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Developing of a Computerized Brain Diagnosing System for Case Study Analyses at a University Teaching Hospital in Nigeria

(Pp. 381-396)

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Abstract

This research presents a conceptual procedure for characterizing the essential nature of the diagnostic reasoning process. This computerization of the medical neurological section of the University College Hospital Ibadan in Nigeria leads to effectiveness and efficiency of the existing medical diagnosing process. The main purpose of this project is to design a computerized brain diagnosing system that would be used in carrying out the daily diagnosing activity in the clinic. The developed computerized system has numerous advantages over manual operation which is very tedious and time consuming. As part of the research method, a set of clinical and ward observations were personally made confirming that the computerized system is prompt, less prone to errors and efficient. This work deals mainly with the

analysis of the manual system and the computerization of the newly design system. Moreover, it explains how operations are carried out on records and use of data encryption method so as to ensure confidentiality in the use of the software.

Key words: Software-design, System-Computerization, Brain-diagnosis, Clinical-routine

Introduction

Our increasing expectations of the highest quality health care and the rapid growth of evermore detailed medical knowledge leave the physician without an adequate time to delve into each case while struggling to keep up with the new development in the field. For lack of time, most medical decisions must be based on rapid judgments of the case relying on the physician's unaided memory. Only in a rare situation can a literature search or other extended investigation be undertaken to assure the doctor (or the patient) that the latest knowledge is brought to bear on any particular case.

Although continued training and recertification procedures encourage the physicians to keep more of the relevant information constantly in mind, but fundamental limitations of human memory and recall coupled with the growth of knowledge assure that most of what is required cannot be known by most individuals. Thus, this is the opportunity for new computer tools: to help organize, store, and retrieve appropriate medical knowledge needed by the practitioner in dealing with each difficult case, and to suggest appropriate diagnostic, prognostic and therapeutic procedures in decision making techniques.

The main purpose of carrying out this project research is to develop a computerized brain diagnosing system that would achieve the following; (i) design a useful computer based system that would be used in carrying out the daily diagnosing activity in the clinic (ii) enhance proper accountability and enforce checks and balances (iii) provide information at appropriate level of details (iv) generate easy and timely reports that is complete and accurate (v) facilitate easy information storage and upgrade in the required field (vi) enable the medical field cope with the dictates of the present era of globalization in the computer age (vii) allow the quick introduction of new observation and detailed research works. The functions of the software developed in this work include; Keeping record of diagnosed patients; diagnosing patient with brain tumour problem; generate timely report and

medical statement; also providing quick reference for doctors during prescription; guidance for physicians in decision-making process.

Diagnosis methods and their applications

Problems of the present diagnosis method

The present method of diagnoses has been noted for the past years of its inability to disclose the total facts needed during treatment. It is not always perfect due to error of omission, parallax or assumption. And these are not so in computerized diagnosing system. More so, the manual systems are also seen to be limited in the areas of quick response to critical problems. It is also less efficient, tedious and time consuming and subject to scrutinizing medical statements. High levels of probabilistic decision are made during diagnosis with manual method. There is high mismanagement of files and record of the diagnosed patients in the present medical system, which can be remove with the use of computerized diagnosing system. In the present setup of diagnosis, urgent problems are still restricted to the experts alone, which do endanger the lives of patients when they are not available.

The computerized diagnosing system

Some of the advantages of the computerized diagnosing system could be categorized under the following sub-divisions. (i) *Precise information:* There will be improvement in quality of treatment being offered, due to the exact information generated by the system. (ii) *Effectiveness:* he ability of the computerized system to perform complex comparison and analysis of various information help in proper decision making. (iii) *Memory storage:* The computerized system helps in the area of file referencing and storage of large related information which may be needed during diagnosis. (iv) *Quick response:* There is fast response in the new computerized system which removes problems of time consuming exercises. (v) *Accuracy:* The new system tends to present more accurate result due to the solution produced by the computer. (vi) *Versatility:* The new system is not limited to a single type of diagnosis, unlike the manual method which is specialized (vii) *Exposure to new research:* The new system can still have more development which covers both the past and present age of diagnosis due to more findings and discovery in the field.

