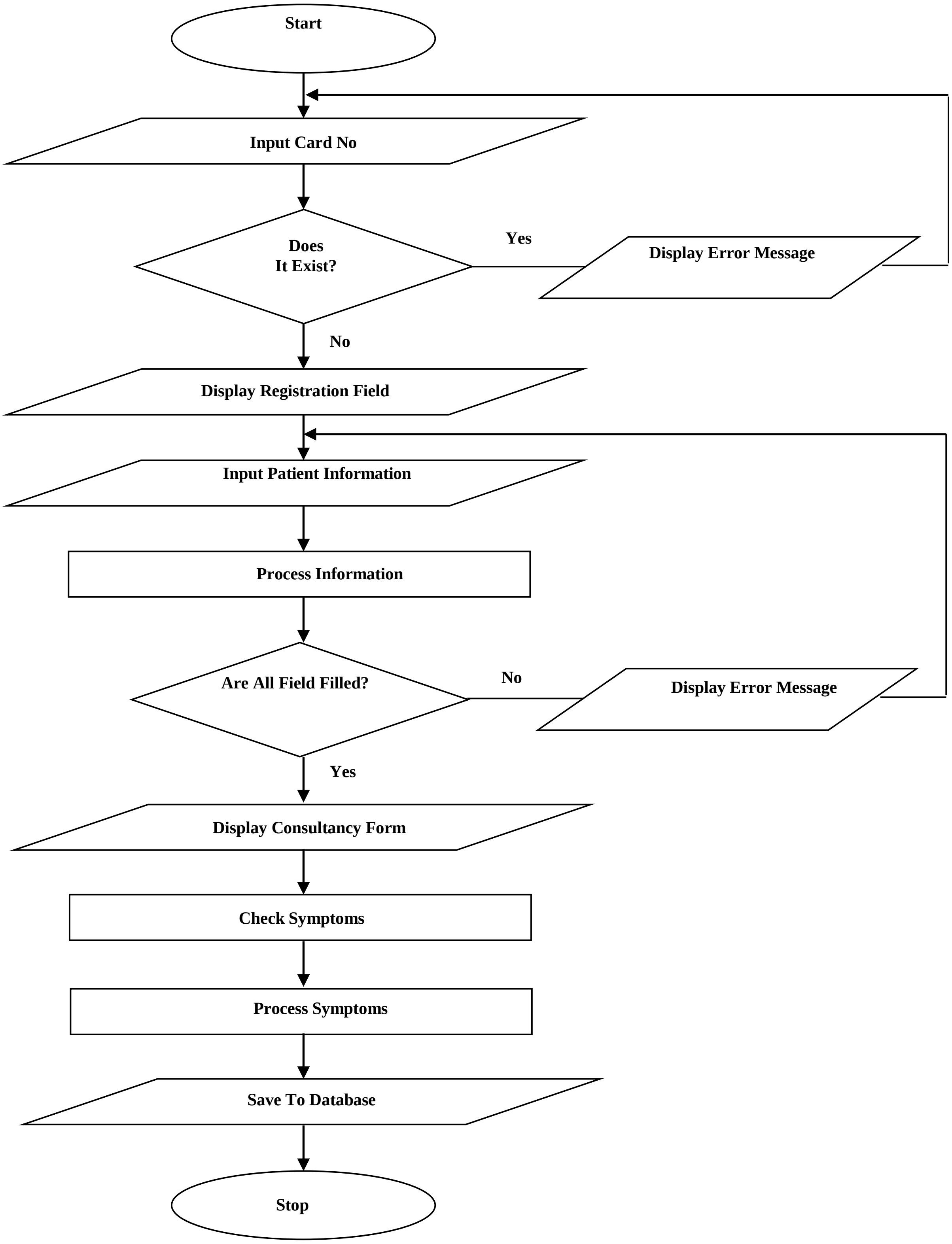


**Fig 4.2** Registration Flowchart.

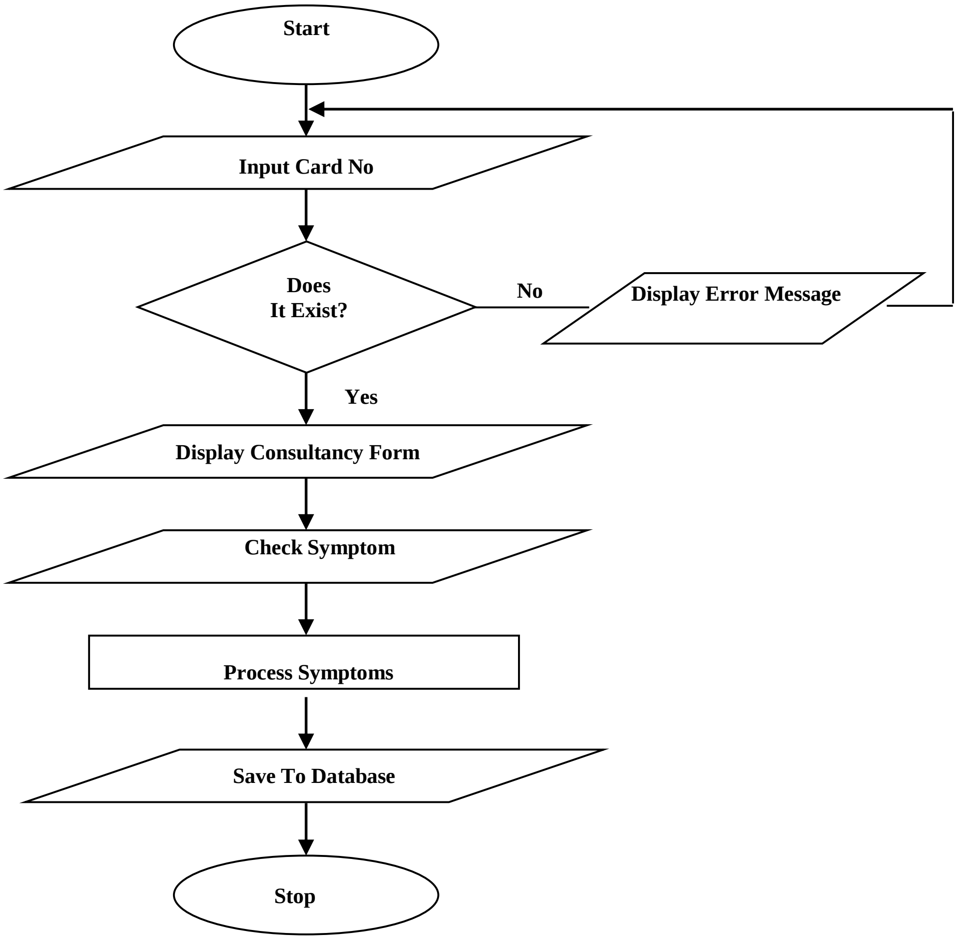


**Fig 4.3.** Consultation Flowchart.

Figure 4.1 is main menu module which is depicted with dataflow symbols, while Figure 4.2 and 4.3 are registration and consultation respectively depicted with flowchart symbols. However, it is important to note that system diagram is a graphical representation of the structure of a program with emphasis on control flow and the action to be performed by the program. It consists of a set of boxes of various shapes, interconnected by a set of directed arrows.

## 4.6. Choice of Programming Language and Implementation

The choice of programming is influenced by the feature it provides to enhance interaction and friendliness. Its scope of manipulating character, whether in groups or in single unit and its provision as regards easy testing of the program. Hence, the programming language chosen for the design of this work is Visual basic 6.0 for the frontend. MS Access was used for the backend database. This language was chosen because it was developed for use with compiler terminal operating in an interactive mode. It provided many tools to design graphical application in a user friendly environment. The screen shoots of compiled and executed selected program modules are shown below.

