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Human Factors in Computerized Medical Systems

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HUMAN FACTORS IN COMPUTERIZED MEDICAL SYSTEMS

by

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VITA

Carol Lynn Curt was born in Chicago, Illinois on 31 January 1956, the daughter of Charles and Edith (Elling) Curt. She received her elementary and secondary education in the public schools of Chicago, and in 1973, graduated from Roald Amundsen high school. Carol entered Loyola University of Chicago in September 1973, and, in May 1977, received the degree of Bachelor of Science, cum laude, with a major in psychology.

Carol entered the graduate program in Experimental Psychology at Loyola in September 1978 and was granted research assistantships from 1978 to 1981. She received her Master of Arts degree in January 1982; her master's thesis was titled: "The Effect of Depressive Affect on Judgments of Frequency of Occurrence".

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1980 to 1984, Carol also worked as a statistical consultant and author for Professional Research Analysts in Chicago, and, in 1986, as a human factors consultant on the development of a computerized expert troubleshooting system for M & M Mars.

Carol is the co-author of the following papers:

Hill, H., Curt, C.L., Kozar, B.K., Hier, D.B., & Evens, M.W. (1985) The architecture of the IIT-MRH Stroke Consultant. In Proceedings of the 9th Annual Symposium on Computer Applications in Medical Care, Washington, D.C.: IEEE Computer Society Press, pps. 314-319.

Li, P.-Y., Ahlswede, T., Curt, C., Evens, M., & Hier, D. (1985) A text generation module for a decision support system for stroke. Proceedings of the 1985 Conference on Intelligent Systems and Machines, Oakland University, Rochester, Michigan.

Curt, C.L. & Zechmeister, E.B. (1984) The influence of primacy and recency on the availability of information. Bulletin of the Psychonomic Society, 22(3), 177-179.

Curt, C.L. & Zechmeister, E.B. (1981) Primacy, recency, and the availability heuristic. Presented at the Midwestern Psychological Association annual meeting, Detroit.

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INTRODUCTION

Research in human factors examines the interaction between systems and their users. The goal of this research is to develop user-system interfaces that adapt systems to the capabilites and limitations of the users so that users do not have to adapt to the systems.

In recent years, a new area within human factors has developed which focuses on the user-system interaction in computer systems (Galambos, Sebrechts, Wilker, & Black, 1982). Although the field of human factors traditionally has addressed the user-system interaction only at the level of physical and mechanical functioning, this new area of human factors addresses the user-system interaction at the level of cognitive functioning. Unfortunately, research on the cognitive aspects of the user-system interface has been slow to accumulate. Since research on human cognitive functioning exists in the literatures of experimental and cognitive psychology, it is proposed that this research should serve as the scientific base for the cognitive aspects of user-system interface design and development.

The present research explored the use of psychological principles in the design of user-system interfaces for two computerized medical systems. The first system was the Stroke Consultant, an expert system developed to assist physicians in the diagnosis, treatment, and management of stroke. An interactive user interface for this system had to be designed which would be suitable for use by physicians. The development process and the design of the interface are described.

The second system was the Stroke Data Bank which, as its name indicates, is a computerized databank for the collection of information about stroke. For this system, hardcopy output interfaces were developed in the form of computer-generated case reports so that users could have easy access to the data in the databank. Several formats for the case reports were developed and evaluated to determine the most suitable format for the presentation of medical information.

HUMAN FACTORS AND THE USER-SYSTEM INTERACTION

The field of human factors can be defined as the application of behavioral principles and data to system design with the goal of maximizing the efficiency of the interaction between the system and the human user of the system. Research in human factors is based on a set of assumptions about the relationship of the user to the system. First, it must be assumed that there is a relationship between the efficiency with which users operate a system and the ultimate effectiveness of that system. Second, it is assumed that characteristics of the system influence how the user operates the system. These system characteristics act as stimuli to which the user must respond. Third, since system characteristics function as stimuli to the user, it is assumed that users will respond more efficiently to certain arrangements of these characteristics/stimuli than they will to other arrangements. The user's performance should be more efficient when system characteristics are matched to the capabilities and limitations of users. Empirical evidence to support all of these assumptions exists (Meister, 1971).

In the past, human factors has addressed the user-machine interaction (traditionally referred to as the "man-machine interaction") solely at the level of physical and mechanical functioning (Hollnagel & Woods, 1983). However, with the proliferation of computers and computer systems, it has become necessary to address the role of cognitive functioning in the user-machine interaction as well. Tasks performed on computers are primarily cognitive, not physical, in nature. More than any other machine system, the user-computer interaction relies on the cognitive capabilities of the user. Of course, some investigations into the user-computer interaction focus on the hardware and the physical and mechanical aspects of operating the computer. This is the traditional approach of human factors research. Of present interest, though, is the relatively new area within human factors that focuses on human cognitive functioning.

The computer, in spite of and because of its complexity and power, can be adapted to suit human capabilities rather than requiring humans to adapt to it. Adapting the computer to the cognitive capabilities of the user is accomplished through careful development of the user interface. The user interface is the point of contact between the system and the user; the user judges the quality of the system on his interaction with the system, and this interaction is mediated by and depends on the interface. The system beneath the interface may be efficient and clever, but if the user interface is poor, the users may reject the system and revert to or retain manual procedures. Even if the system is used, a poor user interface can result in frequent and/or serious errors, confusion, frustration, and slow and inefficient performance. A user interface that causes slow and inefficient performance defeats the purpose of having a computerized system.

The user interface should be designed so that the system is easy to learn and remember, easy and pleasant to use, prompt, reliable, courteous, helpful when difficulties arise, and effective as a tool in solving user problems (Shneiderman, 1980). Gould and Lewis (1983) suggest four principles that they believe are necessary to ensure the development of a user interface that meets these goals. First, the designers of the interface must understand who the users of the system will be. They suggest that this understanding is achieved by studying the users' cognitive, behavioral, anthropometric, and attitudinal characteristics, and by studying the nature of the work to be accomplished. Second, the designers should work closely with a panel of expected users during the early formulation of the system. Users should be included in the design process from the very beginning when their perspectives have the most influence. Third, early in the development process, intended users should use simulations and prototypes to try out the system on real work. Users' reactions and attitudes toward the system should be recorded and their performance should be measured to determine how easy the system is to learn and use. Fourth, when problems are found, they must be fixed. This means that the design process must be a cycle of design, test and measure, and redesign, repeated as often as necessary.

Norman (1983) has suggested that the area of user interface design "should be its own discipline, for it requires sophistication in both programming and human behavior" (p. 2). At present, many user interfaces are designed by people who are sophisticated in programming, but who have little or no background in psychology or human factors. Programmers whose primary goals (and interests) are getting their programs and systems to run correctly develop the interface as a necessary but uninteresting part of the almost finished product. Rarely does evaluation of the interface occur, and when it does, it occurs too late to have a substantial impact on product development (Kraut, Hanson & Farber, 1983). Even when the need for attention to human cognitive functioning is recognized, traditional approaches to user-machine interactions are unable to address cognitive issues. Traditional approaches (i.e., human factors, ergonomics, engineering psychology) focus on the limits of human performance in the physical, not cognitive, domain. They do not possess the tools, concepts, and models necessary to understand and analyze the cognitive issues in the user-computer interaction. Because of this apparent lack of information, intuition and "common sense" are often the guiding forces of the design process. Design by common sense and intuition alone is a trial-and-error procedure.

The field of human factors is useful only if it can provide a predictive basis for user-system interface design. Research and the development of tools, concepts, and models based on this research have enabled the design of the physical aspects of the system to move beyond the trial-and-error stage. Research on the cognitive aspects of the user-system interface has been slow to accumulate. Much of the research in this area has been done within corporations with the goal, not of finding generalizable truths about the user-system interaction, but of finding specific solutions to specific design problems. However, as long as there are human users of a system, there are human characteristics that are brought to the interaction. Vast bodies of research addressing the characteristics of human cognition exist in the literatures of experimental psychology and cognitive psychology. This research can provide background and guidance for the design of the user-system interface.

An Overview

This dissertation describes the use of principles of cognitive and experimental psychology to guide the development of two types of user-system interfaces. Chapter 2 describes the development and design of a user interface for an expert computer system that assists medical personnel in the diagnosis, treatment, and management of stroke. Chapter 3 describes the design, development, and evaluation of computer generated case reports for stroke patients. The design of this type of computer generated output raises questions concerning issues in comprehension and memory for narrative reports. The contributions of research on practical problems to basic research are also discussed.

INTERACTIVE USER INTERFACE FOR THE STROKE CONSULTANT

This chapter describes the development and design of the user interface for the Stroke Consultant. The Stroke Consultant is a computer-based medical expert system that assists medical personnel in the diagnosis, treatment, and management of stroke.

Computer-Based Medical Expert Systems

The development of computer-based medical decision-making systems began in the early 1960's. Most of the decision-making systems that have been and are being developed have not tried to imitate physicians' decision-making processes. Instead, these systems diagnose the patient by statistical analysis: they accept the patient data and then select one disease from a fixed set of diseases using methods such as pattern recognition through discriminant functions, Bayesian decision theory, and decision-tree techniques.

Medical expert systems have tackled a variety of medical problems. For example, current medical expert systems include:

-- MYCIN which gives advice on diagnosis and therapy for infectious diseases (Shortliffe, 1976).

-- Causal Associational Network (CASNET) which is designed to perform medical diagnosis; its major application has been in the domain of glaucoma (Weiss, Kulikowski, Amarel, & Safir, 1978).

-- INTERNIST is a consultation program for diagnoses in internal medicine; this is one of the few programs which has tried to model the way clinicians do diagnostic reasoning (Pople, 1975).

-- Digitalis Therapy Advisor advises clinicians on the appropriate treatment regimen and its subsequent management for patients known to require digitalis (Swartout, 1977).

-- PUFF is a pulmonary-function program (Kunz, 1978).

-- HODGKINS performs diagnostic planning for Hodgkins disease (Safrans, Desforges, & Tsichlis, 1976).

-- HEADMED is a psychopharmacology advisor (Hieser, Brooks, & Ballard, 1978).

-- VM is an intensive-care monitor (Fagan, 1979).

-- ONCOCIN monitors the treatment of oncology out-patients on experimental treatment regimens (Shortliffe, Scott, Bischoff, Campbell, van Melle, & Jacobs, 1981).

Providing reliable and thorough diagnostic services by computerized systems has obvious benefits for society. For example, Ledley and Lusted (1959) have observed that most errors made by clinicians are errors of omission, that is, in trying to identify the disease that a patient has, the physician does not consider all the possibilities, thereby missing the correct diagnosis. Assuming adequate patient data are available, computer programs can be designed to consider all the diseases in a domain. Computers can also handle some tasks more rapidly and accurately than the clinician can. For example, it may be preferable for computers to calculate dosages of medicine, especially where dosage is critical and many factors need to be taken into account in the calculation. In addition, computers can take over tasks that are routine and at which physicians are notoriously poor, such as prescription of antimicrobial therapy (Barr & Feigenbaum, 1982).

There are many social, psychological, and ethical problems surrounding the development of computer-based consultation systems. For example, there are problems in validating the systems, exporting them to hospitals and clinics, getting physicians and patients to accept them, and determining the responsibility for the clinical decisions made with the help of these systems.

Despite the extensive work that has been done, of the current expert systems mentioned above, only PUFF and ONCOCIN are in routine clinical use (Barr & Feigenbaum, 1982). Bischoff, Shortliffe, Scott, Carlson, and Jacobs (1983) have suggested that successful medical consultation systems must not only provide expert level advice, but also fit smoothly into the physician's daily routine. They report that some of the major impediments to successful introduction of these systems into routine clinical use have been poorly designed user interfaces.

The IIT/MRH Stroke Consultant

Begun in 1982, the IIT/MRH Stroke Consultant is the result of a collaborative effort between the computer science department at the Illinois Institute of Technology and the stroke service at Michael Reese Hospital. In order to understand some of the components of the Stroke Consultant, it is necessary to understand the causes and diagnosis of stroke.

Stroke: Cause and Diagnosis

Stroke is a general term that encompasses any neurological deficit that is due to vascular disease of the brain. Stroke is a serious problem in this society; currently, about half a million people suffer from strokes each year, and about half of these people die from stroke (National Institute of Health, 1980). The survivors often suffer from debilitating consequences of the stroke such as paralysis, loss of speech, and/or various cognitive deficits (Weiner & Levitt, 1974; Chusid, 1974). Stroke is generally sudden in onset, and most stroke victims are taken to hospital emergency rooms where they are seen by house physicians who usually are not well trained in neurology (Hill, Hier, Caplan, Perline & Evens, 1983).

Stroke is caused by a disruption of the blood supply to the brain. There are two major pathological processes that affect the brain: infarction and hemorrhage. Infarction is the death of brain tissue due to the lack of the blood supply. Infarction can be caused by emboli, which are traveling blood clots that become lodged in a cerebral blood vessel; thrombosis, which is the progressive narrowing of cerebral blood vessels due to atherosclerosis; or lacunes, which are due to thrombosis of tiny arteries. Hemorrhage is bleeding into the brain tissue. The tissue is often not destroyed, but function is lost due to an enlarging blood clot that pushes normal brain tissue aside. Bleeding may occur into the brain substance (intracerebral hemorrhage or parenchymal hemorrhage) or into the subarachnoid space around the brain (subarachnoid hemorrhage).

Before beginning treatment of a stroke, both the anatomy of the stroke (i.e., the area of the brain that has been injured) and the mechanism of the stroke (i.e., the cause of the stroke) must be determined. Since injury to different brain areas often produces different symptoms, an analysis of the patient's symptoms can suggest the anatomical location of the stroke. Determining the mechanism of the stroke is more complex, but, in general, once the anatomy has been determined, certain anatomies imply certain mechanisms. Also, both the anatomy of the stroke and the mechanism of the stroke often can be directly visualized by the computerized tomography (CT) scanner which provides an x-ray picture of the brain (Hier, 1984).

It is desirable to confirm the physician's diagnoses of anatomy and mechanism by CT scans and other lab tests. However, in many cases of stroke, delaying treatment while waiting for the test results would be dangerous to the patient. Since treatments for strokes vary widely and treatment of the stroke is chosen largely on the basis of the mechanism of the stroke (Toole & Patel, 1974), the mechanism needs to be determined early. Unfortunately, the results of a recent study indicate that trained neurologists agree only 60 to 70% of the time in determining the mechanism of a stroke without access to CT scan results and other lab tests (Gross, Shinar, Mohr, Hier, Caplan, Price, Wolf, Kase, Fishman, Calingo & Kuntz, 1985).