Application of diagnosis methods

Systems that diagnose and treat problems of illness in people or problems in hardware and software are now in widespread use. Diagnostic systems based on Artificial Intelligence (AI) technology are being built into photocopiers,

computer operating systems, and office automation tools to reduce service calls. Stand-alone Units are being used to monitor and control operations in factories and office buildings. AI-based systems assist physicians in many kinds of medical diagnosis, in prescribing treatments, and in monitoring patient responses. Microsoft's office Assistant provides users with customized help by means of decision-theoretic reasoning (Schwartz, 1970). In a review article, Schwartz, (1970) speaks of the possibility of the computer as an intellectual tool capable of reshaping the present system of health care. This is fundamentally useful in the role of the physician and profoundly changes the nature of medical manpower recruitment and medical education. In short, there is possibility that the health-care system in the nearest future will be different from what it is today.

Moreover, some researchers McCosh and Scott (1978) noted that despite the tremendous growth in computer-related activities, Management Information Science (MIS) has had significant impact on different kinds of decisions and the ways in which they are made. These have been affected by computers over the years. This can be traced in large part to the lack of proper perspective on the problems involved in augmenting the decision-making in management (Shortliffe et al. 1979). A currently much similar use of computers in medicine is their application to the substance rather than the form of health care. If the computer is a useful manager of billing records, it should also maintain medical records, laboratory data, data from clinical trials, etc. And if die computer is useful to store data, it should also help to analyze, organize, and retrieve it .Three main approaches of medical computing have so far been used in this work: the *clinical algorithm or flowchart,* the matching of cases to large *data bases* of previous cases, and applications of *decision theory*. Each of these has had notable successes and all contribute to the development of the AI approaches. A supporting review to this work on the state of the art of computer tools for medical decision making can be found in the work done by Szolovits *et al.* (1978) and an accompanying argument for the AI orientation (Perlman *et al.* 1974)

Decision making tools and thoery

Decision making tools

A *flowchart* encodes, in principle the sequences of actions a good clinician would perform for any one of some population of patients. The principal deficiency of the flowchart as a general technique for encoding medical decision making knowledge is its lack of compactness and perspicuity. When

used in a very large problem domain, the flowchart is likely to become huge, because the number of possible sequences of situations to be considered is enormous. Furthermore, the flowchart does not include information about its own logical organization: each decision point appears to be independent of the others, no record exists of all logical places where each piece of information is used, and no discipline exists for systematic revision or updating of the program. Therefore, inconsistencies may easily arise due to incomplete updating of knowledge in only some of the appropriate places, the totality of knowledge of the flowchart is difficult to characterize, except only by the expert. However, flowchart can be use for modeling across any field. It is versatile in operations.

Databases

Large databases of clinical histories of patients sharing a common presentation or disease are now being collected in several fields. The growth of data capture and storage facilities and their co-occurring decline in cost make attractive the accumulation of enormous numbers of cases, both for research and clinical uses. Today we are engaged in numerous long term studies of the heath effect of various substances, the eventual outcomes of competing methods of treatments, and due clinical development of diseases. Large databases on significant populations, concentrating on cardiovascular disease, arthritis, cancer and other major medical problems are now being collected and used to clarify the time incidence of diseases, to identify demographic factors and to measure therapeutic efficacy of drugs and procedures (Rosati *et al*.1975; Weyl *et al.* 1975; Tautu and Wagner, 1978).

For clinical purpose, the typical use of large databases is to select a set of previously known cases, which are most similar to the case at hand by some statistical measure of similarity. Diagnostic, therapeutic and prognostic conclusions may be drawn by assuming that the current case is drawn from the same sample as members of that set and extrapolating the known outcomes of the past cases to the current one. The use of collected past records either for research or clinical practice is clearly a data intensive activity. To sift through the voluminous information at hand, to identify the important generalizations to be found among the thousands of detailed records and to select previous cases likely to shed light on the one under current consideration, numerous statistical techniques have been developed and applied. The literature of medical statistics in large, and all may not be reviewed here; a good survey may be found in Tautu and Wagner, (1978)

Decision theory

Decision theory is a mathematical theory of decision making under uncertainty. It assumes that one can quantify the a priori and conditional likelihoods of existing states and their manifestations and can similarly determine an evaluation (utility) of all contemplated outcomes. Given these data, decision theory offers a normative, *rational* theory of optimal decision making which is urged by its practitioners as an effective technique for structuring medical decision making problems (Raiffa, 1970). Although there is considerable evidence that most human decision makers not specifically trained in decision analysis deviate from this model in their decision making activities (Tversky and Kahneman 1974), the theory is nevertheless appealing as a norm for helping to make explicit the bases of decision making and any existing disagreements among decision makers. Numerous computer programs for decision making in small domains of medicine have employed the decision theoretic formalism (Gorry *et al.* 1973). The chief disadvantages of the decision theoretic approach are the difficulties of obtaining reasonable estimates of probabilities and utilities for a particular analysis.

