An Expert System For HIV Screening Using Visual Prolog

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ABSTRACT

Human Immunodeficiency Virus (HIV) and Acquired Immune Deficiency syndrome (AIDS) is one of the most challenging health problems of this era..Since the first incidence of AIDS was reported in Nigeria in 1986, the number of persons infected with the deadly disease had risen remarkably. By the end of 2010, it was estimated that over 3.1 million people in Nigeria were living with the virus. Globally, 17-51% of people living with HIV know of their status. Thus the need to design a system that would assist physicians in medical screening has become imperative and hence cannot be over emphasized.
In this work, a user-friendly medical expert system for screening HIV was designed using Visual Prolog, to aid medical practitioners and health care workers in the process of screening individuals of HIV. This would in turn help in solving the challenges faced by people most especially in communities where there is shortage or unavailability of medical personnel , as it provides very rapid method of prognosis with much accuracy and reduces the hours patients spend in hospitals and boring routine tasks associated with the existing method of HIV screening. This expert system is user-friendly and carries out prognosis based on patients' symptoms.

Keywords: Expert Systems, HIV,AIDS, Prognosis, Visual Prolog.

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1. INTRODUCTION

Human Immunodeficiency Virus (HIV) and Acquired Immune Deficiency syndrome (AIDS) is one of the most challenging health problems of this era. HIV is a retrovirus that infects cells of the immune system, destroying or impairing their function [11]. As the infection progresses, the immune system becomes weaker, and the person becomes more susceptible to infection. As early as 2-4 weeks after exposure to HIV (but up to 3 months later), people can experience an acute illness, often described as "the worst flu ever." This is called acute retroviral syndrome (ARS), or primary HIV infection, and it's the body's natural response to HIV infection. During primary HIV infection, there are higher levels of virus circulating in the blood, which means that people can more easily transmit the virus to others. After the initial infection and sero-conversion, the virus becomes less active in the body, although it is still present. During this period, many people do not have any symptoms of HIV infection. This period is called the "chronic" or "latency" phase. This period can last up to 10 years—sometimes longer. When HIV infection progresses to AIDS, many people begin to suffer from fatigue, diarrhea, nausea, vomiting, fever, chills, night sweats, and even wasting syndrome at late stages [17]**.** Since the first case of AIDS was reported in Nigeria in 1986, the number of persons infected with the deadly disease had risen remarkably. By the end of 2010, it was estimated that over 3.1 million people in Nigeria were living with the virus**.** Globally, 17-51% of people living with HIV know of their status [18].

During medical screening of HIV, physicians ask patients question and try to find out possible disease based on the answers supplied during the interview. Physicians then write prescription for the patient or advise the patient to go for a medical laboratory test confirming his suspicion. The existing method of medical screening and diagnosis employed by physicians for the analysis of HIV infection uses manual method characterized by inability to comprehend large amounts of data quickly, retaining large amount of data in memory and recalling the information stored in memory.

However, the recent advances in the field of Artificial Intelligence (AI) have led to the emergence of expert systems for medical applications. Major initiatives to improve the quality, accuracy and timelines of healthcare data and information are improving all over the world with the integration of expert system into the healthcare data analysis. An expert system is a computer system that performs a task that would otherwise be performed by a human expert. They are designed to solve complex problems in a particular field by reasoning like an expert in that field. Some expert systems are designed to take the place of human experts, while others are designed to aid them.

In this study, a user-friendly medical expert system for screening HIV was designed using visual prolog, to aid the work of medical practitioners and health care workers in the process of screening individuals of HIV. The application uses in-built Visual Prolog clauses, predicates and fact engine. It permits users to enter their bio-data and respond to questions asked by the system during the screening. Afterwards, the system provides a prognosis.

2. PROBLEM STATEMENT

To understand the problem statement, a medical personel at Osun State Control for AIDS/HIV (O-SACA) was interviewed. It was found that the current system has a few flaws, stated thus:

- Osun State's primary health centers do not have enough available experts in the field so a patient may have to keep coming back till the expert is available before the screening exercise can take place.
- Human experts are unable to retain large amounts of data in memory.
- They are also unable to comprehend large amounts of data quickly and are slow in recalling information stored in memory.
- Human experts may be subjected to deliberate or unintentional bias in their actions.

3. RELATED WORKS

Intelligent systems have become vital in the growth and survival of the healthcare sector. A good number of expert systems have been developed to manage tropical diseases and some medical expert systems have been developed and playing a major role in assisting and providing support in common clinical problems like prediction of diseases, prevention of diseases, diagnosis of diseases, providing patients with medical information, etc. Latha et al, (2007) in a study developed an Intelligent Heart Disease Prediction System using the Coactive Neuro-Fuzzy Inference System (CANFIS) and Genetic Algorithm, which combined the neural network adaptive capabilities and fuzzy logic qualitative approach integrated with genetic algorithm to diagnose the presence of the disease. The objective of the study was to develop a prototype Intelligent Heart Disease Prediction System with CANFIS and genetic algorithm using historical heart disease database to make intelligent clinical decisions which traditional decision support system cannot. The result showed a better accuracy in data analysis than the diagnosis carried out using traditional methods.