Components of the Stroke Consultant

Physicians generally approach diagnosis and treatment of stroke in a series of steps. First the anatomy of the stroke is diagnosed. Second, the mechanism of the stroke is diagnosed. Third, tests (e.g., CT scan, spinal tap, angiogram) are ordered to confirm the diagnoses. Fourth, after the initial diagnosis (and, often, before the results of the tests are available), treatment is decided upon and started. Later, the patient's prognosis is determined and, when necessary, long-term treatment is recommended. Each of these steps can be viewed as a separate subproblem of stroke diagnosis and treatment.

The stroke consultant has been designed to go through the same series of steps as does the physician. Each of these steps is handled by a separate component of the system which is, in fact, an individual expert system. Each component expert system has its own knowledge base, inference engine, and local data store, and each system uses whatever type of reasoning is most appropriate for the problem for which it is responsible. (Currently, the system contains components that use rule-based back chaining, pattern matching, statistical methods, and graph traversers.) (For a complete discussion of the architecture of the stroke consultant, see Hill, 1985; see also Hill et al., 1983 and Hill, Curt, Kozar, Hier & Evens, 1985.)

The component expert systems that make up the stroke consultant are:

PAL - the preliminary anatomical localizer; determines the anatomy of the stroke;

MOS - determines the mechanism of the stroke;

CONFIRM - suggests tests to confirm the anatomy and mechanism proposed by PAL and MOS and processes the results of these tests;

MANAGE - proposes a suitable treatment protocol and gives advice on the appropriate management of the stroke;

PROG - determines the prognosis in the case;

REPORT - generates a case report in English;

RAL - the reverse anatomical localizer; determines the anatomy of prior strokes or other neurological problems.

In addition to these component expert systems, the stroke consultant also contains four explanational support components:

HELP - furnishes advice on how to use the system;

DEFINE - defines terms and displays criteria for making choices;

SEERULE (WHY) - provides an explanation of the reasoning the system is using;

LITREF - furnishes literature references to support the treatment protocol selected.

(This listing contains all the components that have been planned for the system; at present, however, not all of them have been developed. The system is expected to be completed within the next two years.)

The stroke consultant has been designed to be used in several ways. First, of course, the stroke consultant can do virtually all of the work of stroke diagnosis including determining the diagnoses, ordering tests, requesting test results, making treatment recommendations, and generating a case report. If the physician does not need this much support, the system can be used instead to provide a "second opinion" about the case. As a second opinion, the system provides not only its diagnoses and treatment recommendations, but also furnishes literature references to support its recommendations and explains the reasoning used throughout the consulting session. A third way the stroke consultant can be used is as a literature reference source: it can supply references to articles and abstracts of articles that discuss aspects of similar cases in the professional journals. As a reference source, the system also contains data on over 500 cases from Michael Reese Hospital, and can furnish patient data (e.g., symptoms, diagnoses, findings) on any of these cases.

When using the stroke consultant, the component systems are not accessed directly by the physician. The separate components run under the control of a system executive called TOLD (top level driver) which selectively activates each component as required. TOLD contains knowledge about the process of stroke diagnosis and the global knowledge about the case at hand that is needed by and made accessible to all the other components. In addition, the components share a common user interface that furnishes the user with a consistent view of the system. All interaction with the stroke consultant is controlled by TOLD and goes through the user interface.

The use of separate components for each aspect of the system gives the whole system greater flexibility and efficiency. However, requiring or allowing each component to have its own user interface would accentuate the multipartite nature of the system and make the system much more difficult to learn and use. Rather than learning to use the stroke consultant, the user would, in effect, be required to learn to use each separate component expert system. Therefore, the stroke consultant was designed so that all interactions with the system would go through a common user interface. Besides making the system more consistent, and therefore, easier to learn and use, this approach has an additional advantage. The user interface itself must be a separate component of the system. By making the user interface a separate component, changing the design of the interface and testing new designs becomes relatively easy.

Development and Design of the Stroke Consultant User Interface

The Users

It is generally agreed among those who work in human factors that the first step to good user interface design is to understand who the users of the system will be. The primary users of the stroke consultant will be house physicians, interns, and medical students working either in emergency rooms or their hospital's stroke service. It is assumed that any particular user will use the stroke consultant infrequently. Users' typing skills and computer experience may vary widely; the system has been designed to accommodate those with no typing skills or computer experience.

Although "know the user" has become the first rule of user interface design, determining the user's psychological state when using the system is an important but rarely mentioned consideration. "Unusual" psychological states (e.g., stress, anxiety, fatigue, depression) can affect cognitive functioning, which, of course, can affect the user's interaction with the system. The users of the stroke consultant will be under stress when they are working with the system. The interface had to be designed with this in mind.

Other users of the system include program developers and knowledge engineers. Since these people are expected to be familiar with computers and the UNIX development environment, only a minimal engineer's interface was provided and it will not be discussed further.

Constraints Imposed by the System

One of the goals in developing the stroke consultant was to develop the system so that it could run on a high end microcomputer that could be placed in emergency rooms. The current development environment consists of a Vax 750 running Berkeley 4.2 UNIX^{tm}. These machines communicate with users via standard ASCII terminals. Currently, the system is being used on an ADM5, a conventional (monochrome) dumb terminal with a 24 by 80 character display. This terminal, like most dumb terminals, can only display a subset of the ASCII character set, does not support color, and communicates with the processor via a low speed link (e.g., 2400 bits per second). This means the system cannot display diagrams or pictures; even displaying text must be done carefully for the system to appear responsive. The terminals also restrict the system by only allowing input through the terminal's keyboard; pointing devices such as mice and light pens cannot be used.

The Original Design

The stroke consultant's original user interface was designed by the system's architect, Howard Hill. It was suitable for the knowledge engineers and programmers that developed the system, but it was not suitable for use by physicians.

The flow of the original user interface can be seen in Figure 1. After logging onto the system, the user was welcomed to the stroke consultant and given the option of seeing an explanation of how to use the system. After the presentation of the explanation, or immediately if the explanation was not requested, the system asked the user to input his/her name and the patient's name. The main menu of the stroke consultant was then displayed. This menu listed the options that were available to the user (see Figure 2).

Invoking one of the options from the main menu gave the user access to one or more of the component expert systems. For example, the option CONSULT took the user through the component expert systems PAL, MOS, CONFIRM, and MANAGE, which diagnose the anatomy and mechanism of the

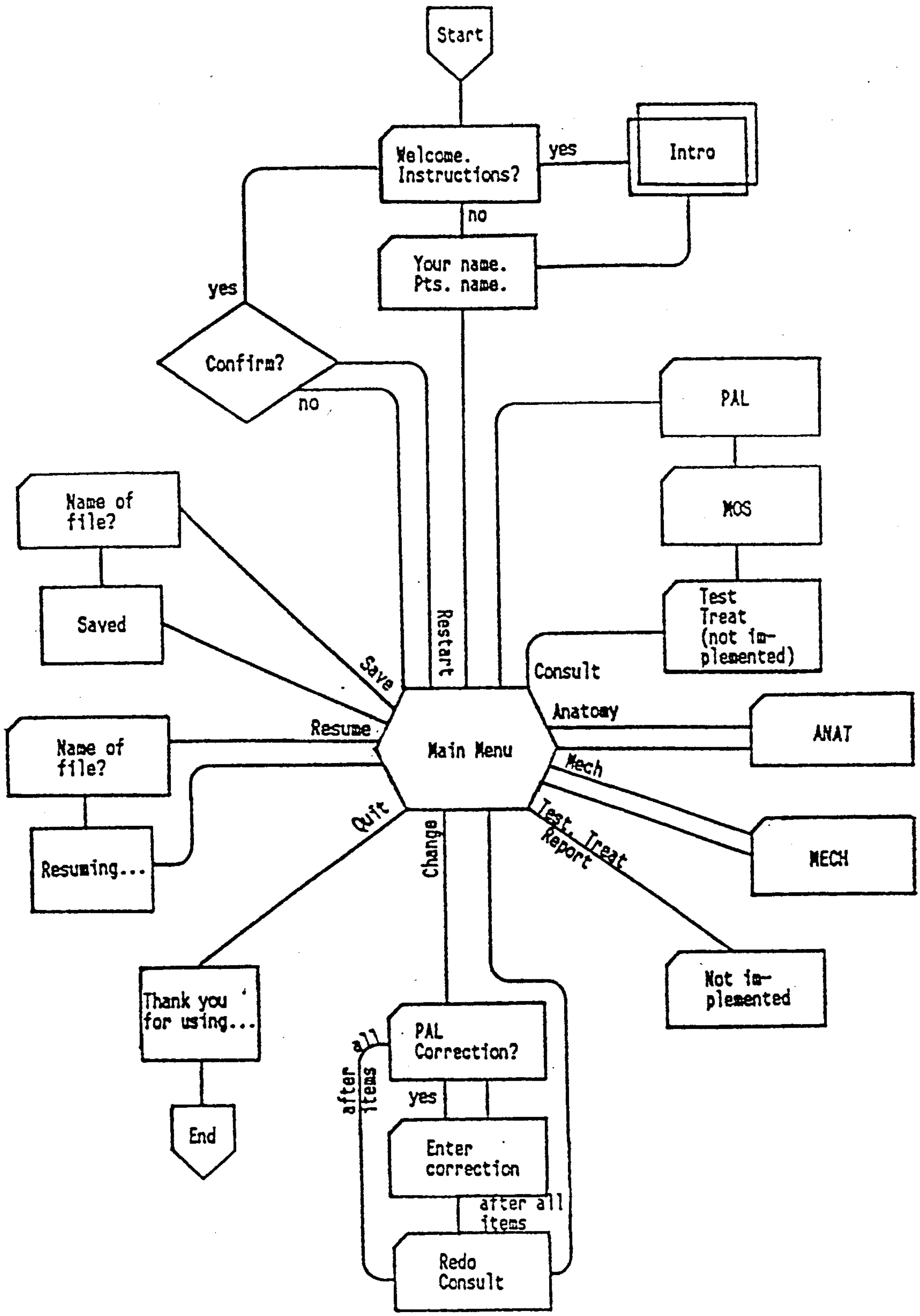

Figure 1. Flow of the original user interface.

```
==========================================================================
                      IIT-MRH STROKE EXPERT SYSTEM

--------------------------------------------------------------------------
 Please enter a command from this menu or enter HELP for help:
 CONSULT - do a normal stroke consultation
 ANATOMY - enter already known anatomy of stroke
 MECH    - enter already known mechanism of stroke
 TEST    - enter one or more test results
 TREAT   - determine treatment for a stroke
 REPT    - generate case report of findings so far
 CHANGE  - change a previously entered answer
 RESTART - restart the case from the beginning
 SAVE    - save results of case on disk for later use
 RESUME  - resume a previous consultation
 QUIT    - quit; return to UNIX system
 >_
--------------------------------------------------------------------------



==========================================================================
```

Figure 2. The main menu screen of the original user interface.

stroke and make test and treatment recommendations. The options ANATOMY, MECH, TEST, and TREAT allowed the user to bypass CONSULT and enter information directly into the system rather than work through the component that would determine it. Note in the flow of the interface, that most of the options returned the user to the main menu after working through each component.

There are many problems with this design, some of which were discovered during extensive use of the system and some of which were discovered when volunteers were observed as they used the system. These volunteers varied widely in computer experience and medical knowledge. The difficulties they had in using the system were noted, and in discussions during and after use, other confusing and unpleasant aspects of the system were revealed. Extensive use of the system and observation of other's use revealed that some procedures were confusing, tedious, inefficient, and/or incongruous.

With the original design, the user immediately encountered tedium and frustration in trying to learn how to use the system. Although the user was given the opportunity to view an explanation on how to use the system, that explanation contained very little information as to what the user could expect or how to use the system. The explanation focused mainly on the underlying structure and the development of the system. The little information that may have been helpful to the user did not appear until the last screens of the explanation and was written using computer jargon. The explanation was long (there were eight screens in all) and after viewing the first several screens and finding no helpful information, users generally did not want to see any more. However, once the explanation was requested, there was no way to escape without going through all the screens.

The volunteers were also confused about when to use some of the options. In particular, they were not sure when to use CONSULT and when to use ANATOMY and MECH. Since they wanted the system to determine the anatomical diagnosis, the inclination was to use option ANATOMY. This, however, only allowed the users to input this information, rather than determining it for them.

Some of the most serious problems in the design occurred in the options CHANGE and RESTART. The option CHANGE allowed the user to change an answer that had been incorrectly entered into the system. Unfortunately, CHANGE did not let the user indicate directly what information needed to be changed and the change to be made. Instead, this time-consuming procedure displayed every question that had been asked, and required the user to indicate whether or not this displayed question was the one to be changed (see Figure 3). When the question to be changed was finally displayed, often the user would try to change the answer directly, forgetting to first reply to the question "Is this the question you want to change?". Attempting to change the answer before giving a positive replay to this question caused the system to "beep" and the screen to disappear and be rewritten, but gave no indication as to why the change was not accepted.

In changing answers related to the anatomical diagnosis, the user was asked at one point to input an "anatomy code". However, the listing of the codes was not made available to the user until many screens later, thereby making it impossible for the user to input the information. However, it was also impossible not to input some information since the system would not allow the user to proceed until a suitable answer was input.

After completing the CHANGE procedure, the users were informed that they would have to redo CONSULT. This was appropriate if the user had invoked CONSULT to determine the diagnoses, since a change in one answer would probably change the diagnosis. However, it was inappropriate and, in fact, incorrect to invoke CONSULT if the user had entered and changed the diagnosis through ANATOMY and/or MECH.

The option RESTART also caused problems. RESTART allowed the user to start the case over from the beginning;

```
==========================================================================
                        IIT-MRH STROKE EXPERT SYSTEM
Is this the question you wish to change? (enter Y or N)
--------------------------------------------------------------------------
What is the patient's level of consciousness?
1 - alert
2 - lethargic
3 - stuporous or comatose
> [current value = 1]




--------------------------------------------------------------------------




==========================================================================
```

Figure 3. Sample CHANGE screen from the original user interface. Note that the question to be answered appears in the upper window of the screen.

restarting the system caused a loss of all the data input by the user up to that point. The smallest problem with RESTART was one of inefficiency in that the system really did restart, i.e., it started users back at the "Welcome" screen and required them to reenter their name and the patient's name. A more serious problem associated with RESTART was that the system sometimes appeared as if it had gone berserk. After the RESTART option had been invoked, the user was asked to confirm the reinitialization of the system (this was important since reinitialization causes the loss of data). To confirm RESTART, the user would type in "y" (for "yes") and hit the return key. After doing this, the system would take approximately 10 seconds to reinitialize. The user was not told that there would be this delay, and in that ten seconds, the system would not respond to any input. Ten seconds is a long time to the user who is accustomed to having the computer respond within fractions of a second. Smith, Irby, Kimball, Verplank and Harslem (1982) remark: "It is disastrous to the user's model (his conceptual model, i.e., his formulation of the way the system works) when you invoke an action and the system does nothing in response. We have seen people push a key several times in one system or another trying to get a response. They are not sure if the system has 'heard' them or not." (p. 262). This is exactly what happened in this case. The users, after the system didn't respond to their "y" and carriage return, hit the return key again, retyped "y", hit the return key a few more times, and so forth, in order to get a response from the system. It should be noted that each reentered answer and each carriage return is stored by the computer as input for the questions and procedures that follow. Since after reinitialization the system proceeded back to the very beginning, those carriage returns and "y"s were answers to questions. Specifically, a carriage return was the default value to the question "Would you like an explanation on how to use the system?"; in this case, the default value was "no" and the system proceeded to the next requests, which were for the user's name and the patient's name. Either a "y" or a carriage return was a sufficient answer for these, and the system proceeded to the main menu. A carriage return or a "y" were not acceptable input at the main menu. Unacceptable input caused the system to beep and the screen to disappear and be rewritten. If the user had hit the return key ten times in the ten seconds it had taken the system to respond, the user saw the Welcome screen and the requests for names print and, without allowing the user to input the information, disappear, then saw the main menu print, disappear, and reprint and disappear seven times, beeping each time. There was no way for the user to stop this from happening once the extra keystrokes had been entered. Unfortunate users who experienced an episode like this (it was a common occurrence) thought that they had broken the computer.