Although techniques such as sensitivity analysis help greatly to indicate which potential inaccuracies are unimportant, the lack of adequate data often forces artificial simplifications of the problem and lowers confidence in the outcome of the analysis. Attempts to extend these techniques to large medical domains in which multiple disorders may co-occur, temporal progressions of findings may offer important diagnostic clues, or partial effects of therapy can be used to guide further diagnostic reasoning, have not been successful. The typical language of probability and utility theory is not rich enough to discuss such issues, and its extension within the original spirit leads to untenably large decision problems. For example, one could handle the problem of multiple disorders by considering all possible subsets of the primitive disorders as mutually competing hypotheses. The number of a priori and conditional probabilities required for such an analysis is, however, exponentially larger than that needed for the original problem, and that is unacceptable.

A second difficulty for decision analysis is the relatively mysterious reasoning of a decision theoretic program-an explanation of the results is to he understood in terms of the numeric manipulations involved in expected value computations, which is not a natural way of thinking for most people. The role of decision theoretic computations is discussed further in (Szolovits and Pauker, 1978)

System of operation at case study hospital

The present method of medical diagnosis at University of Ibadan College Hospital (UCH) is characterized with real life observation, testing techniques and various types of hypothesis. The physicians are met with a great deal of work including; patient examination, medical disease diagnosis, treatment of diagnosed problems, blood test and treatment, hypothesis research, and surgical operations. *Patient examination* is one of the major acts of brain tumor diagnosing by the physician (Neurosurgeon). The affected patients are observed and examined under various inspecting tools as corresponding report are generated based on the seen observation. In *Medical disease diagnosis* appropriate actions that care for and cure detected problem are mentioned. Necessary drugs and incentives are stated. At this point the decision of real time diagnosis is made through the comparison of the past experiences and the up to date researches with the present observations. *Treatment of diagnosed problem a*lso takes place on the day to day process, or at intervals with corresponding observation. This duty is majorly carried out by the physicians in the specialized field or by the nurses and matrons. Patient involve could either be attend to on bed admission or clinical interval treatment basis.

Stating more on the existing traditional medical diagnosing approach, *different tests* are carried out concerning the human circulatory system as affecting the brain problem diagnosis. This moreover, has a direct hypothetical influence on diagnosis made across the internal organs. Looking more into the present situation of diagnosis, some extent of *hypothetical researches* are still being made by the Physicians through IMRAT department, this help in updating the knowledge of each domain expert. More so, surgical operators are still being performed by the domain expert though they may be less available. Patient report and update information are kept in their various case notes. This case notes are edited and updated on each clinical visit. This case note and files are being kept manually in hospital patient shelf.

Problems of the existing system

Looking vividly into the present system of diagnosis at University of Ibadan College Hospital, it's still being noted for some defeating problems which are now considered removable through the use of a computerized system of diagnosis. The present method of diagnosis has been noted for the past years of the inability to disclose the total facts needed during the treatment of patient. The present system is not always perfect due to errors of omission,

parallax, or assumptions. And these are not so in computerized diagnosing system except the error base on garbage-in, garbage-out which can still be traced to human being. The manual system had also been seen to be limited in the area of quick response on critical problems. It is also less efficient, tedious and time consuming, scrutinizing medical statement high levels of probabilistic decisions are made during diagnosing with manual method.