Adekoya *et al* (2008) developed an expert system on tropical diseases to assist paramedical staffs during training and in the diagnosis of many common diseases presented at their clinics. The system was flexible, friendly, and usable by people without much background in computer operations. The study concluded that the implementation of the system reduced doctor's workload during consultation and eased other problems associated with hospital consultations.

Imianvan et al (2011) developed an Expert system for the Intelligent Diagnosis of HIV using Fuzzy Cluster Means Algorithm. The focal point of this research was to describe and illustrate the application of Fuzzy Cluster means system to the diagnosis of HIV. In another study (Imianvan and Obi 2012), a Neuro-Fuzzy Expert Systems for the Probe and Prognosis of Thyroid Disorder was developed using sets of fuzzified data set incorporated into neural network system. It was an interactive system that tells a patient his/her current position as regards Thyroid disease.

Obanijesu and Emuoyibofarhe,(2012) developed a Neuro-fuzzy system for early prediction of Heart Attack and was able to show the risk level of patient classified into four different risk level: very low, low, high and very high. This system was used as a supportive tool for the diagnosis of Heart disease. In agreement, Ephzibah and Sundarapandian (2012) designed a Neuro-Fuzzy Expert System for Heart Disease Diagnosis. This system uses the genetic algorithms for feature selection so that diagnosis can be done with limited number of tests. This expert system helped Doctors to arrive at a conclusion about the presence or absence of heart diseases in patients. It is an enhanced system that accurately classifies the presence of that heart disease.
In another study, Ojeme and Maureen developed an expert system for HIV Diagnosis Using Neuro-Fuzzy Expert System. The system uses a synergistic combination of Neural Network (NN) and fuzzy inference systems (Neuro-Fuzzy) to generate a model for the detection of the risk level of patients with HIV.

4. METHODOLOGY

This section describes the methodology adopted during the development of the system.

4.1. Knowledge Acquisition

The domain knowledge was acquired from a visit to Osun State Action Committee on Aids (O-SACA), Osogbo. Extensive interviews were conducted in order to understand the domain problem properly and be able to extract objects, facts and sets of rules on the domain investigated. Also various books and journals on HIV/AIDS, HIV/AIDS screening, diagnosis and treatment were consulted.

4.2. Knowledge Representation

The domain knowledge acquired is represented in the knowledge base. The objects in the domain are represented by constants and variables, and the properties of these objects and the relations that exist over them are represented by predicates.

4.3. Implementation

The knowledge obtained and its representation is implemented using Visual Prolog, a Microsoft application that can be used to build GUI (Graphical User Interface) applications, Console applications, DLLs (Dynamic Link Libraries) and CGI (Computer Generated Image) programs. The choice of Visual prolog is due to its user friendliness and ease of use.

4.4. Evaluation

The competency of the system was evaluated and tested by the medical personnel, patients and individuals. The chart below shows testing steps during the evaluation of the system.