After these flaws had been identified, it was apparent that the user interface had to be redesigned.

The Redesign: Flow of the Interaction

In the human factors literature today, attention has been given to many aspects of the human-computer interaction. For example, the CHI (computer-human interaction) conferences on Human Factors in Computing Systems for the past several years have had sections on screen layout and design, physical interface devices, voice interfaces, knowledge-based interfaces, prototyping techniques, interface evaluation, user documentation, and programming. But one aspect that has received little attention is the flow of the interaction between the user and the computer. This is a necessary part of all systems, but except in case studies of developed systems (e.g., Smith et al., 1982) it is not mentioned in the literature.

The ordering of events in a system can have a major impact on the user's interaction with the system. The flow of the interaction can affect the amount of time and the number of keystrokes needed to perform a task, the number of errors made, the number of (and the amount of time spent making) corrections and recoveries, and subjective evaluations of the system. Most of the flaws in the Stroke Consultant's original design were flaws in the flow of the interaction. Some examples of this which were mentioned above include the display of the list of anatomy codes many screens after the user required this information, not allowing the user to escape from the introductory explanation, and requiring the user to view every question already answered in order to change an answer.

Working from the original design, the redesign of the flow of the interaction went through approximately five iterations. The major changes to the system included the deletion of some of the options available to the user, the addition of new options, the reordering of certain features, and the addition of system checks. System checks are internal checks by the system for information that guides the flow of the interaction. These checks protect the integrity of the data in the system, reduce the amount of input required of the user, decrease the occurrence of errors, and make it easier for the user to correct errors when they do occur. Each of the changes will be discussed in the following paragraphs. The final design of the flow of the interaction can be seen in Appendix A, and the screen layouts for each of the screens referred to in the flowchart can be seen in Appendix B.

The flow of the interaction begins as in the original with the welcome screen and the optional introductory explanation of the system. However, instead of requiring the input of the patient's name and physician's name, the system proceeds directly to the main menu. Input of the names is delayed until the user indicates what function the system is to perform. Delaying the name input makes it easier for the user to get information on several patients during a single session.

The options available to the user in the main menu have been changed from the original design. In the original design, the options were CONSULT, ANATOMY, MECH, TEST, TREAT, REPT, CHANGE, RESTART, SAVE, RESUME, and QUIT. In the redesign, the main options are CONS, SAVE, SUM, REPT, and QUIT (HELP and LIT are two of the auxiliary functions and will be discussed later).

Although seven options (ANATOMY, MECH, TEST, TREAT, CHANGE, RESTART, and RESUME) were removed from the main menu, no components were removed from the system. In the original design, CONSULT gave the user access to PAL and MOS; ANATOMY, MECH, TEST, and TREAT gave the user access, respectively, to the components ANAT, MECH, CONFIRM, and MANAGE. In the redesign, the user is given access to all of these components through CONS. This design was implemented so that the user would not be confused about when to use each of the options on the main menu. Also, the original design implied that any of the options could be invoked at any time. This was not the case, however. The diagnostic/treatment process proceeds in a specific order and the system does not allow deviation from that order. In the original design, invoking the option TEST before determining the mechanism of the stroke was possible, but it was not allowable (i.e., the system informed the user that the mechanism had to be determined first and the user was returned to the main menu). In the redesign, CONS takes the user through each diagnostic/treatment component in the appropriate sequence.

The RESUME option has also been incorporated into CONS; CHANGE has been redesigned as an auxiliary function called COR (<u>cor</u>rection); and the redesign has removed the need for a separate, and very confusing, RESTART option. A new option, SUM (<u>sum</u>mary), was added to the main menu.

<u>CONS: Starting a case</u>. After the user enters the command CONS, the system checks to see if a patient's name already exists in the dynamic data table. (The dynamic data table is the Stroke Consultant's working memory; it holds the data on the case in progress.) A patient name may already exist in the system if CONS was not the first

option the user selected. For example, the user may have begun by getting a summary of a previous case (option SUM) and now wants to resume that case (CONS). Since the user will have had to identify the patient in order to get the summary, the patient's name would already exist in the system and the user should not have to enter it again.

If a name does not exist in the system, there are two possibilities: the user wants either to start a new case or resume a consultation on a previous case. To start a new case, the user is asked to enter the patient's name and the physician's name, and then consultation begins. To resume a previous case, the name of the patient can be entered directly or the user can see a list of the patients whose cases are on file and resume the consultation by entering the patient's number. If the name is entered directly, the system searches for that file. If the file is found, the consultation resumes; if it is not found, the user is given the opportunity to enter the name again, either directly or through the patient list. The patient list has been provided as an option for several reasons. It minimizes the amount of typing required of the user, it is useful if the user has forgotten the correct spelling of the patient's name, and it can be used to verify that the to-be-resumed case does exist on file. In the original version, there was no way to determine which cases had been saved, and more importantly, there was no way to determine the (user-selected) filename which was needed in order to resume a case. Also, in the the original design, a filename entered by a user that could not be found by the system caused the entire program to abort (i.e., the user was thrown out of the Stroke Consultant and into the computer's operating system); the user then had to re-enter the Stroke Consultant and start over from the beginning.

If a name does exist in the system, there are three possibilities: the user wants either to continue the case that exists in the system, start a new case, or resume a previous case. To continue the case that exists in the system, the user only has to indicate that that is what is to be done and the consultation resumes; no other input from the user is required. If the user indicates that a new case is to be started or a previous case is to be resumed, the system first checks to make sure that the case that exists in the system has been saved. If it has not, the user is given the opportunity to save the case. This is important since the dynamic data table can only hold the data of one case at a time. Starting or resuming a case destroys the data of the case currently in the system.

<u>CONS: The consultation</u>. After the user has indicated that the consultation involves a new case and has entered

the patient's name and physician's name, the system is ready to begin the first step in the diagnostic/treatment sequence: determining the anatomical location of the stroke. Because both the ANAT component and the PAL component are included in the system, the user can either input the anatomy directly or let the Stroke Consultant determine the anatomy. The user is given this choice, not through main menu options (as in the original design), but in the first question of the consultation. The user is asked "Have you determined the anatomical location of the stroke?". If the user answers "yes", the component ANAT is invoked; if the user answers "no", PAL is invoked.

When ANAT is invoked, a numbered list of 48 anatomical locations is displayed. The user indicates the anatomy of the stroke by entering the number label of one of the anatomical locations. After doing this, the system confirms the entry by displaying "The diagnosis for the anatomical location of the stroke has been recorded as [the user's selection]". The system then proceeds to the next step in the diagnostic process, i.e., determining the mechanism of the stroke.

When PAL is invoked, the user is asked a series of multiple-choice questions. Diagnoses in PAL are determined by working through a decision-tree; the response to each question directs the system down a path of the tree to a diagnosis (see Figure 4). After the user has answered all the questions needed to determine a diagnosis, but before the diagnosis is given, the user is presented with a list of the responses which were given to the PAL questions. The user is asked to check the list for errors. (This list is relatively short - the number of questions PAL needs to ask to determine a diagnosis ranges from 3 to 14 with an average of 7.6.) If the list contains errors, the user indicates the incorrect items and the system asks those questions again and then asks any further questions needed to determine the diagnosis. (Further questions may need to be asked because each path in the decision-tree contains a different set of questions, and an incorrectly answered question causes the system to follow an incorrect path. After correcting the item, the system can proceed down the correct path, but the user must answer the questions in the correct path that were not asked in the incorrect path.)

(If more than one question has been answered incorrectly, PAL, in some cases, could determine the correct diagnosis without requiring the user to correct all of the items. For example, in Figure 4, the user incorrectly indicated that the patient had no visual field deficits but did have nystagmus when in fact the patient had visual field deficits but no nystagmus. After correcting the question on visual field deficits, the path

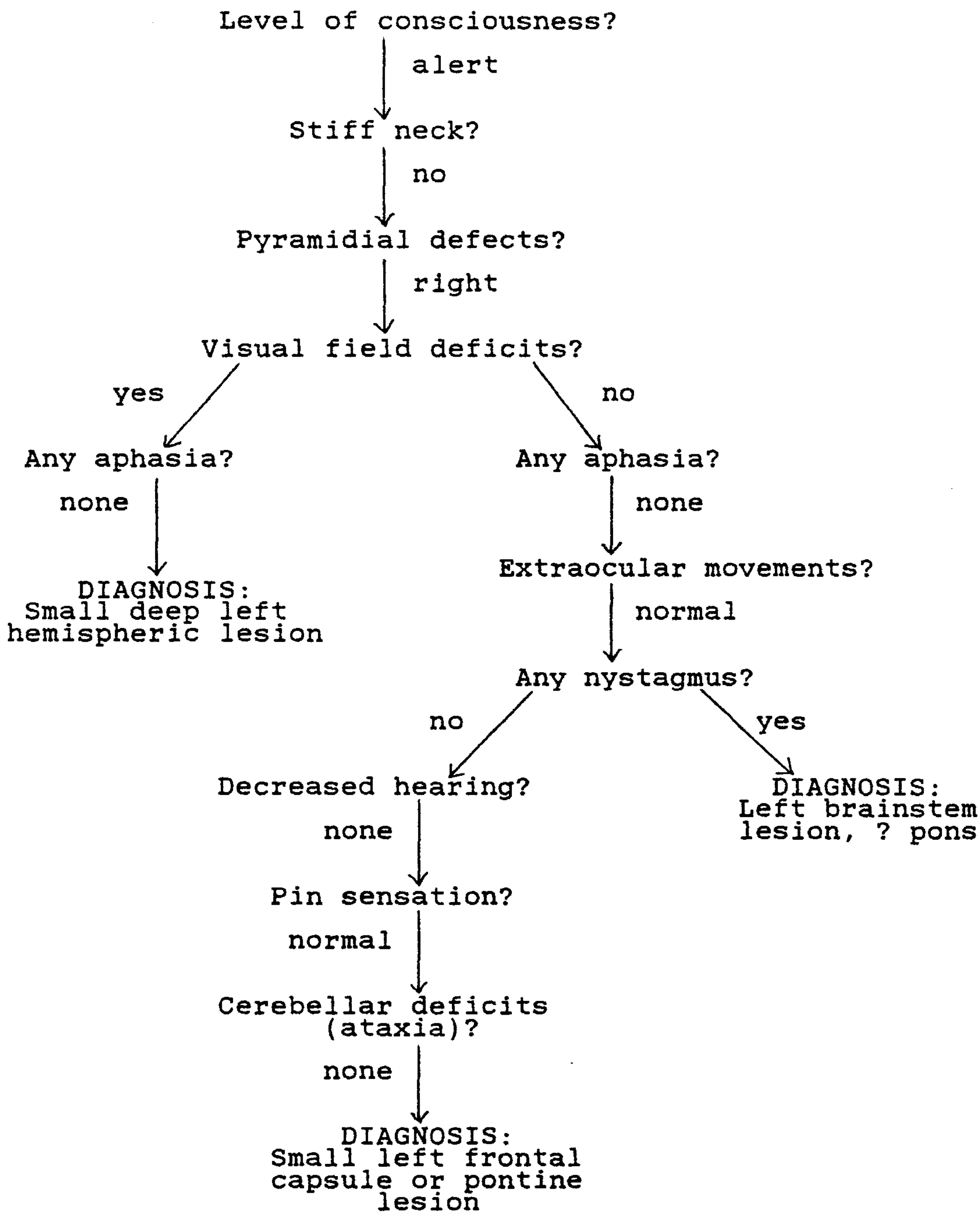

Figure 4. Several paths of the PAL diagnostic tree.

leading to the correct diagnosis does not ask about nystagmus. Along this path, the system does not need information about nystagmus to determine the anatomical location, and in effect, ignores any information on nystagmus that exists in the system. Although correcting this information is not necessary for the system to reach the correct diagnosis, it is necessary for the user to make these corrections. It is important that the user not be left with the impression that the decisions being made are based on incorrect information that exists in the system. The interface has been designed so that the user can correct all the information that has been indicated to be incorrect.)

When all PAL answers are correct, the diagnosis for the anatomical location of the stroke is presented and the system continues on to next step in the diagnostic process, determining the mechanism of the stroke.

The flow of the interface for finding the mechanism of the stroke is similar to that for finding the anatomical location since the user again has the choice of inputting the information directly (MECH) or having the system determine it (MOS). CONFIRM and MANAGE should be handled in a similar way, although these components have not yet been developed and it is not clear what their requirements will be. After working through the four steps of the consultation (anatomy, mechanism, confirm, and manage), the user is informed that the consultation has been completed and is then returned to the main menu.

The confirmation and feedback procedures that have been incorporated into the system serve two important functions. First, providing feedback to novice or infrequent users can give them confidence and make them comfortable with the system by allaying fears about the system's reliability (Shneiderman, 1980). Second, because the Stroke Consultant makes decisions that are concerned with human health and life, it is imperative that the data upon which those decisions are made be error-free. Many of the correction features that were added to the system work in conjunction with these feedback screens.

<u>CONS: Resuming a case</u>. After the user has indicated the case to be resumed and the system has found the case on file, the patient's full name and the attending physician's name are displayed. This display confirms the entry and allows the user to correct either of the names. The system then goes through a series of internal checks, searching for the place at which the consultation had been suspended. The next display (which follows the display of the patient's and physician's names) is a summary of the information already known about the case: this could

include the anatomical location of the stroke, the mechanism of the stroke, the laboratory tests requested, and the test results (if the management of the stroke is also known, then all four steps in the consultation have been completed, and this is indicated to the user and the user is returned to the main menu). This display, like the other confirmation and feedback screens discussed, allows the user the opportunity to correct any misinformation in the system. After this display, the system proceeds with the consultation from the point at which it had been suspended.