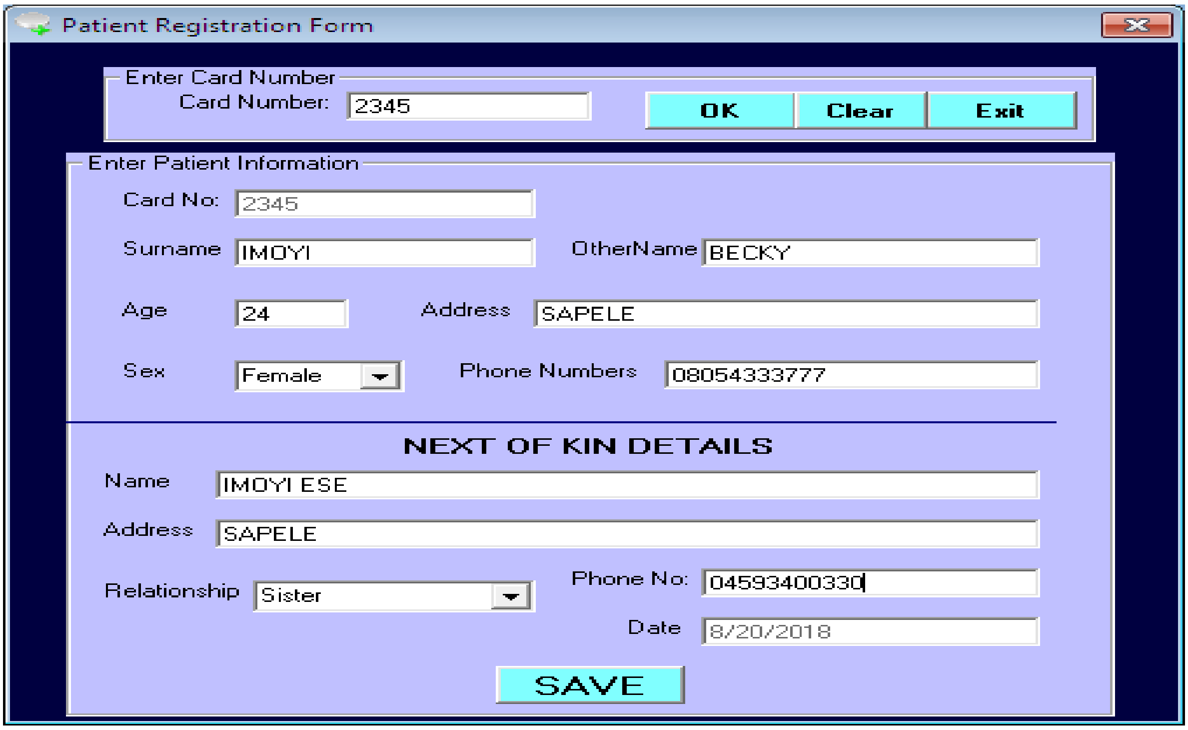


**Fig. 4.4.** Patient Registration Form

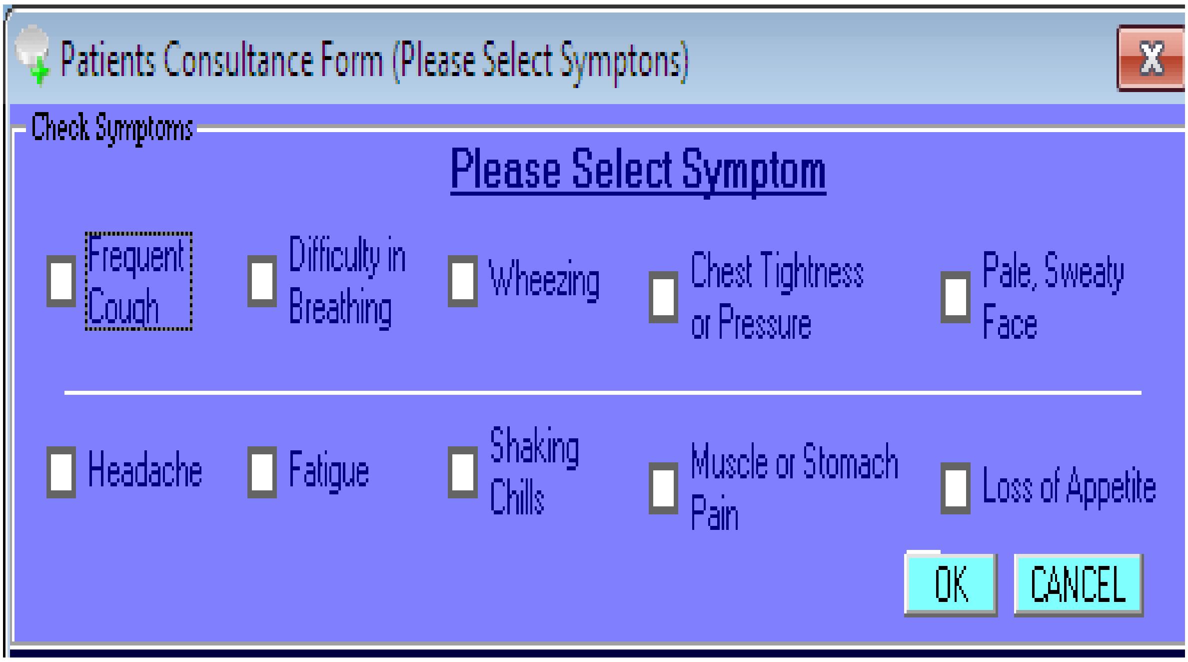


**Fig. 4.5.** Consultancy Form

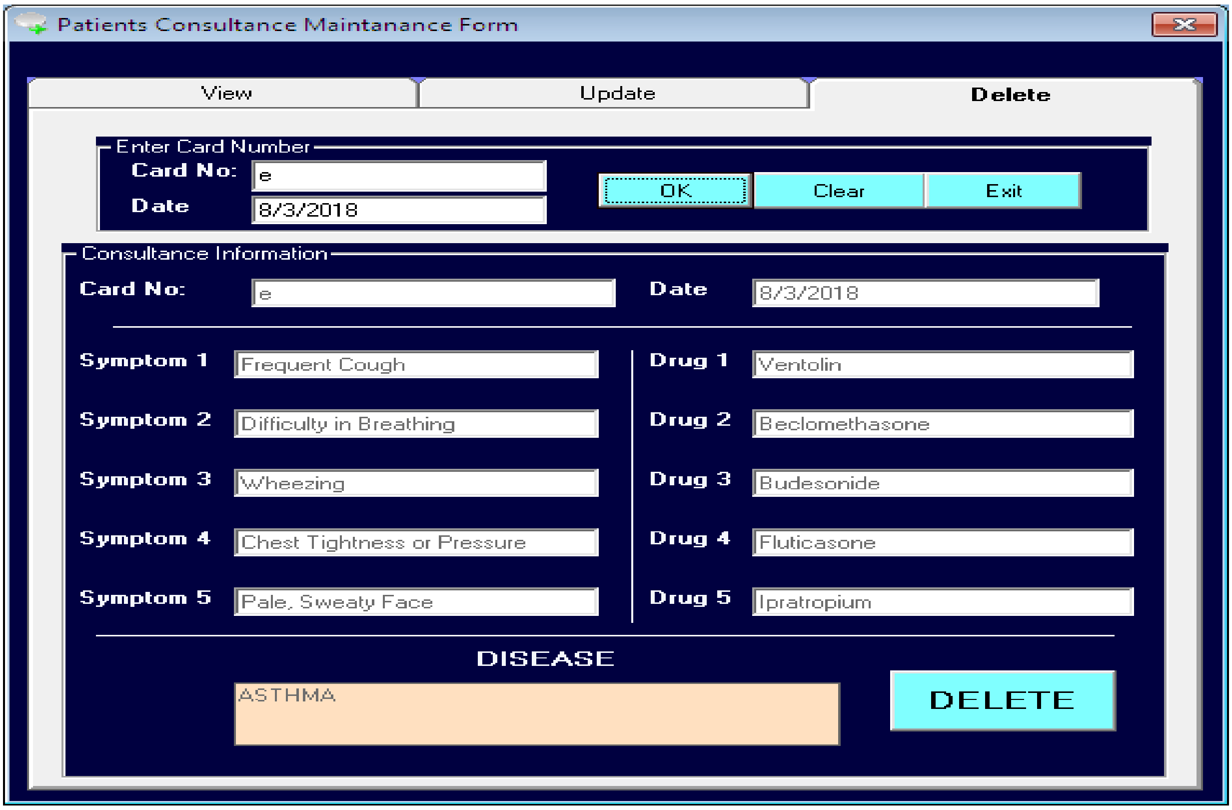


**Fig. 4.6.** Consultancy Maintenance Form.

**Reports**

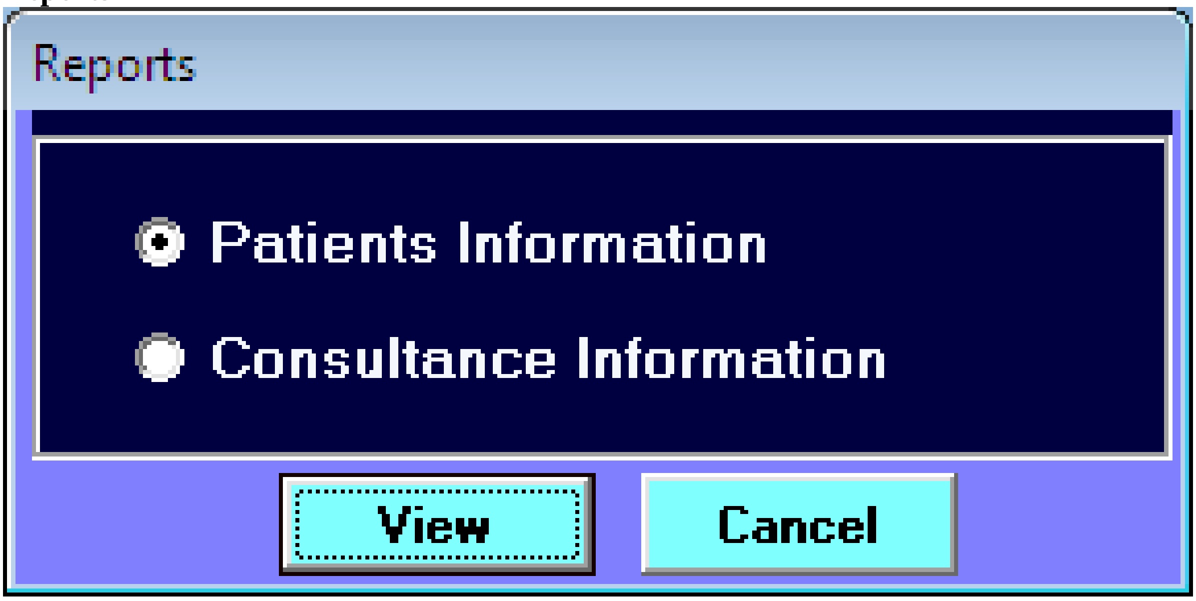


**Fig. 4.7.** Report Screen Shot


**Fig. 4.8.** Treatment platform for Malaria and Asthma

The registration form of Figure 4.4 registers patient information, at execution the patient card number is use as authentication. It is expected that the patient correct card number is entered and the click on the 'ok' button to gain access. If the card number is incorrect, access will be denied. The consultancy platforms of Figure 4.5 and Figure 4.6 contains the symptoms of the disease, as result the patient is also expected to tick the various symptom and then click on the 'ok' button. This will run the process and proffer solution to the ailment of the patient or not and give necessary advice as can be viewed from the Report module when the correct radio button is enabled and click the 'view' button. Figure 4.8 is the treatment platform that provides clinical information as the case may be either for Malaria or Asthma and drug prescription and dosage.