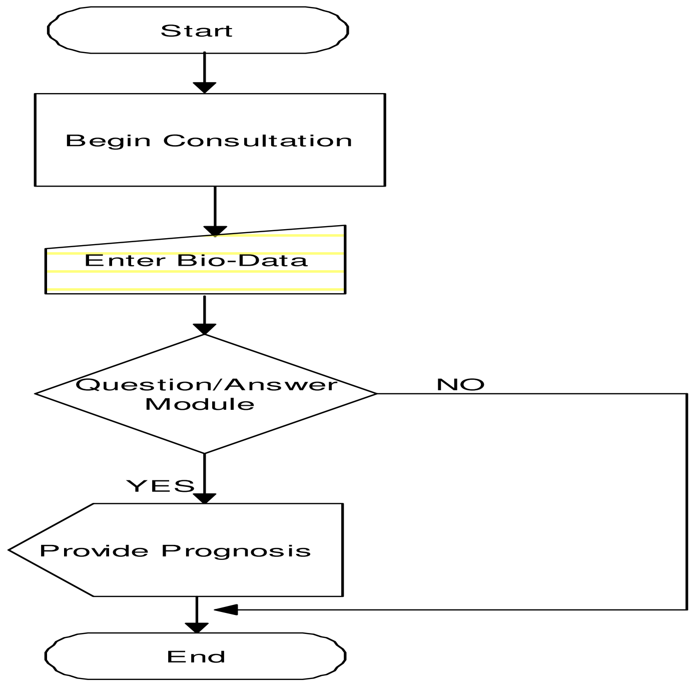

Figure 1: Flowchart

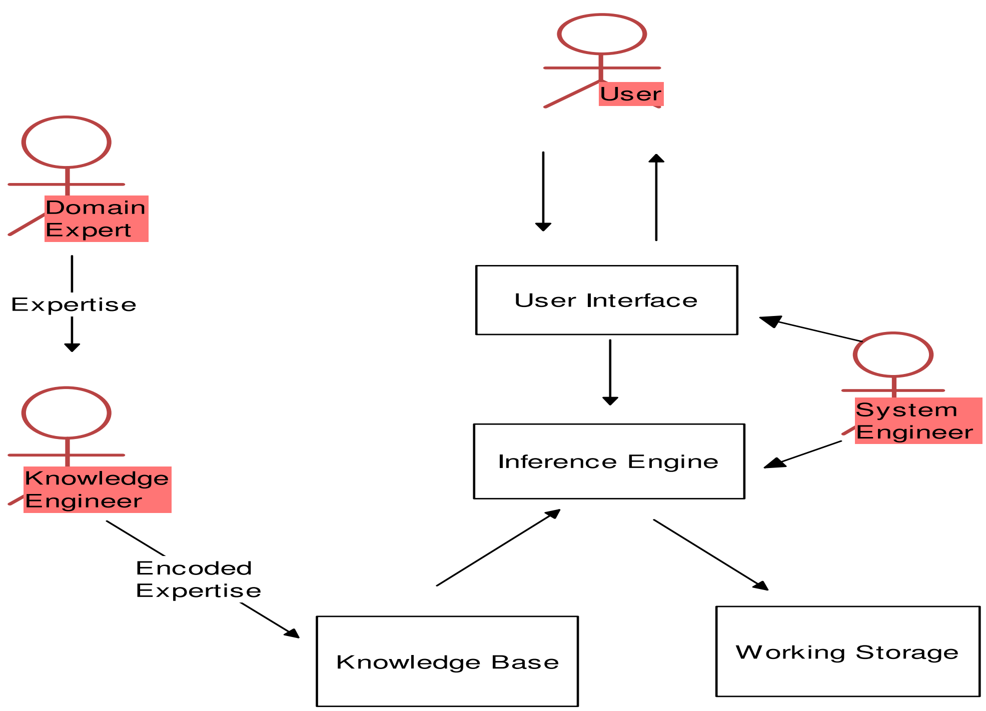

Figure 1: Expert system components and human interfaces
Source[5]

5.THE EXPERT SYSTEM

5.1Analysis and Design

1) System Input

- It requires information about the patient.
- Requires answers to the questions the system asks.

2) System Output of the proposed system

- It gives the result of the screening exercise which is the likelihood or unlikelihood of the user being infected with the virus.
- If there is a possibility that a group of symptoms produce more than one disease then the system will display the name of all diseases, relating to the symptoms.

3) Functional Requirements

1) **Data Input:** Accept user information using a question and answer format
2) **Processing:** Data processing will be carried out after the user provides a Yes or No answer.
3) **Data Output:** Use the information provided by the user to produce result from the screening exercise.
4) **User Interface:** The system will communicate with the user through the console.
5) **Operating System**: The system will run on Microsoft Windows XP or higher with Visual Prolog platform

4) Non-Functional Requirements

1) **User-Friendliness:** The system must be user friendly so as to allow users with little or no computer or IT training use the system.
2) **Usability:** The system must be easy to use, understand and learn
3) **Portability:** The system must be portable, i.e. it must be easy to move from one system to another. Factors like size of the software will determine its portability; it is preferable if the software is of a small size.
4) **Reliability:** The system must maintain its performance over time.

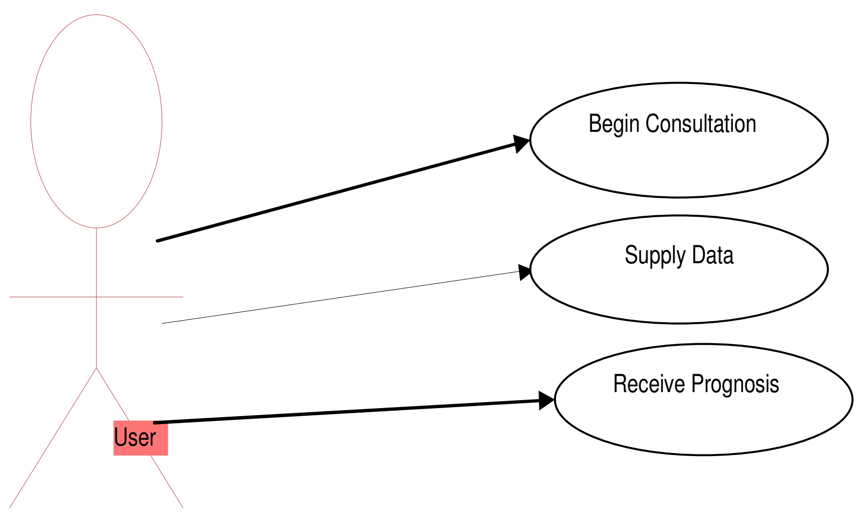

Figure 2: Use Case diagram showing the actions that can be performed by the user.