SAVE. When the option SAVE is invoked, the system first checks to verify that a case exists in the dynamic data table. A case is assumed to exist if a patient's name can be found, even if no other data on the patient exists in the system. If the case is saved, this is indicated to the user; if no case exists and there is nothing to be saved, then this is indicated to the user. The user is then returned to the main menu.

SUM and REPT. The option SUM will produce a summary of the information determined during the consultation, i.e., the anatomical location and mechanism of the stroke, the test results, and the treatment plan. REPT will produce a more complete case report of the patient. The procedures for SUM and REPT are almost identical and, therefore, will be discussed together.

Upon invoking SUM or REPT, the system checks the dynamic data table for the name of a patient. If no name exists in the table, the user must indicate the name of the patient about whom the summary/report is desired. The user can enter the name directly or through the patient list (as in CONS). If a name does exist in the table, the user will want either a summary/report of the case presently in the system or a summary/report of a previous case on file. If the user wants a summary/report of a previous case, the system checks first to see if the present case has been saved, gives the user the opportunity to save it if it has not been saved, and then has the user input the patient's name either directly or through the patient list.

Once the case for which the summary/report is to be generated has been established, the system checks to verify that the anatomical location of the stroke is known. Finding the anatomy of the stroke is the first step in the diagnostic/treatment sequence; if the anatomy is not known, then the only complete information on the patient would be the patient's name and the attending physician's name. This is not enough information to warrant a summary or report. In this event, the system displays the patient's and physician's names and indicates that nothing else is known about the patient. The user is then returned to the main menu. If the anatomy of the stroke has been determined, a hardcopy case report is printed (for REPT), or (for SUM) a summary of the consultation is displayed on the terminal screen and the user is given the opportunity to have a hard copy of the summary printed. The user is then returned to the main menu.

QUIT. When the user invokes the option QUIT, the system checks to see if the case in the dynamic data table has been saved and, if it has not, gives the user the opportunity to save it (without requiring the user to return to the main menu). The user is then thanked for using the Stroke Consultant, and is returned to the computer's operating system.

The auxiliary functions. In addition to the five main options, there are six auxiliary options available to the user. These are HELP, STOP, COR(rection), DEF(ine), WHY, and LIT(erature reference).

HELP. HELP is available to the user at any time when he or she is working with the Stroke Consultant. The user's progress through the system is monitored so that when HELP is invoked, the information that is presented is specific and appropriate to the main task on which the user is working. After this information is presented, the user is given the opportunity to see a list of other topics for which help is available. To view one of the other help scripts, the user enters the number label of the topic from the list. After leaving HELP, the user is returned to the main task at the point at which the task had been suspended.

STOP. The option STOP is an escape procedure; it allows the user to leave any procedure at any time and return to the main menu. This feature is particularly important when doing a consultation, since CONS takes the user through the diagnostic/treatment sequence uninterrupted, even though in most cases the user will not be able to proceed uninterrupted through the entire sequence. For example, after determining the anatomical location and mechanism of the stroke, the system requests laboratory test results to confirm the diagnoses. Since it is unlikely that the user will have the test results at the same moment that the system initially requests them, the user will have to leave the consultation, save it, and resume it at a later time.

COR. COR is the correction procedure. It is available only at certain points during consultation, usually in conjunction with the confirmation or feedback screens.

COR is available when the user inputs the anatomical location of the stroke through procedure ANAT. After the user has indicated the anatomy, the system displays a screen confirming the entry. COR is available at this point. If the anatomy is incorrect, the user can invoke COR, and the system returns the user to ANAT so that the correct entry can be made.

COR is also available when the user has the Stroke Consultant determine the anatomy of the stroke. As was described previously, determining the anatomy has three major parts: the user answers the questions presented by PAL; the system displays a response list at which time the user can correct any errors (this is part of the procedure - it is not invoked by COR); and, when all responses are correct, the system displays the diagnosis. Although this second part is a built-in correction procedure, the user does not have to continue working through PAL until this procedure is made available in order to correct an error. If the user is working through PAL and realizes that an error has been made, COR can be invoked and the response list (i.e., the built-in correction procedure) will be displayed immediately. This allows the user to correct any error as soon as it is realized, rather than requiring the user to proceed in the PAL tree through an incorrect path. After correcting the error, the user is returned to PAL at the next question in the correct path of the tree.

When a case is resumed, COR is available to the user at all the confirmation and summary screens. After the user has indicated the case to be resumed, the system confirms the entry by displaying the patient's full name and the attending physician's name. If either (or both) of these is incorrect (e.g., misspelled), the user can invoke COR and the system will ask for the correct name(s). The system then reprints the confirmation screen with the corrected names.

After displaying the names, the system displays a summary of the information already known about the case (anatomy, mechanism, test results). If any of this information is incorrect, COR can be invoked at this point. Once in COR, the user is first asked to clarify the area of information that is incorrect. The user is then warned that changes to one area of information may cause changes to other areas (e.g., a change in the diagnosis of the anatomy of the stroke may change the diagnosis of the mechanism of the stroke) and that, after changing the incorrect information, the system may request additional data to make sure that all information in the system is correct. (The clarification and warning is unnecessary if anatomy is the only information known.) The consultation then begins in the appropriate component system. For example, to correct the anatomy by entering it into the system directly, the user would start the consultation in ANAT; to correct the anatomy by having the system determine it, the user would be started in PAL.

DEF and WHY. The auxiliary functions DEF (define) and WHY are available only at certain points during CONS. DEF defines the terms used in CONS questions and explains the criteria to be used when choosing an answer to the question. WHY provides an explanation of the reasoning the system is using (this is similar to the WHY command in Shortliffe's [1976] MYCIN). As with HELP, the user's progress through the system is monitored so that information specific to the task at hand is generated when these functions are invoked. After the DEF or WHY information has been presented, the user is returned to CONS at the point at which CONS had been suspended.

LIT. LIT provides explanational support, literature references, and abstracts of journal articles. LIT can be invoked either from the main menu or from CONS. When LIT is invoked from CONS, the system first displays an explanational script (e.g., to explain the treatment that the system is suggesting), which, like HELP, DEF, and WHY, is linked to the user's progress in the system so that the script is specific to the topic at hand. After this script is presented, a list of literature references on the topic is displayed, and the user is able to view the abstracts of these references by entering the number labels of the references. After exiting from LIT, the user is returned to CONS at the point at which CONS had been suspended.

LIT is slightly different when it is invoked from the main menu. Because it is not linked to a specific problem or topic, it does not display an explanational script. Instead, it first displays a list of topics on which the system has available references. The user indicates the desired topic by entering its number label. A list of references is then displayed and, as before, the user is able to view the abstracts of the references by entering the number labels of the references. In this mode, the user is returned to the main menu after leaving LIT.

The Redesign: The Use of Psychological Principles in Screen Design

The preceding section described the redesign of the flow of the interaction from each of the options available to the user. In this section, the design of the screens and the factors that influenced the design are described. "Screen design" refers to the design of whatever the user will see on the terminal screen. This is a broad area and, as such, will be described in three parts: screen layout, transaction selection and data entry, and user guidance and support. (The screens of the Stroke Consultant can be seen in Appendix B.)

Screen layout. The screen is divided by dashed lines into three windows. There are three types of information to be displayed to the user: the main task, auxiliary explanational information, and orienting information. Since all three types of information may be displayed simultaneously, it is important to keep each type of information distinct from the others. Partitioning the screen into windows, with each window reserved for one type of information, keeps the three information types distinct and clearly perceptible to the user (Miller & Thomas, 1977; Smith & Mosier, 1984; Stewart, 1980). Partitioning the screen also enhances usability since locating information is faster and easier when it is presented in a consistent physical location (Streveler & Harrison, 1985; Teitelbaum & Granda, 1983).

The first window consists of the top two lines of the screen and is used to display the goal toward which the user is working. For example, during a consultation the header might read "Determining the anatomical location of the stroke"; if the user then invoked one of the auxiliary functions, a second header would be added so that the window displayed the goals of both the suspended primary procedure and the secondary procedure in use. It has been found to be important to provide the user with this type of orienting information especially when the user will be switching tasks and/or suspending and resuming tasks (Bannon, Cypher, Greenspan & Monty, 1983; Kraut et al., 1983).

The second window consists of fourteen lines in the middle of the screen. It displays the tasks invoked by the main options.

The third window is used to display the auxiliary functions, is located at the bottom of the screen, and is expandable. When no auxiliary function has been invoked, the third window displays a list of the available auxiliary functions in the bottom six lines of the screen. When one of the auxiliary functions (other than STOP) is invoked, Window 3 doubles in size by expanding up seven lines into Window 2 and displays the requested information. This allows more information per window screen to be displayed. Although the last seven lines of Window 2 are written over when Window 3 expands, the top seven lines remain as they were when the auxiliary function was invoked.

There are several advantages to locating the auxiliary functions in a separate window. First, a list of the available auxiliary functions can be kept displayed while the user is working on the main task. This list serves to remind the user of the functions available and how to access them and, therefore, reduces the amount of information the user needs to remember when using the system. Also, since some of the functions are not available at all times, this list serves to inform the user of the functions that are available at any particular time. Second, by presenting the auxiliary information in a window separate from the main task, interference in the main task is minimized (Bannon et al., 1983). It is easier for the user to suspend and resume tasks without forgetting the main goal or the reason auxiliary information was requested. Third, because part of the main task remains displayed in Window 2, any fear the user has of getting lost in the system or of not being returned to the same place in the main task after requesting auxiliary information is minimized (Bannon et al., 1983).

Transaction selection and data entry. After considering the needs and abilities of the users, the most appropriate methods of transaction selection and data entry were considered to be menus and question-and-answer formats. With a menu, a set of options is presented and the user selects one of them; with a question-and-answer format, the user is prompted with a question and must fill in the appropriate response.

Several considerations led to the use of menus and question-and-answer formats. First, the interface needed to be designed for users with no prior computer experience. Second, any particular intern or house physician will be an infrequent user of the system; therefore, memorization of the available options and the command words to invoke them would be impractical and undesirable. It is generally agreed (e.g., Bailey, 1982; Norman, 1983) that menus are the most useful dialogue mode for the beginning or infrequent user. They are easy to learn, allow the user an easy way to explore and become familiar with the system, and require very little prior knowledge or memorization to use; unfortunately, menus can be very slow to use and errors often lead to a legal command and action, after which it may be difficult for the user to determine what happened and how to correct the error. These disadvantages can present serious problems for some systems. However, in the Stroke Consultant, most of the menus are brief and can be displayed and searched quickly, and if an error does occur, orienting information which indicates where the user is in the system is always displayed in Window 1 and the command STOP can be used at any time to return the user to the main menu.

A third consideration which led to the use of menus was that menus mimic the stroke service forms now in use at several hospitals. Physicians have become accustomed to recording medical information in discrete categories such as those presented in the multiple-choice menus, and some of the questions and categories used in the Stroke Consultant are the same as those used in the forms. In effect, the user's present methods of recording patient data were transferred to the system in the form of menus. This type of transfer of knowledge has been shown to reduce errors when using a system (Bailey, 1982).

The fourth consideration was that, when working with the system, the users will be under stress and will be switching their attention back and forth between the patient and the Stroke Consultant. Research has shown that stress and anxiety can impair memory (Hockey, 1979; Lazarus, 1952; Warburton, 1979), and Hockey (1979) has shown that, in dual task situations, the task that is given less attentional priority is the task that suffers most the effects of stress (presumably, working with the Stroke Consultant would have less attentional priority than examining and treating the patient). Under these circumstances, the least cognitively demanding methods of data entry are menus and question-and-answer formats. In addition, the effects of stress could affect interaction initiation and data entry. It has been reported that stress can cause increasingly disorganized activity (Lazarus, 1952), selective inattention to information (Easterbrook, 1959; Hockey, 1979; Warburton, 1979), and rigid problem-solving behaviors (Cowen, 1952), all of potentially serious consequence in the diagnosis and treatment of illness. Rather than giving the user control over data entry, the system has been designed to initiate all data entry. This maintains organization and focus during the interaction, and entry of data necessary for the task is assured (and, of course, the system does not have the capability to ignore data or to forget to consider possible diagnoses and treatments).

Finally, it was important that the system work quickly and that potential errors be minimized. Although normally the use of menus is contraindicated when fast system performance is required, in this case the use of menus is faster and more efficient than giving the user control over data entry (e.g., through use of a command language) and requiring the entry of all available medical information. With the use of system-initiated menus, the system requests only the data needed to determine a diagnosis or give advice (e.g., PAL needs only an average of 7.6 questions to determine the anatomy of the stroke). In addition, data can be entered very quickly with menus, without the problems of misspelled, incomplete or unintelligible input (Miller & Thomas, 1977). Data entry from the menus is made by keying the selected answer's number label. Numbers were chosen for labels instead of letters because numbers are easier for nontypists to find on the keyboard. Transactions from the main menu are selected with three-letter abbreviations or four-letter words. Since the menu options include QUIT and HELP, it was felt that the user should be able to enter the words for these actions instead of trying to remember the number labels that would invoke them. The three-letter abbreviations have mnemonic value and an unwanted option is less likely to be accidentally invoked with a three- or four-letter code than with a one-letter code.

Consistency has been the watchword of user interface design. A consistent system is easier to learn, remember, and use and is less prone to error than an inconsistent system (Barnard, Hammond, Morton & Long, 1981; Mooers, 1983; Shneiderman, 1979). Because consistency is very important, all possible paths of PAL (the anatomical diagnosis procedure) were tested in order to discover inconsistencies in question presentation. In addition to several minor inconsistencies (e.g., answer alternatives that read "1. No; 2. Yes" instead of, as in all other questions, "1. Yes; 2. No"), a major flaw was discovered. When the PAL questions were answered as if in regards to a healthy, normal person (i.e., the responses indicated that there was nothing wrong with the person), PAL diagnosed the person as having a lesion of the left parietal lobe. Sometimes user interface evaluation reveals more than just the flaws in the user interface.

User guidance and support. The functions that provide guidance and support to the user's interaction with a system are often thought of (and in this system are called) auxiliary functions of that system. However, these "auxiliary" functions can have a significant impact on the efficient use of the system and the user's attitude toward the system (Smith, 1981). Magers (1983) has shown that good user guidance can result in faster performance, fewer errors, and greater user satisfaction.

One user guidance feature that has been shown to be beneficial, particularly to infrequent and inexperienced users, is the provision of status or orienting information. In the Stroke Consultant, Window 1 is reserved for messages that indicate the primary and secondary goals towards which the user is working and, therefore, keep the user oriented within the system. This orienting information is displayed throughout the user's interaction with the system.