There is high mismanagement of files and records of diagnosis patients in the present medical system which can be removed with the use of computerized diagnosis system. In the present set up of diagnosis, urgent problems are still restricted to the expert alone, which do endanger the lives of patient when the are not available. Due to increase in population of the present era of world globalization, there is for more physician work which call for more efficiency, accuracy and available. And this is still limited in the present system

Development of the new diagnosing system

The proposed and research system is meant to work and correct the deficiencies of the manual traditional method of diagnosis. The system enhances fast and quick diagnosing process, with precise result. This system is also meant to keep the patient record intact and easy to access database. The system is based on *Exhaustive* and *Heuristic Research (HER)* method. The Exhaustic search method takes care of all diagnosis in major two ways. (i) *Breadth-first search*: This searches the database across its branches in a treelike format, finding out the correlating symptoms and their diagnosis. This method of search, searches one branch before going to another. (ii) *Depth-first search*: This searches the database across each level before going to another. These methods are being used to search across all the levels of the database.

The *heuristic method* of search is also used in the database, for the purpose of searching the corresponding texts and strings (both in phrase, clause and exact words) across the database. This makes the diagnosing system exact, fast and effective in its mode of response. The new system would therefore take care of the patient records across its years of usage. It also monitors the current procedures of diagnosis as related and makes the exact needed data available to the physicians. This system will also provide quick reference for the purpose of further research in the relevant fields respectively.

System design and implementation

This aspect explores the techniques use for the design of interface, menus and databases of the new system, based on the requirement specification worked out during the analysis phase. Structured design has being noted as a good programming practice and a software design method, used in current parallel trend of technology for easy and inexpensive system construct and maintenance.

System designs describes the features of the proposed systems in terms of the nature of input, files and output as well as showing the processing procedure by which they are connected. This stage is most important stage that deals with the development of this entire system. For instance, the input and output design are well stated and represented so as to ensure the optimum usage of the new system. In essence, the function of the system design is the production of the detailed computer based system and specification of the new system. Shown in figures 1 is the flow chart of the algorithm of the developed diagnosis system. Figures 2 and 3 are the diagrams for data flow and entry relationship of the developed system. The interfaces of the developed software showing the various stages of its application are presented in figures 4 -7

Choice of programming language

Microsoft Visual Basic 6.0 and Microsoft Access were used to in designing and implementation of this software. Microsoft Visual Basic was used to design the interface and Access 2000 was used to set-up the Database. The languages were chosen because of the following reasons. (i) Visual Basic is a graphical user interface software, which made it users friendly (ii) Visual Basic can be easily deployed to generated a stand-alone programme (iii) Microsoft Access operates as a relational Database Model, which enables table to relate with each other (iv) Microsoft Access is large and can accommodate large number of data.

Data collection

This involves how information, data or facts were gathered from various sources. The methods employed in this project work include self-administration interview as well as reading records and documentation relating to the existing system. The former involves face-to-face interaction with the experienced experts and doctors in the exact field of study. Personal interview was used in eliciting facts from the respondents because it yielded an overall assessment of the respondents. Reading records and

documentation relating to the system gives a pictorial view of the personnel and either duty, detailed job description and functions which are being performed. Moreover some considerations were also taken based on the sampling data derived from the documented database.

Conclusion

The main purpose of designing a computerized brain diagnosing system that would be used in carrying out the daily diagnosing activity in the clinic has been achieved in this work. The scope of this project that covers the area of computerized brain tumour diagnosing system would be of tremendous help if properly used. The adaptation of computer in brain problem diagnosing goes a long way in speeding up the process of *computational neuroscience*. Advantages of applying this new diagnosing system in everyday clinical activities include the following; (i) There would be greater degree of diagnosed system integration (ii) There would be quick supply of information for improve managerial and diagnosing decisions. (iii) The reference and balancing of patient records would be done easily. (iv) There would be no problem of data loss which is peculiar to manual method of medical system. This system is being recommended to all medical professionals in their process of diagnosis.