5.2 Development

The system was developed using Visual Prolog, a Microsoft application that can be used to build GUI (Graphical User Interface) applications, Console applications, DLLs (Dynamic Link Libraries) and CGI (Computer Generated Image) programs. Figure 4 below shows part of the code and knowledge base for the system.

```
class clinicalScreeningForm : clinicalScreeningForm
    open core

predicates
        display : (window Parent, string Firstname, string Lastname, string
        PhoneNumber, string Gender, integer Age, integer RiskAnalysisCu
        mulative, integer STIScreeningCumulative) -
        > clinicalScreeningForm ClinicalScreeningForm.
constructors
    new : (window Parent, string Firstname, string Lastname, string Phon
        eNumber, string Gender, integer Age, integer RiskAnalysisCumulati
        ve, integer STIScreeningCumulative).
end class clinicalScreeningForm

implement clinicalScreeningForm
    inherits dialog
    open core, vpiDomains, stdio, string

clauses
        display(Parent, Firstname, Lastname, PhoneNumber, Gender, Age,
        RiskAnalysisCumulative, STIScreeningCumulative) = Dialog :-
      Dialog = new(Parent, Firstname, Lastname, PhoneNumber, Gender
        , Age, RiskAnalysisCumulative, STIScreeningCumulative),
        Dialog:show().

facts
    firstname : string.
```

Figure 4. Part of the Expert System's source code and knowledge base

5.3 Testing/Interacting with the System

The system provides the users with instructions on how the system works. It informs the users on how to interact with the system. This also serves as a guide to train users in order to aid the use of the system. Figure 5 below show the usage instruction.