This work developed a medical diagnostic system that is able to diagnose Malaria and Asthma, and recommend treatment. The approach adopted in this work is conceptual, in other a prototype system that gives an insight into the development of medical diagnostic systems.

However, the diagnosis and recommendation for treatment of Malaria and Asthma as it relates ailment by the system developed are in agreement with the expected results as they compare favorably with decision human domain expert would take in similar situations.

**5.0. Conclusion**

The illness of the body of the mind is usually caused by infection or internal disorder, and the process to determine or attempt to identify it is known as diagnosis. The disease diagnosis and treatment is the major work of physicians; the problem therefore, is that in most cases diagnosis is wrongly done. Malaria is an infectious disease caused by Plasmodium parasite, while Asthma is a heterogeneous disease of the lower respiratory tract which are common and most widely spread in our locality. Hence this work was aimed at conceptualization of predictive diagnosis and treatment for malaria and asthma. To achieve this, we used Structured System Analysis and Design (SSADM) model while undertaking the research. Visual basic 6.0 programming language was used to develop the frontend interface and MS Access for the backend database because it enhances interaction and flexibility. The system will eliminate time wasting in interview of patients.

**6.0. Recommendation**

Researchers especially students should examine the conceptualization of this work as it would serve as a guide to constantly maintain, update and review related literatures to meet the dynamic nature of information in medical diagnosis.

The medical professionals should adopt and implement the concept of this work because no doubt it would enhance medical practice within the medical profession.

Finally, future work should explore the field of artificial intelligence to employ expert systems methodologies in the development medical diagnostic systems.

**7.0. References**

Badnjevic, A., Koruga, D., Cifrek, M., Smith, H. J, & Bego T. (2013). Interpretation of Pulmonary function test results in relation to Asthma classification using integrated Software suite. In: *MIPRO 2013 36th International Convention on Information and Communication Technology, Electronics and Microelectronics*; May 20-24, 2013; Opatija, Croatia: 140–44.

Bates, I., Bekoe, V., & Asamoa-Adu, A. (2004). *Improving the Accuracy of Malaria-related laboratory tests in Ghana.* Malar J. 2004, 3: 38-10.1186/1475-2875-3-38.

Bhandari, P., L., Raghuveer, C., V., Rajeev, A. & Bhandari P. D. (2008). Comparative study of peripheral blood smear, quantitative buffy coat and modified centrifuged blood smear in malaria diagnosis. *Indian J Pathol Microbiol* 51, 108–112 (2008).

Buist, A., S. (2003). Similarities and differences between asthma and chronic obstructive Pulmonary disease: Treatment and early outcomes. *Eur Respir Journal*. 2003;21(Suppl 39):30S-5s.

Churchill, L. (1995). *Pocket Medical Dictionary*, Longman Group UK Limited, New Castle. Pp 20-25.

Coleman, R. E, Maneechai, N., Rachaphaew, N., Kumpitak, C., Miller, R., Soyseng, V., Thimasarn, K., & Sattabongkot, J (2002). Comparison of field and expert laboratory Microscopy for active surveillance for asymptomatic Plasmodium falciparum and Plasmodium *vivax in Western Thailand. Am J Trop Med Hyg.* 2002, 67: 141-144.

David, W. (1985). *Where There Is No Doctor*, Macmillan Publishers. New York. Pp 54 - 70.

Global Initiative for Asthma (2018). Pocket Guide to Asthma Diagnosis, Management and Prevention. Available at*: https://ginasthma.org/gina-reports/Accessed January 12, 2018.*

Hanscheid, T., (2003). Current strategies to avoid Misdiagnosis of Malaria. *Clin Microbiol Infect.* 2003, 9: 497-504. 10.1046/j.1469-0691.2003.00640.x.