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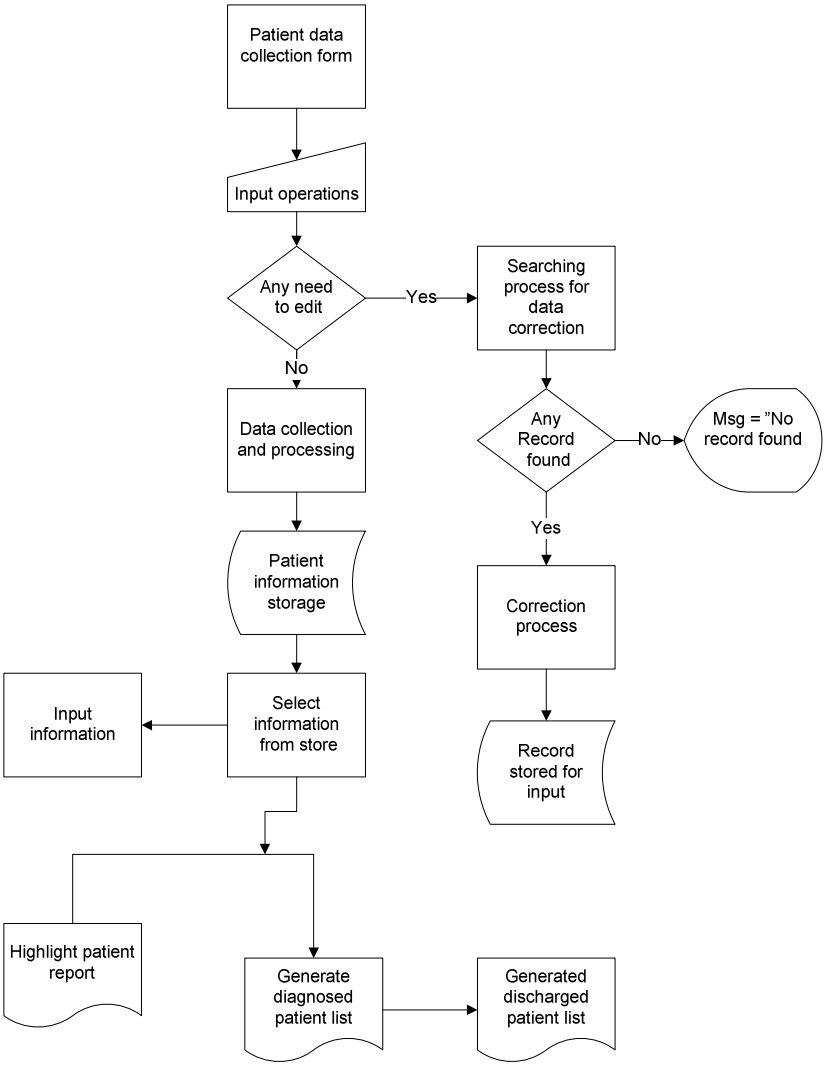
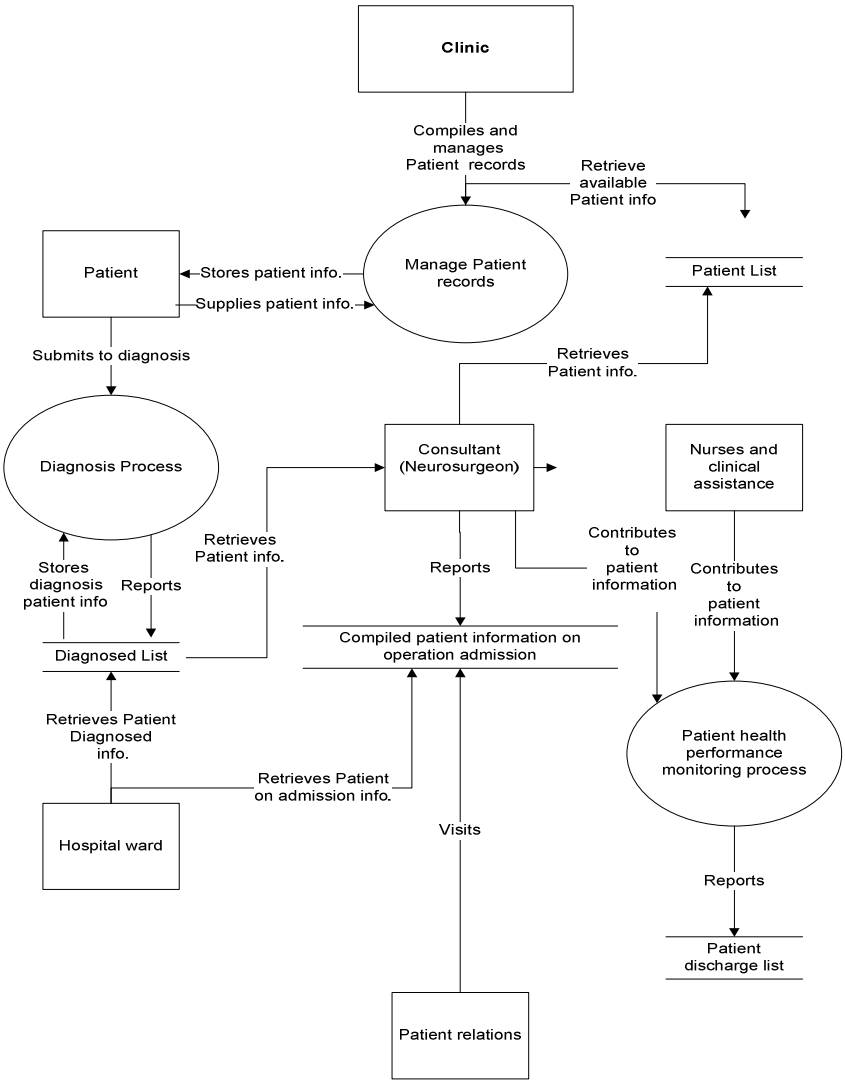