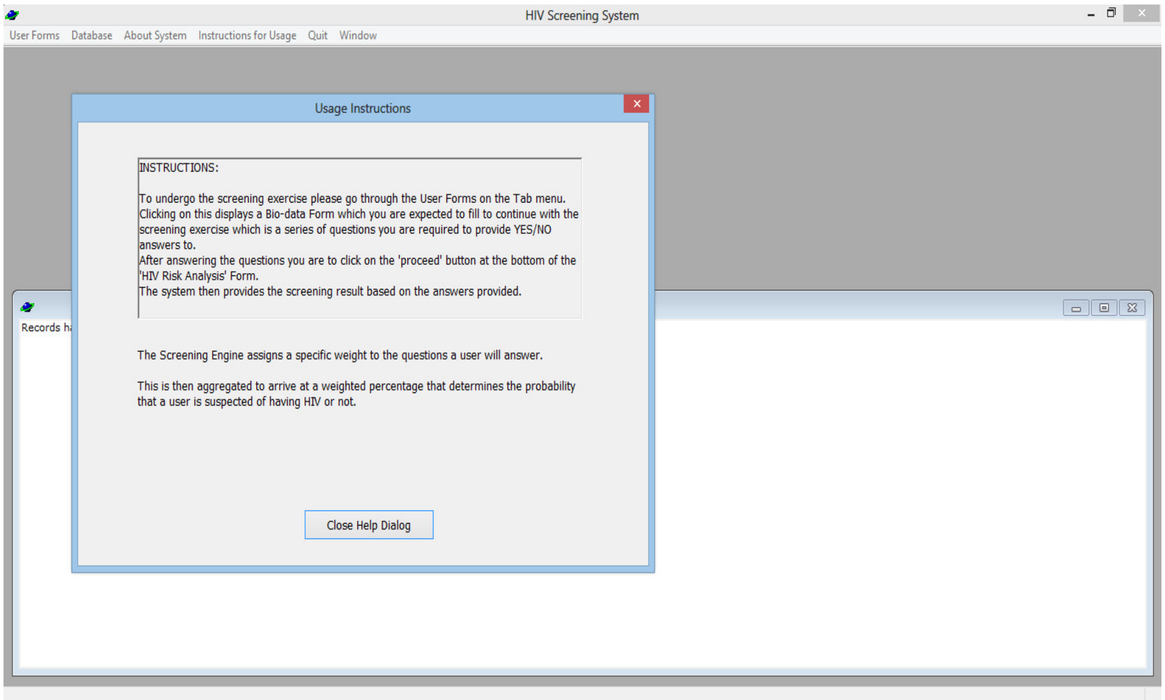

Figure 5: Usage Instruction

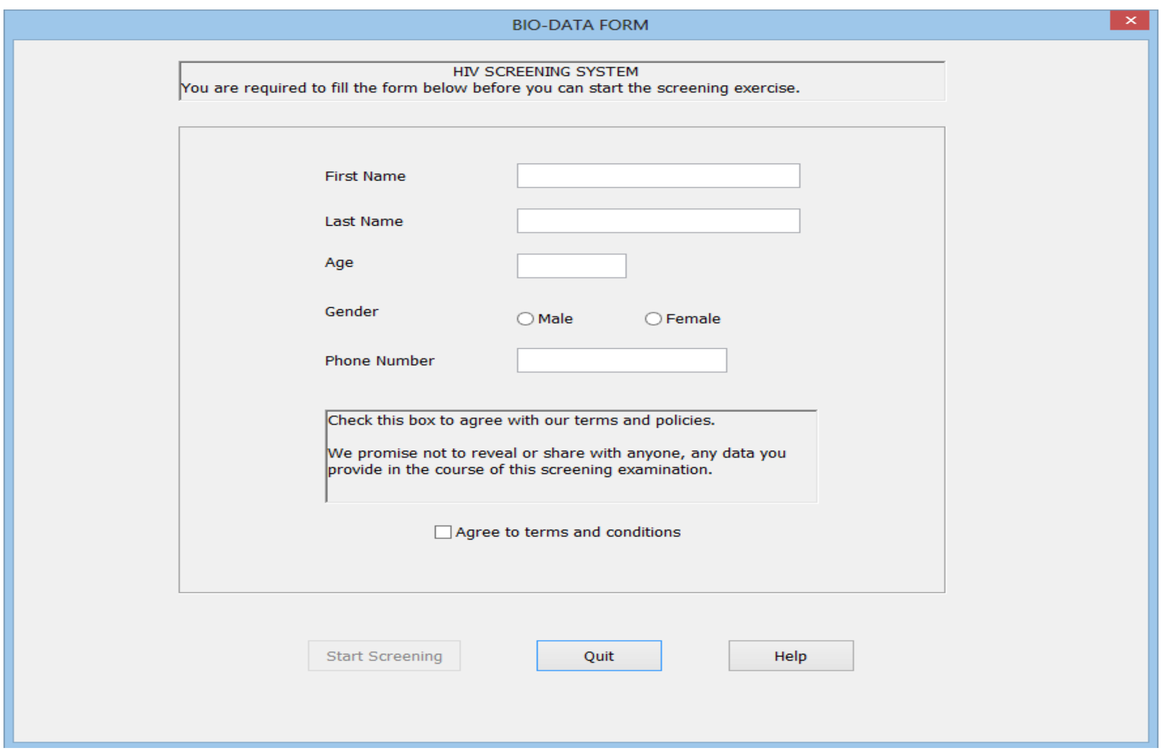

Figure 6: Bio-data Form

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Figure 6 above shows the Bio-data Form where the user enters his/her personal data. The form also displays a check box which when clicked implies the user accepts the terms and policies of the application that the data provided in the course of the screening exercise will not be disclosed.

Figure 7 to 9 contains the questions that the user will provide a YES/NO answer to. The questions however, are categorized into three (3) groups; Risk Analysis, S.T.I Screening and Clinical Screening