User guidance and support in the Stroke Consultant are also provided by HELP, DEF(ine), WHY, LIT(erature reference), and, of course, the introductory instructions to the system. O'Malley, Smolensky, Bannon, Conway, Graham, Sokolov & Monty (1983) have suggested that help files should contain three types of information: basic information for quick reference, task specific help, and full explanations containing the more detailed and abstract information about the system and its functions. The Stroke Consultant has been designed to monitor the user's progress through the system so that task specific information is presented first when the user invokes one of the help files (i.e., HELP, DEF, WHY, LIT). This "cued" mode of presentation has been reported by Rouse and Rouse (1980) and Paxton and Turner (1984) to be more useful and satisfactory than the presentation of either general information or detailed but voluminous information. After the task specific information has been presented, the user is given access to the other help information.

Barr and Feigenbaum (1982) report that the inclusion of procedures that explain and justify the system's reasoning is important for the acceptance of medical systems by physicians. In the Stroke Consultant, the auxiliary functions WHY and LIT have been designed to provide this needed information. WHY provides an explanation of the reasoning the system has used to reach a particular diagnosis; LIT provides references to the research literature. LIT, in fact, plays a double role in the system: it provides support for the diagnoses and treatment recommendations, and it also functions as a literature reference source unconnected with the system's diagnostic/treatment functions; in this mode, users can obtain information on whatever aspect of stroke they need. Geschwind (1985) has discussed physicians' current haphazard methods of searching for relevant information and has emphasized the need for this type of computerized literature retrieval system in hospital wards.

Discussion

This chapter has described the development and design of the user interface for the IIT/MRH Stroke Consultant. The flow of the user interface has been described in detail, the screen designs have been presented in Appendix B, and the factors that have influenced the design of the interface have been discussed. The user interface component of the Stroke Consultant has been coded to implement this design and has been added to the system (Streeter, 1986). However, the user interface is not yet complete. Some of the components planned for inclusion in the system (e.g., CONFIRM, MANAGE) have not yet been fully developed and it is not clear what the requirements of these components will be. Although the flow of the user interface has been designed to accommodate these components, the flow of the interface within each of these components and, of course, the screens for these components could not be designed.

In addition, changes to the redesigned interface are already in the discussion stage. For example, a decision must be made as to whether to incorporate a component that would remove from the system cases that have been saved. A decision must also be made as to who should have access to this component; for example, it must be decided whether the casual user should be allowed to remove data from the system, or whether only designated users or the program developers and knowledge engineers should be given this access.

Changes to the component REPT are also in the discussion stage. REPT has been designed to generate a case report with more complete information than that produced by SUM (SUM produces a summary of the information determined during the consultation). However, in its present design, the system does not provide a way for the user to input the detailed patient information needed by the report generator to produce a complete, detailed report. Whether the procedure to input these data should be incorporated into REPT or whether a new component should be developed for this purpose has not been decided.

Still to be written for inclusion in the system are the HELP, DEF, WHY, and LIT files and the introductory instructions to the system. Some of the information needed to write these files must be provided by the stroke expert involved in the development of the system. For example, the knowledge engineer must select the literature references and provide the explanational scripts that constitute LIT, and also must provide the explanational scripts and definitions that constitute DEF.

A frequent complaint about explanations, instructions, and messages that appear in computer systems is that they are not written clearly and understandably (Chapanis, 1965; Shneiderman, 1980). It is useful to consult the literature on the comprehension of written information for research findings that can aid in the composition of these materials. Miyake and Norman (1979), for example, reported that comprehension of instructional material was better when technical language was avoided, and that concepts were best understood when readers were given concrete examples first, and then later, abstract explanations. At the paragraph level, Kieras (1980) advised that paragraphs should be written with the important thematic information at the beginning since he found that initial mention appeared to guide the reader's processing of the paragraph. At the sentence level, one research result that has become an often quoted guideline is that the use of negatives reduces comprehension (Schwartz, 1971; Wason & Jones, 1963). Another often quoted guideline has been that active sentences are easier to comprehend than passive ones; Slobin (1966), however, found this to be true only under some semantic conditions involving the reversibility of the passive sentence. In two studies of particular importance when writing directions, Clark and Clark (1968) reported better comprehension when directions appeared in correct temporal order than when they did not, and Dixon (1982) reported better sentence comprehension when the action information was presented first and was then followed by the condition information.

When writing instructions and explanations, the reading level of the users also should be considered: if the writing is at a level above the abilities of the users, it may not be understood, and if the writing is far below the users' abilities, it may appear to be patronizing. Readability formulas such as the Kincaid (Kincaid, Fishburne, Rogers, & Chissom, 1975) and the Automated Readability Index (Smith & Kincaid, 1970) are available to estimate the reading difficulty of written material. Instructions and explanations should be measured with one of the available readability formulas and revised until they are written at an appropriate (previously determined) reading level.

Evaluation

In the preceding paragraphs, the changes and additions that have been planned for the user interface were discussed. In addition to implementing these changes (and any others that may be necessary), the user interface must be evaluated.

An evaluation is important so that problem areas in the user interface can be identified. Any problem in the interface, of course, requires attention, but Lund (1985) has specified several potential problem areas on which the evaluation might focus. First, Lund has suggested that the evaluation should determine if the interface anticipates the user's train of thought. If the system is to be easy to use, it should not require users to rearrange their customary patterns of thinking. Second, if users get lost in the system, exactly what led them in the wrong direction should be identified. Third, during the evaluation, a problem needs to be noted the first time it is encountered, before the user has a chance to get used to it. If an initially confusing situation is encountered several times, it may become familiar to the user. Although the user may have been able to figure out how to handle the situation, the initial confusion should be eliminated. Fourth, it should be determined whether specific features of the system (such as the help files) are used, and if so, it should also be determined how often they are used and whether they are used at appropriate times.

Evaluation methods tend toward the utilization of observation rather than experimentation. Usually, a group of typical potential users are given a set of simple tasks and are observed as they use the system to complete them. The users may be asked to "think aloud" while they are working (Lewis, 1983; Newell & Simon, 1972), and sometimes the interaction is videotaped (Lund, 1985); at the very least, users are always interviewed after the session.

There are several disadvantages to videotaping users and asking them to "think aloud" while working. These procedures create an artificial situation and may make the users self-conscious and nervous. In addition, analysis of the videotapes is time-consuming, because context is often necessary to interpret what has happened. Finally, it is not possible to compile any meaningful data for timed performance since the users are asked to verbalize their thoughts during the session.

Though these disadvantages are of legitimate concern, the advantages of these methods make them worthwhile techniques for interface evaluation. For example, a videotape allows an in-depth analysis of the session that cannot be achieved by observation and note-taking alone.

Determination of which features were used (and how often and in what context) can easily be determined from a videotape. Also, watching a user's actions on the videotape and listening to the accompanying comments makes it easy to see where (and why) the user got off on a wrong track. These methods also capture problems that are confusing at first but later become familiar. This type of problem may not be mentioned in an interview (since, after the problem has been figured out, each subsequent encounter is not a problem and, therefore, the initial confusion may be forgotten by the time of the interview), but is revealed in the analysis of the videotape. Finally, since problems with the interface become obvious with the first few users, these methods can minimize the number of users needed for the evaluation while they provide a wealth of information about the interface.

Currently, the components of the Stroke Consultant that are ready for use are in the process of being transferred to the AT&T 3B2/300 computer that will be installed at Michael Reese Hospital. The evaluation of the interface can then be conducted at Michael Reese with the physicians and students associated with the hospital. Unfortunately, initial tests of the interface must be artificial since they will not be conducted during emergency situations with actual stroke patients. Instead, users will be given a set of tasks to complete involving past patients. This set of tasks might, for example, include the following:

1. begin a new case for patient A.B.; diagnose the anatomy and mechanism of A.B.'s stroke
2. save the case of A.B.
3. print out a summary of the case of patient C.D.
4. find references describing the risks associated with the use of anticoagulent medication for thrombophlebitis
5. resume the case of patient E.F.
6. change the anatomy for case E.F. to "right occipital lesion"
7. leave the Stroke Consultant

(This set of tasks would require the user to use four of the five options from the main menu of the system and at least three of the auxiliary functions.) The patient information that would be needed to determine diagnoses and that would normally come from an examination of the patient must be presented to the user (during the evaluation) in some other format. For example, the user might be given a detailed case report or patient file in which the needed information would be provided.

Videotaping the users' interactions with the Stroke Consultant is desirable, but may not be feasible. If videotaping is not possible, audiotaping the users' interactions may be helpful if the users are willing to verbalize their thoughts. Procedures can also be added to the system that record the sequence of input and output during the interaction. This record would provide information about the features of the system that were used, including how often they were used and in what context. The record would also reveal the errors that occurred, from misspelled words to the attempted use of a wrong option. If users are reticent in verbalizing their thoughts, the record should also include the time of each output-input interval. A long interval between system response and the next user input might indicate a point at which the user became confused or was unsure as to how to proceed.

The initial tests of the interface will not provide information about how users interact with the system in the emergency room. However, they will provide initial data on the ease with which the system can be learned and used; they allow videotaping, audiotaping, and/or the "think-aloud" approach to be used during the session; and they allow the user to concentrate totally on using (and criticizing) the system rather than simultaneously attending to the care of a patient.

HARDCOPY OUTPUT INTERFACES FOR THE STROKE DATA BANK

Computer-Generated Patient Reports

Attempts to use computer technology to decrease physician workload and improve information flow to the physician have been increasing. When making decisions, the physician draws on both clinical knowledge and specific information regarding the patient, including information derived largely from the medical record. Whiting-O'Keefe, Simborg, Epstein, and Warger (1985) report that, as a source of information, the medical record has been criticized because of problems of availability, retrievability, legibility, and organization. In an attempt to solve these problems, various forms of computer-generated case summaries have been developed (Bischoff et al., 1983; Li, 1985; Stern, Lincoln & Robinson, 1975; Whiting-O'Keefe, et al., 1985).

Whiting-O'Keefe et al. (1985) have developed a time-oriented computer-generated chart that is used with a medical record system (a databank). They report that physicians can predict their patient's future symptom changes and laboratory test results more accurately with the computer-generated chart than they can using only the standard medical record. Whiting-O'Keefe et al. (1985) concluded that physicians' predictive accuracy was increased by the computer-generated chart because the chart provided a legible summary of most relevant and important clinical information presented in a well-defined and predictable format, and that large amounts of low-priority information that are of little relevance to the decision process had been eliminated.

Bischoff et al. (1983) describe the integration of a computer-based oncology protocol management system into a clinical setting. After the system had been in use, some physicians requested that the system generate a progress note for the patient's visit. After including this feature in the system and installing a smaller printer to prepare the notes in triplicate, use of the system was immediately made more desirable because this capability saved the physician the time required to write or dictate the note. This feature was also beneficial in helping to maintain the integrity of the data in the system: because the quality of the progress note was dependent on the data entered into the system, physicians were more likely to enter relevant data completely and accurately.

Computer-generated reports appear to be acceptable to physicians, may be beneficial during the decision-making process, and provide a good incentive for physicians to use computerized systems in their practices and to be involved in and contribute to medical databanks which are necessary for some types of research. However, these computer-generated reports are being developed in much the same way that computer terminal user interfaces have been developed in the past, that is, without the careful consideration and evaluation needed to establish the suitability of the design. A computer-generated report is a hardcopy interface between the computerized system and the user. This area of user interface design (i.e., hardcopy computer-to-user interfaces) has been neglected. No research has been reported that has evaluated the suitability of the design of computer-generated output. In the present study, computer-generated patient case reports were developed for use with the Stroke Data Bank. These case reports were evaluated to determine the format most suitable for physicians' use.

The Stroke Data Bank

The Stroke Data Bank (SDB) was initiated in 1982 for the collection of information about the onset, symptomatology, clinical course, therapy, and outcome of patients who have suffered from stroke (Kunitz, Gross, Heyman, Kase, Mohr, Price & Wolf, 1984). Four clinical centers currently contribute to the databank: Boston

University, Michael Reese Hospital, the Neurological Institute (New York), and the University of Maryland. The SDB is supported by the National Institute of Health.

The SDB serves as a data source for clinical research. By systematically gathering information on a large number of patients, medical researchers hope to be able to address questions pertaining to stroke classification, evolution, diagnosis, and prognosis. For example, studies that will be accomplished using the SDB include the characterization of evolving stroke, clinical course and outcome of subtypes of stroke, identification of the complication-prone patient, and predictors of outcome. In addition, the SDB will provide data on the success rates of current treatments, describe the characteristics of patients receiving standard treatment, identify trends, and provide data on complications of surgical and medical treatments.

Physicians record patient information using a set of nineteen data collection forms. Each form covers a different aspect of the patient information. For example, separate forms cover the patient's background information, social history, medical history, neurologic history, neurological examination, CT scan, angiogram, death information, autopsy information, summary of hospitalization, and the diagnosis of the stroke. Most forms are filled out only once for each patient (e.g., background information); however, there are some forms that need to be included more than once for some patients (e.g., the CT scan form must be filled out each time the patient has a CT scan).

Most questions on the forms are in a precoded (i.e., multiple-choice) format. Questions that ask for continuous data (e.g., age, blood pressure) use fill-in-the-blank formats. A small percentage of the questions ask the physician to write in more specific information when the answer to the question has been "other". Longer physician comments are allowed in only two places on the forms: at the end of the autopsy form and in the intra-arterial studies section of the angiography form.

Currently, physicians contributing to the SDB duplicate their work when recording patient information. For each patient, they fill out the forms needed to enter the patient's data in the databank, and they also write or dictate a case report for their files. Except for anecdotal information that may be included, all the information in the case reports can be found in the databank. If case reports were automatically generated from the databank, the amount of time and effort physicians spend in record-keeping activities could be reduced. In addition, this feature would encourage physicians to record complete and accurate data, and might serve as an incentive to other physicians to become involved in the SDB project.

Case Report Formats

Case reports and other summaries of patient information are written or dictated by physicians in a textual (narrative) format. The textual format is the most common and familiar format for case reports. However, computer-generated summaries of patient information (e.g., patient charts, Whiting-O'Keefe et al., 1985; progress notes, Bischoff et al., 1983; discharge summaries, Stern et al., 1975) tend to be presented in tabular format. It is not known how the processing of patient information is affected by these different presentation formats or what physicians' attitudes are toward these formats. In order to examine these questions, computer-generated case reports were developed in three different formats: a textual format, a tabular format, and a textual format that contains section headings.

Each of these three formats has qualities that would seem to recommend its use. For example, the high level of organization of the tabular report allows it to be more easily scanned than a textual report for quick location of particular information. Physicians may prefer the tabular report, with its consistently placed categories and items of patient information, since it is more functional in this regard. In addition, organization of material can facilitate later recall (Kintsch, 1968).

On the other hand, textual reports (at least physician-written textual reports) convey a "feel" for the case which is not conveyed in tabular reports. This "feel" for the case may be due to the anecdotal information that is usually included in physician-written textual reports. Unfortunately, computer-generated reports cannot include anecdotal information because it is not recorded in the databank.