Figure 1: System flow chart

Figure 2; Data flow diagram of diagnosing system



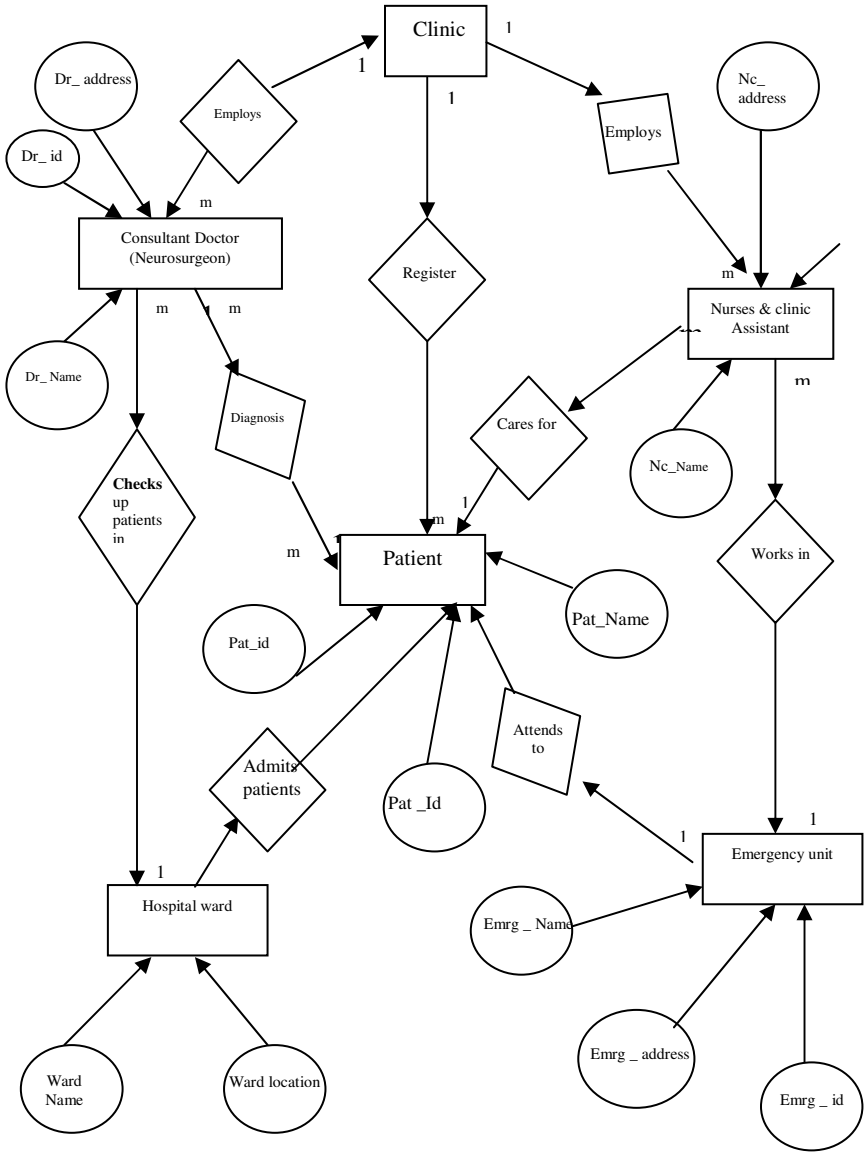

Clinic
Dr_ address
Employs
Dr_ id
Consultant Doctor (Neurosurgeon)
Register
Employs
Nc_ address
Nurses & clinic Assistant
Dr_ Name
Diagnosis
Cares for
Nc_Name
Checks up patients in
Patient
Works in
Pat_id
Pat_Name
Attends to
Admits patients
Pat _Id
Hospital ward
Emergency unit
Emrg _ Name
Ward Name
Ward location
Emrg _ address
Emrg _ id