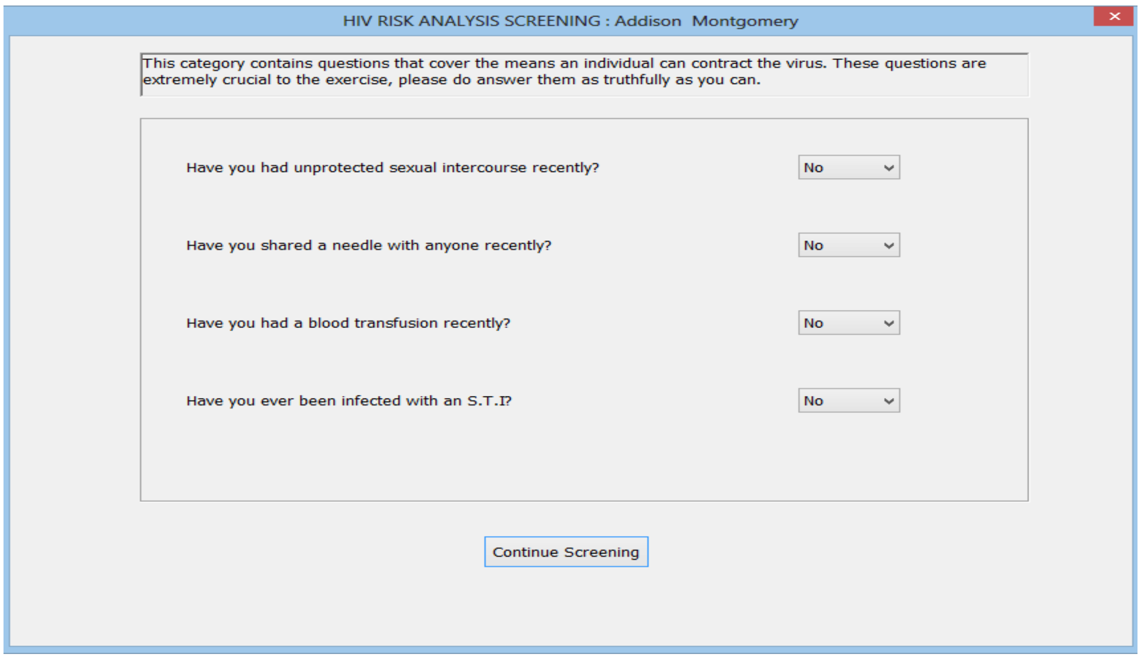

Figure 7: HIV Risk Analysis Screening Form

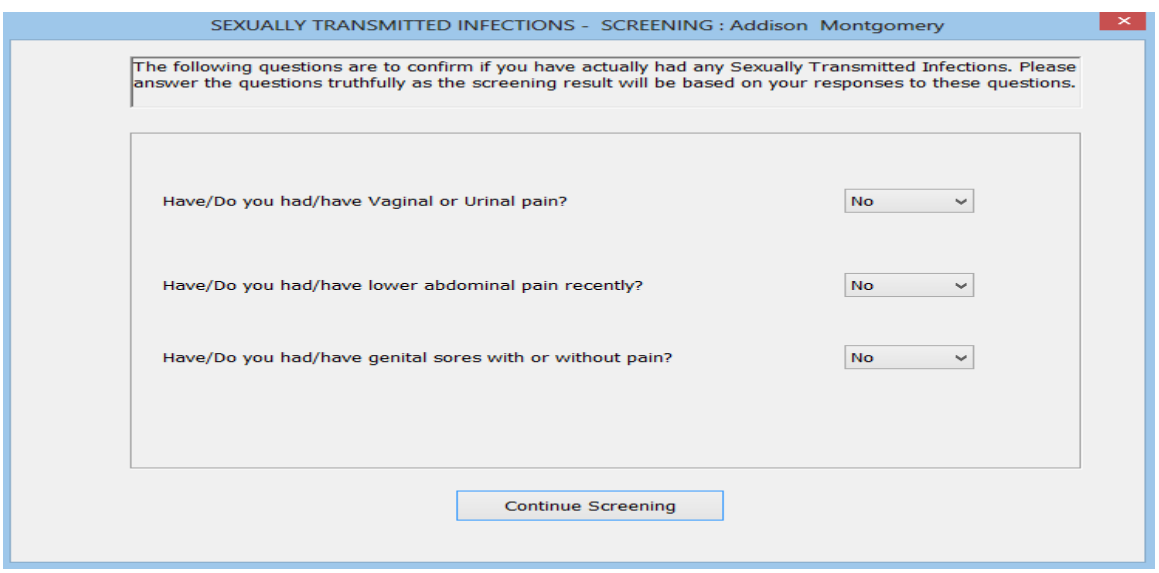

Figure 8: S.T.I Screening Form

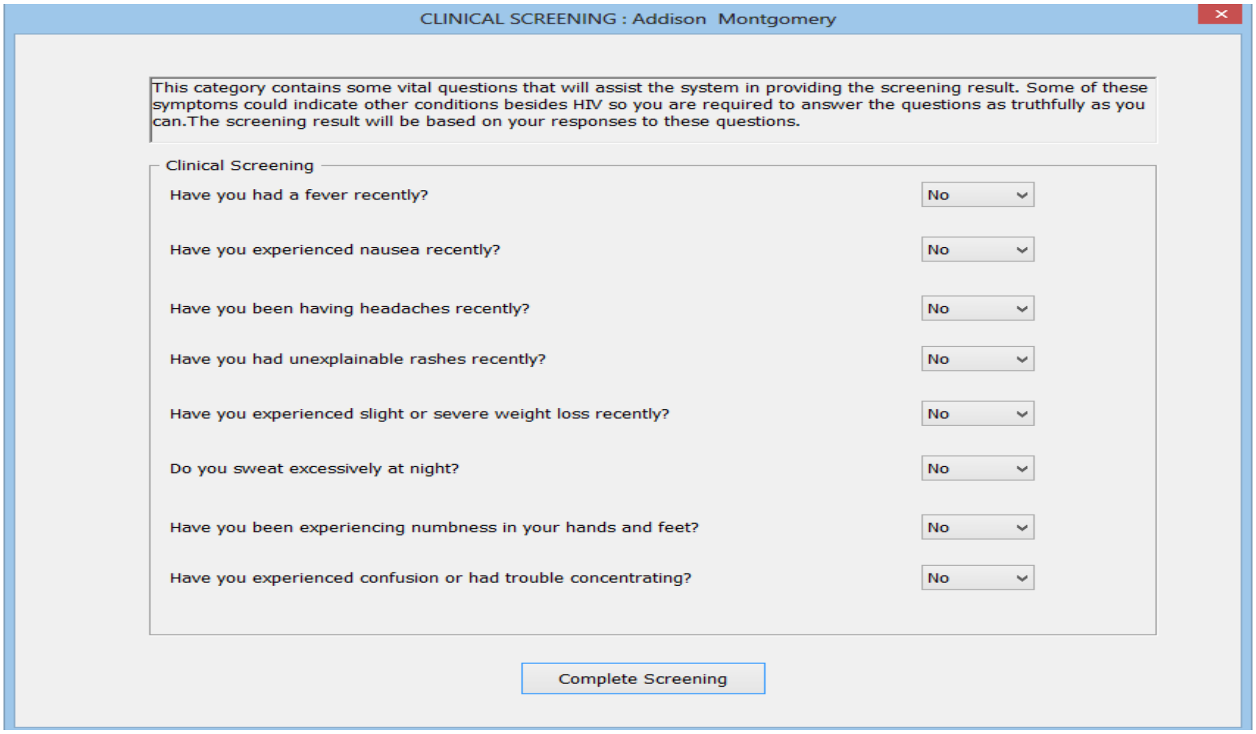

Figure 9: Clinical Screening Form

Figure 10 shows the screening result that is displayed for the user or patient's with no symptoms of HIV, while Figure 11 shows the screening result that is displayed for the user/patient's suspected of having HIV.

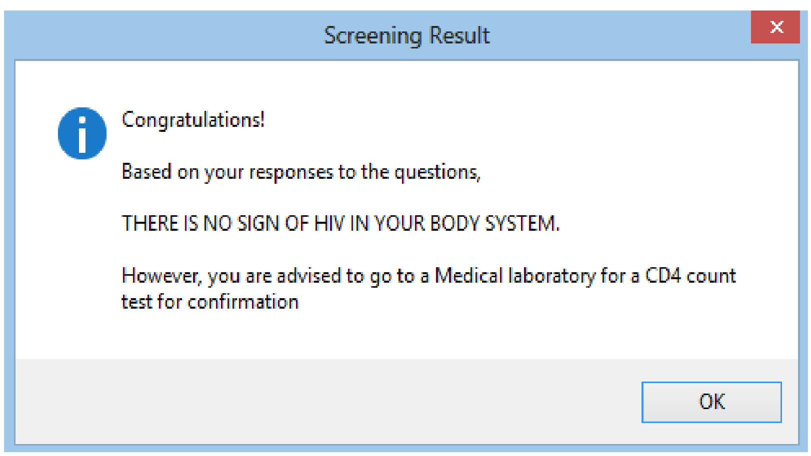

Figure 10: Screening Result of a patient with no symptoms of HIV.