In addition to conveying a "feel" for the case, research on textual material (e.g., narrative paragraphs and stories) indicates that prose has an underlying abstract structure which facilitates processing and comprehension. This abstract structure was called the "schema" by Bartlett (1932). During encoding, the schema acts as a framework within which comprehension takes place. The schema aids encoding and comprehension by 1) directing attention to certain aspects of incoming information; 2) helping the reader/listener keep track of what has gone before which increases the predictability of what will follow; and 3) telling the reader/listener whether some part of the story is complete and can be stored, or if it is incomplete and must be held until more information has been encoded (Mandler & Johnson, 1977). During reconstruction, various omissions, distortions, and other changes in memory can be explained if it is assumed that people use schemata for retrieval cues.

Thorndyke (1977) has shown that comprehensibility of and recall from a (narrative) story are a function of the amount of structure in the story. His research also showed that when a story structure was repeated, recall of the second story improved despite the fact that setting, characters, and specific events in the passages were unrelated. Thorndyke concluded that when people are able to recognize that a particular story is an instance of a previously learned organizational framework, they use that framework to facilitate comprehension and encoding of the information in the story.

A situation similar to that which Thorndyke investigated exists in physician-written case reports. There is a customary order in which the patient information is presented in these reports: the patient's identifying information and chief presenting complaint are presented first, followed by the patient's medical history and medical examination. The rest of the patient information is then presented in (more-or-less) chronological order. The patients ("characters") and specific events may differ from case to case, but the consistent order in which information is presented in physician-written textual case reports gives these reports an underlying structure or framework. This framework may facilitate physicians' comprehension of and memory for the information presented in the textual case report.

The third format to be developed, the textual format with headings, will be a combination of the textual format and the tabular format. Klare, Shuford, and Nichols (1958) have reported that textual material that was organized with headings was preferred to and was remembered better than material that contained only the paragraph divisions and no headings. Adding headings to the textual case report should add organization similar to that of the tabular report but still retain the familiarity and framework of the textual report.

Design and Development of the Case Reports

The first step in designing the computer-generated case reports was to analyze physician-written case reports (such as those presented in Castleman & Richardson, 1968) to determine their style, content, and order. Because the computer-generated reports were to resemble as closely as possible physician-written case reports, it was important to note nonstandard grammar and word usage. For example, stroke case reports often contain sequences of noun phrases that are strung together without a verb (Li, Ahlswede, Curt, Evens & Hier, 1985).

The second step in designing the case reports was to select the information to be included in the report. The complete record of a case in the Stroke Data Bank may contain hundreds of items, but not all of this information needs to be included in the case report. Information must be carefully selected so that it is useful, and so that the report is clear, concise, and free of the clutter of irrelevant and inferable information.

The selection of information to be included in the report and its order of presentation were decided through consultation with the chairman of the Department of Neurology at Michael Reese Hospital, Daniel B. Hier, M.D. Of the nineteen SDB data collection forms, items from nine of these forms were selected for inclusion in the reports. These nine forms were:

-- Background Information

-- Medical History

-- Neurologic History

-- Neurologic Examination

-- CT Scan

-- Angiography

-- Death Information

-- Summary of Hospitialization

-- Diagnosis of Stroke

(These forms are presented in Appendix C).

For each item selected for inclusion, a decision had to be made as to when the item would appear in the report. To generate a clear and concise report, it is important to determine the items that must be stated explicitly and the items that the physician can infer from previous information. For example, if the patient's cranial nerve functioning is found to be abnormal, it is important to report the test results on related functions (extraocular movements, articulation, etc.); however, if cranial nerve functioning is reported to be normal, the physician can infer the normalcy of the related functions, and, therefore, it is unnecessary to include these results in the report. Other items are not always included in the report because they are assumed to be normal unless otherwise stated; for example, the patient's history of cancer is included in the report only if the history has been positive. Of course, the status of some items is stated explicitly at all times; for example, the patient's history (or lack of history or unknown history) of stroke, TIA, diabetes, and hypertension is always reported.

The order of the information in the reports paralleled that of physician-written case reports. The patient's demographic information and chief complaint or presenting symptoms were presented first, followed by the patient's neurologic history, medical history, neurologic examination, laboratory results, hospital management, diagnosis, and the follow-up or outcome of the patient's case.

After determining the items to be included in the reports and their order of presentation, the textual report was designed and a pseudocode detailing the generation of the report was written. In essence, the pseudocode was a fabricated computer language; it was written in a style similar to a formal computer language such as FORTRAN or PASCAL, but without adherence to the constraints of a formal computer language. The pseudocode presented a detailed plan of the decisions needed to generate the report and the text to be output. Such a detailed plan was necessary because the textual report had to emulate physician-written reports, with fluent text and smooth transitions between all possible combinations of recorded and missing data. The following are some examples of the problems that were faced and the planning and programming that were needed in order to generate fluent text:

-- The first sentence of the textual case report provides identifying information about the patient and the patient's date of admission. In the second sentence, the patient's level of consciousness and admitting complaints are listed. If any of the patient's identifying data or admitting complaints are not recorded in the databank, the text still will flow smoothly without this information:

"The patient is an 82-year-old left-handed black woman..."

"The patient is an 82-year-old woman..."

However, when the patient's level of consciousness is not recorded, the two sentences of the report are combined into one so that a smooth transition between the items is made:

"The patient is a 45-year-old white man admitted on July 15, 1982. On admission, he was alert with impaired articulation and left ataxia."

"The patient is a 45-year-old white man admitted on July 15, 1982 with impaired articulation and left ataxia."

-- In the datatbank, the patient's condition during certain time intervals is recorded. For example, the patient's condition during the first 24 hours after the onset of the stroke was recorded in four intervals. These intervals were 1-10 minutes, 11-60 minutes, 1-12 hours, and 12-24 hours. When the patient's condition did not change between adjacent time intervals, it was necessary to combine those intervals into one time period. For example, instead of "He improved during the first ten minutes after onset, improved during the next 50 minutes, stabilized during the next 11 hours, and stabilized during the next 12 hours", the report should state "He improved during the first hour after onset and then stabilized during the next 23 hours." Phrases that covered all possible combinations of intervals and patient conditions (including death) had to be incorporated into the program.

-- Cognitive functioning, motor functioning, and cranial nerve functioning are not individual items from the SDB forms, but are categories of items. For example, articulation, swallowing, extraocular movements, and visual fields are individual SDB items that make up the category of cranial nerve functioning. When one of these items is impaired or abnormal, the abnormality is reported. However, when all of the items are normal, only the statement "Cranial nerve functioning was normal" is necessary.

Cognitive functioning and motor functioning are handled in the same way. Therefore, in addition to keeping track of the normalcy of the individual items, the program has to keep track of the normalcy of the categories. Instead of generating the series of statements "Cognitive functioning was normal. Motor functioning was normal. Cranial nerve functioning was normal", the report should generate the statement "Cognitive, motor, and cranial nerve functioning were normal."

-- The results of a patient's CT scan can be characterized by any combination of nine types of pathology and 23 anatomical locations (with multiple pathologies and anatomies possible) in up to six lesions per scan. In addition, patients often had more than one CT scan while in the hospital. Because of the complexity of the data, the procedure that generates the CT scan results originally generated the results of each scan without knowledge of the results of previous scans. This sometimes resulted in the repetition of statements, e.g., "A CT scan performed the day of admission showed a deep, large infarct of the left caudate and left centrum semiovale. A second CT scan performed Aug. 3 showed a deep, large infarct of the left caudate and left centrum semiovale." This repetition is awkward and would not be found in physician-written reports. Therefore, the procedure had to be redesigned so that knowledge of previous results was taken into consideration. With this knowledge, the above results are reported as "A CT scan performed the day of admission showed a deep, large infarct of the left caudate and left centrum semiovale. A second CT scan performed Aug. 3 was unchanged."

-- The data regarding a patient's surgeries are recorded in the databank in a somewhat arbitrary order. Although listing the surgeries in the order in which they appear in the databank would be the easiest way to report this information, a more logical listing would report the surgeries in chronological order. To accomplish this, a procedure was developed that converted the dates of the surgeries into numbers which would allow the determination of the chronological order of the surgeries.

The five examples presented above only hint at the intricacies involved in generating fluent text. Finding these problem areas and deciding how to handle them was accomplished during the preparation of the pseudocode, before a line of actual code was written.

Once the pseudocode had been written, it was given to a computer programmer who produced the first version of the textual report by converting the pseudocode into PASCAL and adding procedures to control the printing of the text.

When the tabular report was designed, no pseudocode was written. Like the textual report, the tabular report had to be able to handle missing data, categorized data, time intervals, and chronological order, but the tabular report did not require the fluent text and smooth transitions of the textual report. Also, the procedures to handle the more complicated aspects of the data and the report generation had already been developed for the textual report. Therefore, writing the PASCAL program to generate the tabular report using the data from the SDB was fairly straight-forward.

The programs for both the textual and the tabular reports went through many versions. As each version was finished, it was tested on data from the SDB. Perusal of these test case reports and periodic consultations with Dr. Hier revealed awkward, ambiguous, and incorrect phrasings, errors in grammar, errors in the programs, and the need for the reordering of some items and the need for additional procedures.

Once the programs for the textual and tabular reports were written so that acceptable reports were generated, the program to generate the textual report with headings was created. This was easily accomplished by taking the textual report program and adding code to the main procedure to print headings before each paragraph of the report. The three case report formats were then ready to be evaluated.

(Unfortunately, one section of the case reports was designed and coded but could not be tested and evaluated. The data tape sent by the SDB did not contain data from the Angiography form for any of the patients. Therefore, all the case reports had to be generated without reference to this test.)

Evaluation of the Case Reports I: Preferences and Suggestions

The first evaluation of the case reports was designed to determine physicians' preferences for the format of the report and to elicit suggestions for improvements of the reports.

Method

Case reports were generated in the three formats for eight patients using data obtained from the SDB. (The case reports for three of the patients are presented in Appendix D.) A questionnaire was then developed to elicit physicians' preferences and suggestions regarding the reports. The questionnaire contained items that were concerned with additions, deletions, and item order in the reports; length of the report; format preference; ease in locating specific information; and the ability of the reports to evoke an image of the patient. The questionnaire can be seen in Appendix E.

Questionnaires and copies of the case reports were mailed to two groups of medical personnel for evaluation.

Group I: SDB. The first group consisted of the twelve physicians and four project nurses at Boston University, Michael Reese Hospital, the Neurological Institute (New

York), and the University of Maryland who are directly involved with the Stroke Data Bank project. Each person was mailed a questionnaire and a set of six case reports: three of the reports (one of each format) were of three different patients; the other three reports (one of each format) were of the same patient. Each set of six case reports consisted of a different combination of cases so that all eight patient cases were seen (across subjects) an equal number of times in each of the three formats. In addition, the order of mention of the three format types (text, text with headings, and tabular) was rotated in the cover instructions and questionnaire as well as in the actual order of inclusion in the packet. Approximately two weeks after the mailing, reminder postcards were sent to those who had not yet returned the questionnaire.

Group II: AAN. Although the entire population of clinicians involved in the SDB was surveyed in the first mailing, since this included just sixteen people, it was felt that additional input from a second group of clinicians would be useful. This group consisted of thirty-one physicians who were selected from the American Academy of Neurology (AAN) 1986-7 Membership Directory and who were known by Dr. Hier to be interested in stroke and/or computer applications to medical care.

Each AAN physician was mailed a questionnaire and a set of three case reports; a set consisted of one report in each format, all of the same patient. (Only three reports were included because it was felt that physicians not directly involved in the SDB might be reluctant to closely examine six reports.) Again, the order of mention of the three format types was rotated in the cover instructions and questionnaire and in the actual order of inclusion in the packet. The questionnaire had to be modified slightly for this group. A two-part question was deleted that referred specifically to the SDB forms; these forms would not be familiar to physicians who were not directly involved in the SDB.

Results

Responses were received from fifteen of the sixteen SDB clinicians, producing a 94% return rate. Of the thirty-one AAN physicians, fourteen responses were received, producing a 45% return rate.

Additions. There were two items on the questionnaire that dealt with additions to the reports. The first item was an open-ended question which asked the respondent to indicate patient information that should be added to the reports. The second item appeared in the questionnaires that were sent to the SDB group, but not in those sent to the AAN group. This item was a two-part checklist. The first part listed the eight SDB forms that had been used to generate the case reports and the second part listed the eleven forms that had not been used (the Angiography form was listed with the forms that had not been used because the case reports were generated without this information). Respondents were asked to indicate the forms that contained items that they would like to have added to the reports. They were also asked to indicate, for each form, whether the additional information should be included in the basic report or whether it should be available in an optional supplemental report. The responses to this checklist are presented in Table 1.

In the open-ended comments, any particular addition requested was not likely to be echoed by many of the respondents since the number and variety of possible additions is enormous. However, the comments that were made were very useful. Whereas the checklist only indicated the forms from which the respondents wanted additional information, the comments discussed and requested specific items from those forms. Although the AAN physicians could not request specific items from the SDB forms, many of their requests were similar to those of the SDB clinicians and, therefore, referred to items that can be found in the

TABLE 1

Percentage of Respondents, per SDB Form, Requesting Additional Information for the Case Reports

	Basic Report	Supple-mental Report	Total
SDB forms that were used to generate the case reports:			
Background Information	7%*	33%	40%
Medical History	27	0	27
Neurologic History	13	0	13
Neurologic Exam	20	0	20
CT Scan	7	7	13
Death Information	27	20	27
Summary of Hospitalization	27	13	40
Diagnosis	20	0	20
SDB forms that were not used to generate the case reports:			
Stroke Daily Flow Sheet	0%	7%	7%
Social History	13	20	33
Functional Assessment	33	33	67
Angiography	73	7	80
Evolving Stroke Laboratory Exam	7	7	13
Pure Motor Syndrome Daily Course Exam	0	13	13
Complications Following Stroke	53	13	67
Autopsy	20	20	40
Follow-Up	13	27	40
Recurrent Stroke	33	20	53

* Percentage of SDB respondents that indicated that information from this form should be added to the reports.

databank.

In both the checklist and the open-ended comments, the respondents most often requested the addition of the patient's angiogram results. In fact, on the checklist, 80% of the respondents indicated that information from the Angiogram form should be included in the report. Ironically, the procedure that generates this information in the reports already exists in the program, but it could not be evaluated.

On the checklist, 67% of the respondents indicated that information from the Functional Assessment form should be reported, though they were equally divided as to whether the information should be presented in the basic report or in an optional supplemental report. The open-ended comments indicated that the respondents wanted the functional assessment of the patient that was done at or near the time of discharge.

Sixty-seven percent of the respondents also indicated that information from the Complications form should be included in the report, though only one respondent thought to mention this addition in the comments.