Figure 3: Entry Relationship Diagram

Figure 4: Screen shot of Main Menu interface

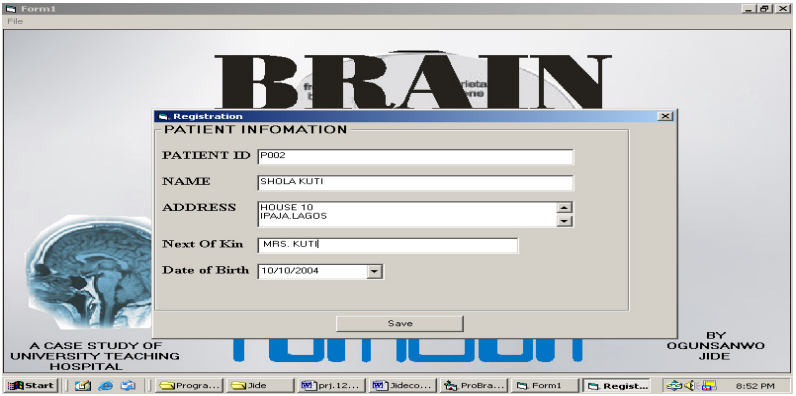


Figure 5: Screen shot of Patient Registration Form interface

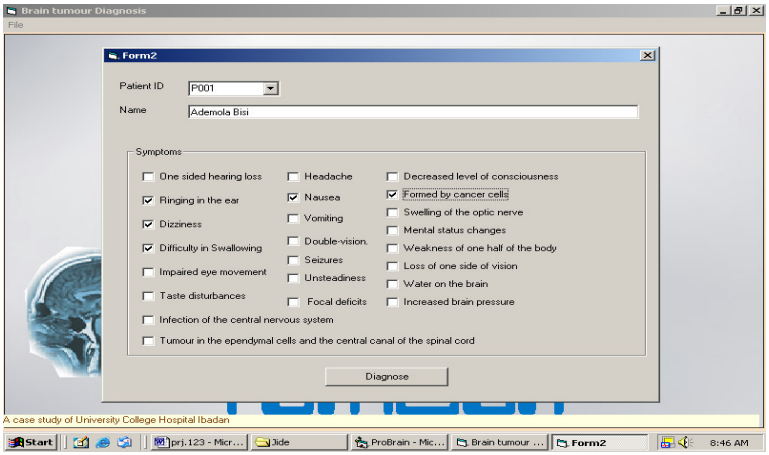


Figure 6: Screen shot of Diagnose Form interface

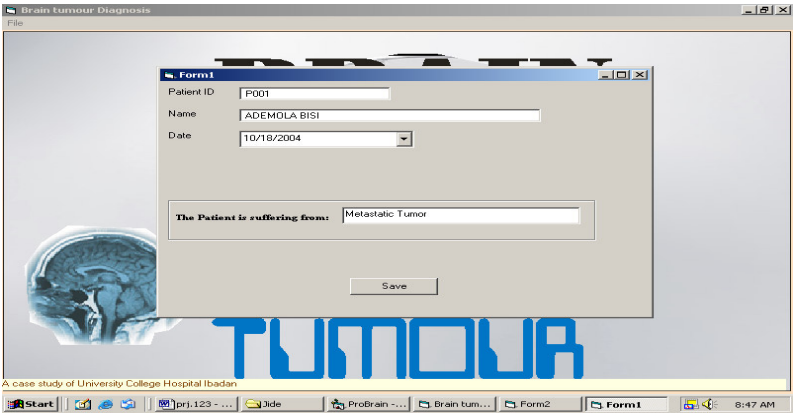


Figure 7: Screen shot of Result Form