Hanscheid, T., Melo-Cristino, J. & Pinto, B. G. (2001). Automated detection of malaria pigment in white blood cells for the Diagnosis of Malaria in Portugal. *Am J Trop Med Hyg* 64, 290–292 (2001).

Hawkinson, L. (1980). *A Linguistic Memory System*. TM-173, MIT Lab. for Comp. Sci., Cambridge, Mass., (1980).

Kettelhut, M. M., Chiodini, P. L., Edwards, H., & Moody, A. (2003). External quality Assessment Schemes raise standards: evidence from the UKNEQAS Parasitology Subschemes. *J Clin Pathol.* 2003, 56: 927-932. 10.1136/jcp.56.12.927.

Kotepui, M. *et al*. (2015). A diagnostic tool for Malaria based on computer software. *Sci. Rep*. **5**, 16656; doi: 10.1038/srep16656.

Korenromp, E., Miller, J., Nahlen, B., Wardlaw, T., & Young M (2005). World Malaria Report. Tech rep. 2005, *World Health Organization*, Geneva

Looareesuwan, S. (1999). Malaria. In Clinical Tropical Medicine. 1st ed. edn, 5–10 (*Medical Media, 1999).*

Mitiku, K., Mengistu, G., & Gelaw, B. (2004). The reliability of Blood film examination for Malaria at the peripheral health unit. *Ethiopian J of Health Dev*. 2003, 17: 197-204.

Mwangi, T. W., Mohammed, M., Dayo, H., Snow, R. W., & Marsh, K. (2005). Clinical algorithms for Malaria Diagnosis lack utility among people of different age groups. *Trop Med Int Health* 10, 530–536.

Murray, C. J, Lopez, A. D. (1997). Alternative projections of mortality and disability cause 1990-2020: *Global Burden of Disease Study*. *Lancet* 1997; 349: 1498–504. 1997;

Neukirch, F et al. (1995). Prevalence of Asthma and Asthma-like symptoms in three French cities. *Respir Med*. 1995;89(10):685-92.

Ngasala, B. et al. (2008). Impact of training in Clinical and Microscopy Diagnosis of childhood Malaria on anti-malarial drug prescription and health outcome at primary health care level in Tanzania: a randomized controlled trial. *Malar J 7*, 199 (2008).

Reyburn, H. et al. (2004). Over diagnosis of malaria in patients with severe febrile illness in Tanzania: *A prospective study*. *BMJ* 329, 1212 (2004).

Sistek, D et al. (2018). Clinical diagnosis of current asthma: Predictive value of respiratory symptoms in the SAPALDIA study. Swis study on air pollution and lung disease in adults. *Eur Respir J*. 2001;17(2):214-9.

Tagbor, H., Bruce, J., Browne, E., Greenwood, B. & Chandramohan, D. (2008). Performance of the OptiMAL dipstick in the diagnosis of malaria infection in pregnancy. *Ther Clin Risk Manag* 4, 631–636 (2008).

Vo, T. K. et al. (2007). Evaluation of a real-time PCR assay for malaria diagnosis in patients from Vietnam and in returned travelers. *Trans R Soc Trop Med* 101, 422–428 (2007).

Wongsrichanalai, C., Barcus, M. J., Muth, S., Sutamihardja, A. & Wernsdorfer, W. H. (2007). A review of malaria diagnostic tools: microscopy and rapid diagnostic test (RDT). *The American journal of tropical medicine and hygiene* 77, 119–127 (2007).

World Health Organization, Malaria., (2019). Available at: *http://www.who.int/mediacentre/factsheets/fs094/en/. (Accessed: 2th January 2019).*

Zerpa, N. et al. (2008). Evaluation of the OptiMAL test for diagnosis of malaria in Venezuela. Invest Clin 49, 93–101 (2008).