An addition that was requested by one-third of the SDB respondents in the comments would have been missed if only the checklist had been examined. This request was for the date and time of the onset of the stroke. Currently, only the date of admission to the hospital is reported.

In other comments, requests were made for inclusion of the stroke severity score and the depression scale score (both are found on the Functional Assessment form); the date of the patient's last myocardial infarction (Medical History); additional laboratory results (e.g., blood sugar level, additional EKG findings: from the Summary of Hospitalization); and the patient's occupation (Background Information). Still other comments requested greater detail for items already included in the reports. For example, instead of stating only that the patient's EEG was abnormal, respondents requested that the report specify the abnormality that was found (Summary of Hospitalization). Similarly, there were requests for details regarding "abnormal cognitive functioning" and "abnormal language functioning". Unfortunately, these phrases are generated in the report only when an abnormality has been indicated but no details are available. Although the programs have been designed to report specific cognitive abnormalities (e.g., Broca's aphasia, abulic speech, visual agnosia), these cannot be reported unless they have been entered into the databank.

The AAN physicians were, of course, more likely than the SDB clinicians to request information that is not recorded in the databank. For example, AAN physicians requested more information about the patient's previous TIAs and strokes; the names and dosages of the patient's medications; how and why the medications were administered; the patient's current medications; and the patient's history of smoking. Some of the SDB clinicians requested similar additions, even though they acknowledged that the information is not available in the databank. Typical of the responses of several SDB physicians, one commented:

> "To be more useful clinically, much additional information would be helpful. Unfortunately, this is not available from the Data Bank forms. For example, dosages and names of medications, especially those on discharge, and the timing of medications in the hospital relative to clinically relevant events (i.e., was heparin administered before, during, or after worsening?)... would be useful. In general, these are not available from SDB forms but are clinically important."

Deletions. There was one open-ended question which asked respondents to indicate information that should be deleted from the reports. Very few deletions were suggested and only one deletion was called for by more than one respondent. Five of the fifteen SDB respondents (but none of the AAN respondents) indicated that the patient's alcohol intake need not be reported unless it appeared to be a contributing factor to the stroke.

Paragraph placement and order of the items. These two open-ended questions asked respondents to indicate if any item belonged in a different paragraph or under a different heading or if there should be any change in the order in which the items were presented. These questions elicited very few responses. However, several SDB respondents indicated that the report of the patient's blood pressure was out of place since it is not usually part of the neurological examination. Also, several of the respondents felt that the presentation of the other information in the neurological examination needed to be reordered. One respondent suggested that the patient's level of consciousness should be presented first, followed by cognitive functioning, cranial nerve functioning, motor functioning, and sensory deficits. (Currently, cranial nerve functioning is reported after motor functioning.)

Length of the reports. The respondents were asked to indicate, on a checklist, whether they felt any of the formats were too long or took too long to read. The tabular report for a patient was usually about a page longer than either of the textual reports because each item in the tabular report appears on a separate line. Thirty-one percent of the respondents (27% of SDB respondents; 36% of the AAN respondents) indicated that the tabular report was too long. Only one respondent (AAN) indicated that the textual reports (both types) were too long.

Ability to evoke an image of the patient. The respondents were asked to indicate on a 7-point scale (1 = not at all important; 7 = very important) how important they felt it was for the case report to evoke an image of the patient and the patient's case. The overall mean rating for this question was 6.14 (SDB: 6.60; AAN: 5.64). The respondents were also asked to indicate (on 7-point scales: 1 = not at all; 7 = very well) how well each report format was able to evoke this image. The overall mean rating for the textual report was 5.34; for the textual report with headings, 5.45; and for the tabular report, 3.17. A one-way repeated measures analysis of variance revealed that the difference in the ratings was significant, $F\ (2,56) = 30.86$, $p < .0001$ (see Table 2). A Newman-Keuls analysis of the mean ratings indicated that the textual report and the textual report with headings did not differ, but that both were significantly different from the tabular report.

Locating specific information quickly. The respondents were asked to indicate on a 7-point scale how important they felt it was to be able to locate specific

TABLE 2

Analysis of Variance of the Ratings Indicating the Ability of the Report Format to Evoke an Image of the Patient

Source of variation	SS	df	MS	*F*	*p*
Between Subjects	74.99	28			
Within Subjects	182.67	58			
Case Report Format	95.79	2	47.90	30.88	.0001
Residual	86.87	56	1.55		
Total	257.66	86			

Cell Means and Standard Deviations

	textual format	textual format with headings	tabular format
mean	5.35	5.45	3.17
s.d.	1.26	1.27	1.61

information quickly in the case report. The overall mean rating for this question was 5.93 (SDB: 5.73; AAN: 6.14). The respondents were then asked to indicate (on a checklist) the report format in which information was easiest to locate and, on another checklist, the report format in which information was the hardest to locate. The percentage of responses to each question appear in Table 3. Since there were only three formats, these two questions established each respondent's ranking of the formats. A Friedman analysis of variance for ranks (on the combined data for the SDB and AAN groups) indicated that the rankings were significant, $\chi^2(2) = 29.95$, $p < .03$. In examining the percentages of responses for each format, it is clear that the textual format was considered the most difficult format in which to locate information, while information was considered easiest to locate in both the textual report with headings and the tabular report.

Format preferences. There were two (non-contiguous) questions that were concerned with format preference. The first was a two-part question in which respondents were asked to indicate (on checklists) the report format that they would be most likely to use and the report format that they would be least likely to use. The results appear in Table 4. As above, these two questions served to establish

TABLE 3

Format Preferences for Locating Specific Information

	Format in which information is easiest to locate			Format in which information is hardest to locate		
	SDB	AAN	Total	SDB	AAN	Total
Tabular report	43%	57%	50%	13%	14%	14%
Textual report	0	0	0	80	86	83
Textual report with headings	57	43	50	7	0	3

TABLE 4

Preferred Case Report Formats

	Format most likely to be used			Format least likely to be used		
	SDB	AAN	Total	SDB	AAN	Total
Tabular report	13%	43%	28%	73%	50%	62%
Textual report	27	0	14	20	50	35
Textual report with headings	60	57	58	7	0	3

each respondent's ranking of the formats. A Friedman analysis of variance for ranks (on the combined SDB and AAN data) indicated that the rankings reached significance at $p = .06$ ($\chi[2] = 14.43$). An examination of the percentages in Table 4 shows that respondents indicated that they would prefer to use the textual report with headings.

The second question that was concerned with format preference asked SDB respondents to indicate the report format that they would like to have as a permanent feature of the Stroke Data Bank; AAN respondents were asked to indicate the report format that they would like to have available for their use. In addition to the three formats, the choices that were given to the respondents included: "none of these - I would not use computer-generated case reports", "none of these - I would use computer-generated case reports, but I would not use any of these", and "none of these - other (please explain)". The results can be seen in Table 5. Sixty-six percent of the respondents indicated that they preferred the textual report with headings to the two other formats. (As might be expected, the results of this question are similar to the results of the question in which respondents indicated the format that they would be most likely to use; there were, however, several respondents who were not consistent in their responses.) It

TABLE 5

Case Report Format Requested as Permanent Feature

	SDB	AAN	Total
Tabular report	13%	36%	24%
Textual report	20	0	10
Textual report with headings	67	64	66
None, I would not use computerized reports	0	0	0
None, I would not use these reports	0	0	0
None, other	0	0	0

should be noted that none of the respondents indicated that they would <u>not</u> use computer-generated case reports.

Discussion

The respondents agreed that it is important for the case report to evoke an image of the patient and indicated that the textual report and the textual report with headings were best able to do this. The respondents also agreed that they needed to be able to quickly locate information in the reports; locating information was found to be easy in both the tabular report and the textual report with headings. The format the respondents preferred to have available for their use both evoked an image of the patient and enabled location of information; this format was the textual report with headings.

It is interesting that respondents found information to be easy to locate in both the tabular report and the textual report with headings, but difficult to locate in the textual report. The textual report with headings was identical to the textual report except, of course, that it contained section headings. It is worth noting that the simple addition of section headings increased the reader's reported ability to locate specific information and, presumably, the reader's satisfaction with the report. It is also worth noting that the textual report, which is the format in which information was the most difficult to locate, is the format most similar to physician-written case reports.

Another important and gratifying finding was that none of the respondents indicated that they would not use computer-generated case reports. At least in theory, computer-generated reports seem to be acceptable to physicians. However, in remarks regarding the practical use of the reports, the respondents expressed concerns which made it questionable whether physicians would use the reports on a day-to-day basis with their patients. For example, one SDB respondent commented: "Because the information is incomplete (of necessity), I would find these reports useful as SDB records (since they are easier to look at than the actual forms) but would not like to see them used in other contexts (such as part of a patient's permanent record) for fear of misinterpretation by non-SDB personnel." Another SDB respondent commented: "Interpreting the information given is straightforward for Data Bank participants since we know what was asked and what was not asked. This would not be true in general. So the question is - to what use would these reports be put? Terms [used in the SDB forms] might be misinterpreted by someone unfamiliar with the Data Bank." One of the AAN respondents (who was unfamiliar with the SDB forms) echoed the need for knowledge of the questions in the database: "For my purposes, the original forms would be most useful. The choices available, not just those made, need to be known." Though the point is a valid one, his solution obviates the need for the case report.

Evaluation of the Case Reports II: Memory for Patient Information

The second evaluation was an experiment designed to determine whether the format of the case report had an effect on physicians' ability to remember the patient information presented in the report.

Method

Case reports were generated in the three formats for three patients using the SDB data (these reports can be seen in Appendix D). Each case was assigned a fictitious name which was typed on the reports and by which the case could be identified.

The experiment was run during one of the clinicopathological conferences held weekly at Michael Reese Hospital. The intent of the experiment was explained and the eleven residents and interns in attendance agreed to participate in the experiment. Each physician was then given a packet containing three case reports; there was a report for each of the three patients, and each report was presented in a different format. (The reports were counter-balanced across subjects so that each case appeared in each format an equal number of times. Also, the order of the formats was counter-balanced so that each format was seen first, second, and last an equal number of times.) The physicians were instructed to study the reports as if they were reports for patients that they would be seeing later that day. The physicians were then given approximately ten minutes to study the reports, after which the chairman of the neurology department gave a fifteen minute slide presentation/lecture.

After the lecture, each physician was given three questionnaires, one for each of the three case reports that had been studied. Each questionnaire consisted of all the SDB questions (in multiple-choice form) that had been used to generate the case reports; there were approximately 165 items in all. However, only about half of the items were specifically mentioned in any particular case report; the other items either were not applicable to the patient (e.g., laboratory test results) or were normal and, therefore, not reported. The answers to these items would have had to have been inferred from the report, but the items could still be answered since choices such as "normal" and "not done" (for lab tests) were included among the answers. In answering the questionnaire, the physicians were told that items that were not specifically mentioned in the report should be answered if the information could be confidently inferred; otherwise, they were to leave the items blank. The physicians were given as much time as they needed to fill out the three questionnaires.

Results

The experiment was a single factor design with repeated measures on the case report formats.

Items on the questionnaire were divided into two categories: those that had been specifically mentioned in the report and those that could have been inferred from the report. Within these categories of specified and inferable items, there were three types of data for each report format: correct answers, incorrect answers, and answers that were left blank. Therefore, there were six different categories of data: correct-specified, incorrect-specified, blank-specified, correct-inferred, incorrect-inferred, and blank-inferred.

Of the three patient cases that were used in the experiment, each had a slightly different number of specified and inferred items. Therefore, in each of the analyses, percentages were used as data instead of the raw scores.

Each category of data was analyzed by a separate analysis of variance. Clearly, it was important to determine whether the case report formats affected the correct data, but it was also important to determine whether the incorrect and blank data were affected. Items which were left blank indicated information which the physician did not know and realized he or she did not know. In such a case, the physician would have to refer to the patient's file for the information. Items which are answered incorrectly have potentially more serious consequences. These items indicated information which was unknown but which the physician did not realize he or she did not know. In this case, the physician would not be likely to check the information and would proceed with incorrect data.

The analysis of variance revealed a significant difference among the three case report formats for the correct-specified data, $\underline{F}$ (2,20) = 3.99, $\underline{p}$ <.03 (see Table 6). Examination of the mean recall showed that information was remembered best from the tabular reports ($\bar{X}$ = 0.533), next best from the textual reports ($\bar{X}$ = 0.492), and worst from the textual reports with headings ($\bar{X}$ = 0.407). A Newman-Keuls analysis of these means indicated that the only significant difference was between the means of the tabular report and the textual report with headings.

TABLE 6

Analysis of Variance of Correct-Specified Data

Source of variation	SS	df	MS	F	p
Between Subjects	0.256	10			
Within Subjects	0.317	22			
Case Report Format	0.091	2	0.045	3.99	.03
Residual	0.227	20	0.011		
Total	0.574	32			

Cell Means and Standard Deviations

	textual format	textual format with headings	tabular format
mean	0.49	0.41	0.53
s.d.	0.13	0.10	0.15

The analyses of variance for the other data showed no significant differences between the case report formats: incorrect-specified: $\underline{F}(2,20) = 2.17$, $\underline{p} < .14$; blank-specified: $\underline{F}(2,20) < 1$; correct-inferred: $\underline{F}(2,20) < 1$; incorrect-inferred: $\underline{F}(2,20) = 1.82$, $\underline{p} < .19$; blank-inferred: $\underline{F}(2,20) < 1$.

Discussion

Research on the comprehensibility and recall of narrative material (e.g., Mandler & Johnson, 1977; Thorndyke, 1977) has shown that recall of the information in a narrative is facilitated when the narrative has an underlying organizational framework (schema). Since it was argued that textual case reports (physician-written or computer-generated) have such a framework, it would have been reasonable to expect better recall from the textual reports than from the tabular reports. However, the results of the experiment indicate that physicians remember patient information better when it is presented in a tabular format than when it is presented in a textual format (at least a textual report with headings).

Although the research on schemata has not investigated this, it is possible that schemata are used in some cases to comprehend and encode non-textual material. Mandler and Johnson (1977) have suggested that schemata are constructed from two sources: from listening to many narratives and from experience. From listening to narratives, the schemata acquire knowledge about the sequence of narrative events (e.g., how they begin and end). From experience, the schemata acquire knowledge about causal relations and the various kinds of action sequences that are possible. If schemata are constructed in this way, it is reasonable to assume that physicians develop a "medical case report" schema through their exposure to physician-written case reports.

In this experiment, the physicians were aware that they would be reading case reports. Since case reports were expected, the physicians may have utilized a medical case report schema to comprehend and encode the information, regardless of the format of presentation. Since the information presented in all formats of the computer-generated reports would fit into the domain of the schema, use of the schema should not have facilitated recall of one format more than another.