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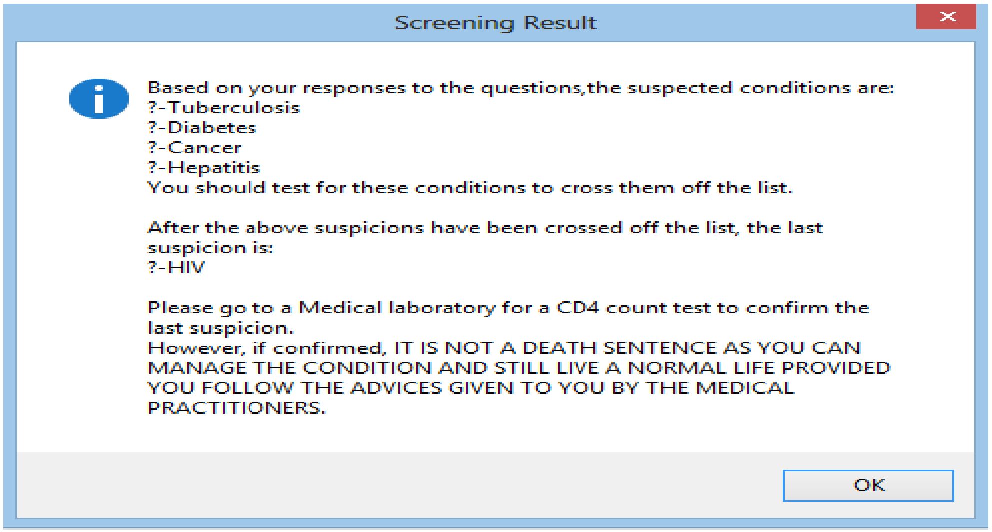

Figure 11: Screening Result of a patient suspected of having HIV.

5.4 Evaluation

The system was evaluated using a questionnaire. Fifty (50) copies of the questionnaire were distributed to people while providing them access to the system. Forty Five (45) copies were returned and the evaluation result is based on the copies filled and returned. Figure 12 below shows the evaluation result using bar chart.

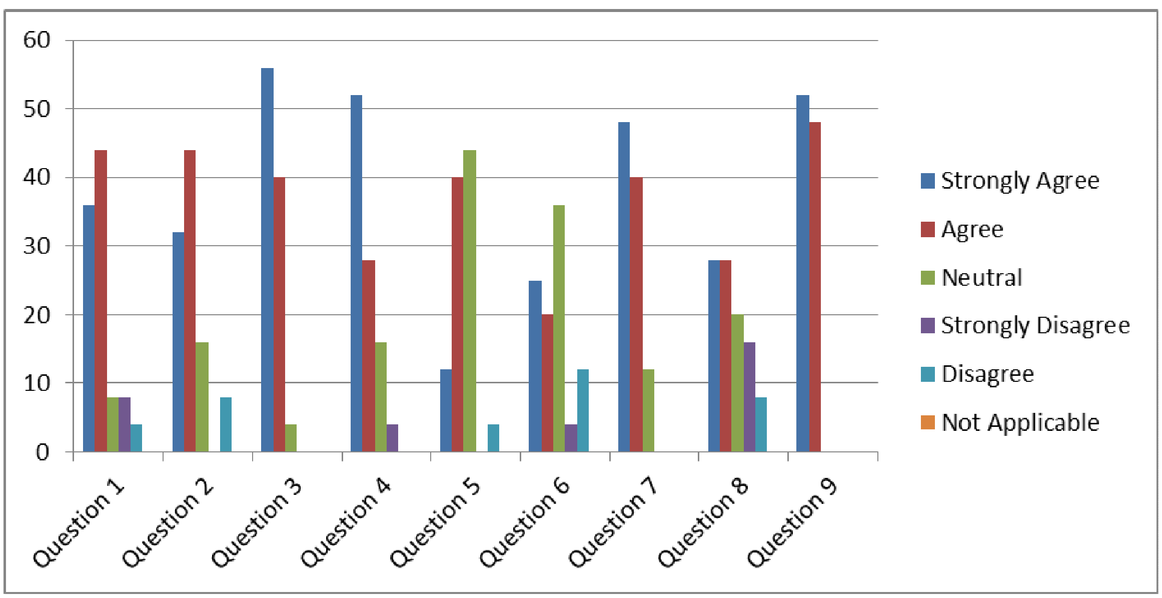

Figure 12: Bar Chart Depicting the Evaluation Results

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For Question 1, it was found that most users agree that a person with no computer skills can use this system. Therefore this system can be deployed in rural areas.. The users commented that it is a good idea to have yes or no answer rather than asking a user to enter full answers or sentences. This aspect is important because most people in rural areas have little or no computer skills, therefore, ful textual answers will not work for them. For Question 2, it was found that most users agree that the system can help medical assistants to learn more about HIV. Thus the system could be utilized to decrease the rate of late diagnosis of HIV most especially in rural communities. For Question 3, most users strongly agree that the system can be very helpful and could reduce some of the workload for medical assistants especially during peak times by decreasing the long queues in clinics because other patients can still use the system without assistance.

For Question 4, it was found that most users strongly agree that the system will be very useful in rural communities where there is a shortage of medical expertise and medical facilities in rural areas. Therefore the system gives suggestion to the user‘s information that is of relevance to them. For Question 5, it was similarly found that most users stand a neutral ground that the system looks at some vital areas that need to be considered before giving the result of the screening exercise. For Question 6, it was found that most users stand a neutral ground on recommending the system to their friends if necessary. For question 7, it was found that most users strongly agree that the system provides correct and helpful advice. Similarly for question 8, it was found that most users agree that the advice given by the system can be understood by patients with poor literacy. Finally, for the last question, most users agree that it is a good idea that the system uses a YES/NO format rather than asking users to enter full answers or sentences.

6. CONCLUSION

The need to design a system that would assist medical personnel in medical screening has become imperative and hence cannot be over emphasized. This work presents an expert system to help in the prognosis of HIV using a series of symptoms in medical domain. This would in turn help in solving the challenges faced by people most especially in communities where there is shortage or unavailability of medical personnel , as it provides very rapid method of prognosis with much accuracy and reduces the hours patients spend in hospitals and boring routine tasks associated with the existing method of HIV screening. This expert system is user-friendly and carries out prognosis based on patients' symptoms.

7. FUTURE WORK

As a direction future work on this system can take, the use of a standard reporting tool to generate report of all the patients that have used the system and their results will be an improvement and ensure system optimality and efficiency. Also, security measures should be implemented such that unauthorized users cannot view the generated report sheet of patients. In addition, modules can also be added if it is determined that they will increase the system's functionality without leading to a trade-off in response time and load time.
These would help improve the overall system security, efficiency, convenience and ease of use.

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