The difference in recall that was found may be due to the extra effort required to process the information in the tabular report. Holland and Redish (1982) use protocol analysis to examine comprehension of (tabular) forms. They found that attention to the narrative features (such as cohesion, i.e., the surface structure ties between sentences in text) that existed in the forms and the reader's addition of narrative features to the forms facilitated comprehension. Since the textual formats obviously contain more narrative elements than does the tabular format, it may have taken more cognitive effort to comprehend the tabular format. Research has shown that when increased effort is required to process information, recall improves (Craik & Tulving, 1975; Hyde & Jenkins, 1973; Jacoby, 1978; Kahneman, 1973).

GENERAL DISCUSSION

The present dissertation has described the design and development of two types of user-system interfaces: the interactive user interface for the IIT/MRH Stroke Consultant and hardcopy interfaces for the Stroke Data Bank.

The development of the interface for the Stroke Consultant demonstrated that principles of cognitive and experimental psychology can be applied to user-system interface design. Although it is clear that a body of research that specifically addresses the needs and issues of human factors is needed (and is slowly accumulating), it is important that the existing research on human cognition not be ignored. The application of basic research findings from the existing literature to user interface design contributes to both basic science and applied science: basic science benefits from the verification of its findings in settings outside of (and much more complex than) the laboratory and from the identification of areas that need further research; human factors benefits from the development of new guidelines that can aid user-system interface design.

By way of illustrating one of the above points, several areas requiring further research were identified by the development and evaluation of the case reports for the Stroke Data Bank. The first area is concerned with the identification of the most suitable format in which to present patient information to physicians. The results of the evaluations of the three case report formats were mixed: physicians were best able to remember patient information from the tabular reports, but they indicated a preference for the textual reports with headings. From these results, it is not clear which format is the "best" format for the presentation of patient information. What needs to be determined is how important it is for physicians to remember the information presented in the case report. If physicians can refer to the reports at any time or if the reports are used as discharge summaries, perhaps remembering detailed information is not extremely important. Furthermore, it should be noted that, of the three report formats, the majority of physicians indicated that they would be <u>least</u> likely to use the tabular report. This finding is noteworthy since many of the computer-generated summaries of patient information are generated in tabular formats.

The second area requiring further research is concerned with the reluctance of the physicians to include the computer-generated case reports in their patient files. Several of the physicians indicated that this reluctance stemmed from a fear that the reports would be misinterpreted by non-SDB personnel. Since the reports were not tested for misinterpretation of the information, it is not clear whether this is a valid fear; however, the AAN physicians who participated in the evaluation did not report any trouble in this regard. Nevertheless, the reluctance of physicians to use computerized systems and their products must be investigated if these are to be used on a day-to-day basis in the physician's practice.

The third area of research was revealed in physicians' comments which indicated the importance of the anecdotal information that usually is included in physician-written reports but is not included in computer-generated ones. For example, one SDB respondent wrote:

> "One of the main problems with computer-generated reports is that they lack the real identifying information that brings the case to mind. We have generally found that the patient was best recalled by phrases such as: 'This 47-year-old college-educated sales representative for Johnson & Johnson experienced the sudden onset of severe headache while attending an annual company meeting in California' etc. At the time of follow-up visits, we would always

find ourselves looking over the forms for such a description. Needless to say, each of us began writing such descriptions in the same place on every form and relied heavily upon that information to recall particular details about the various cases - and, in general, to help us remember the patients."

The design and development of the textual case reports demonstrated that adequate text can be generated in a restricted environment with relatively simple programming methods. However, anecdotal information is too variable for the simple methods used in this dissertation to be able to produce fluent text. In order to handle this type of information, better methods for natural language text generation must be developed.

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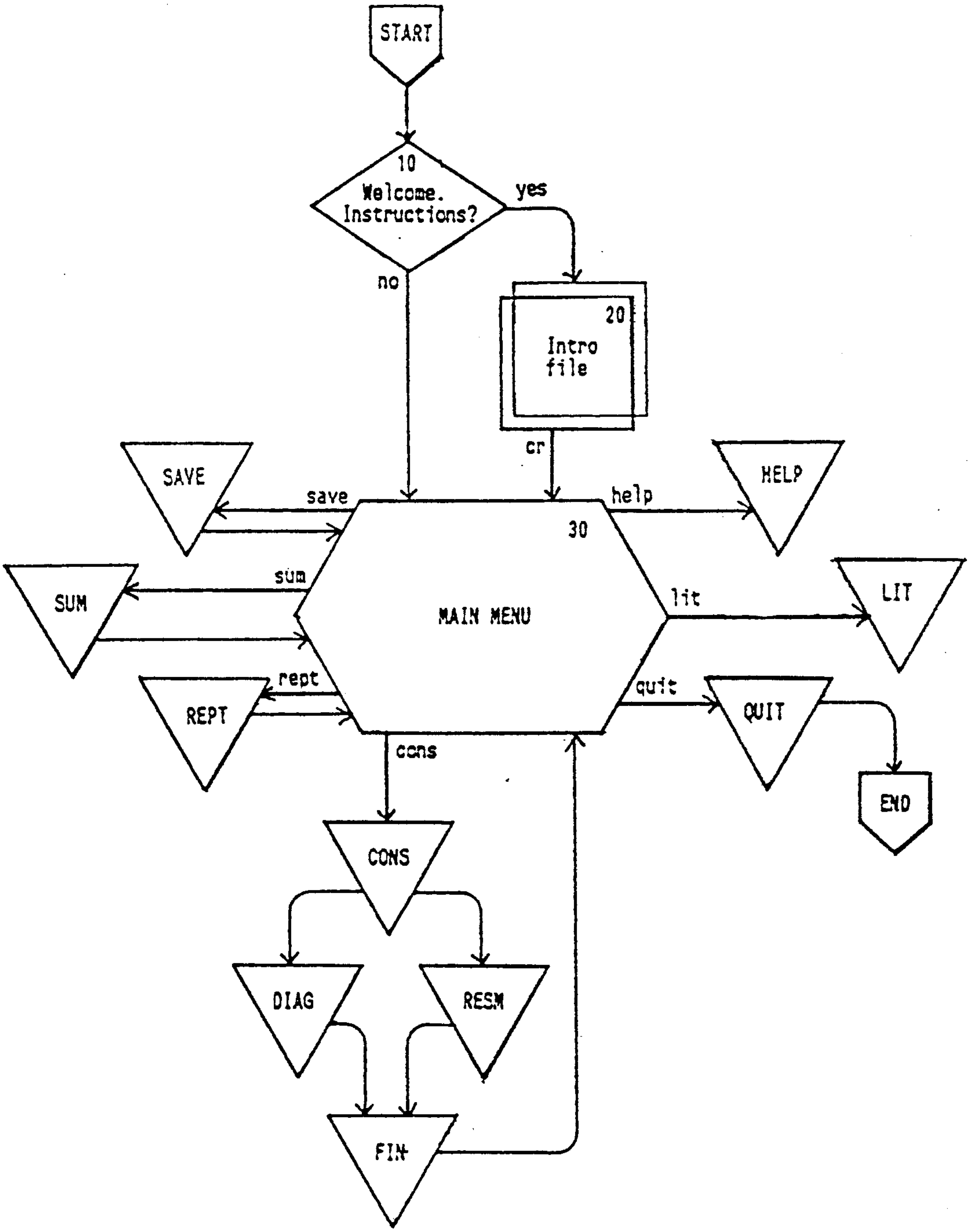
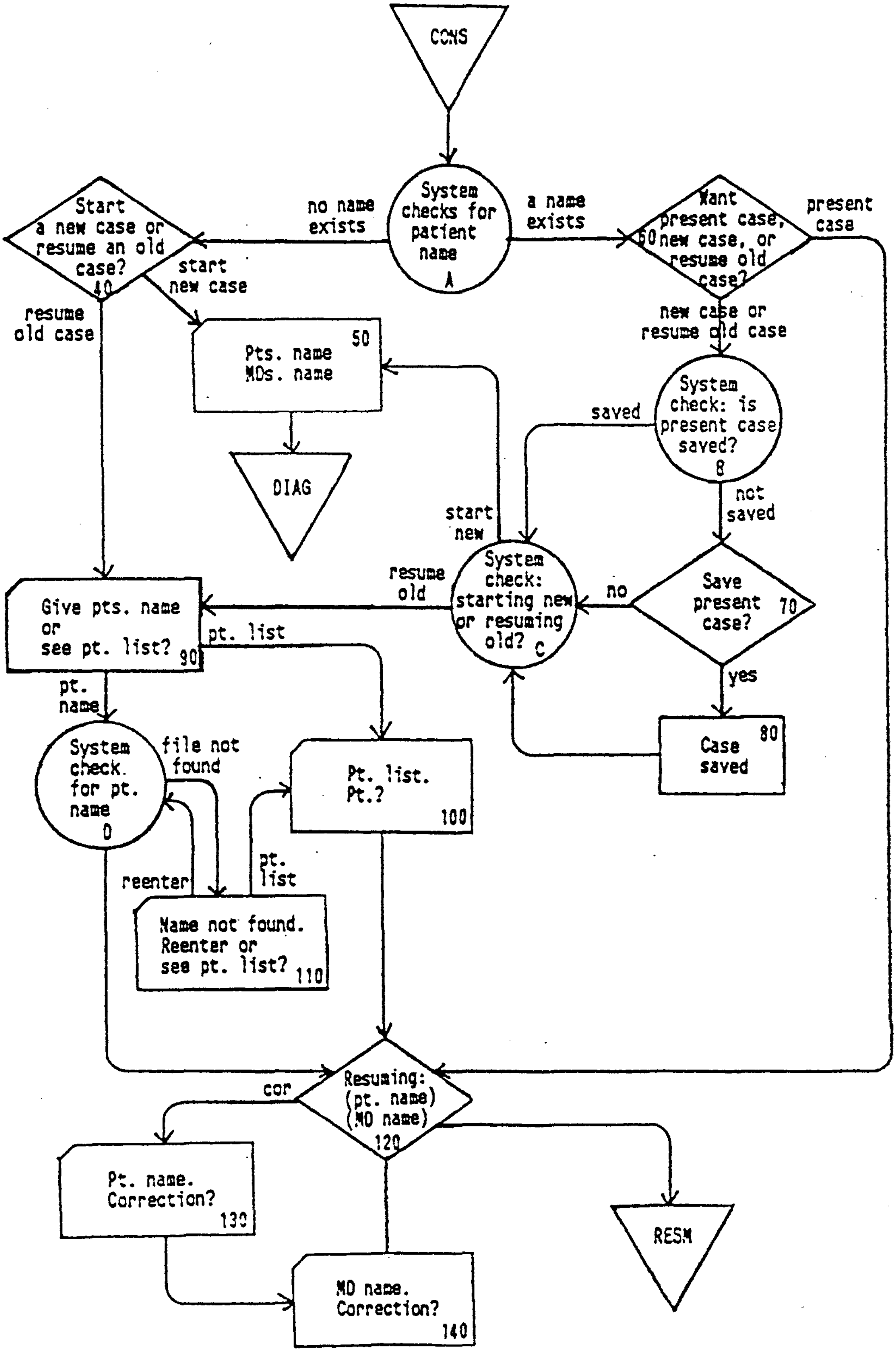
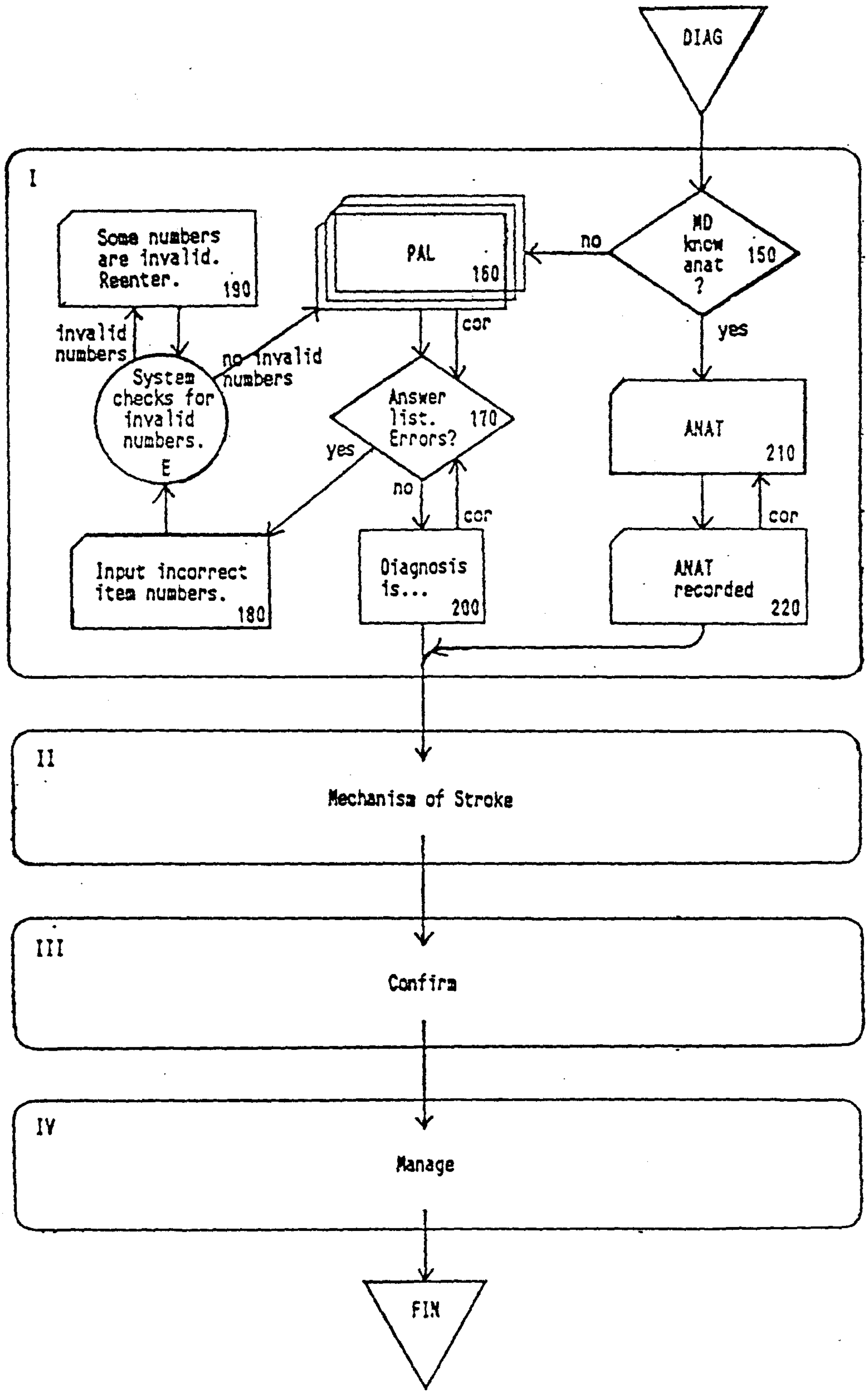
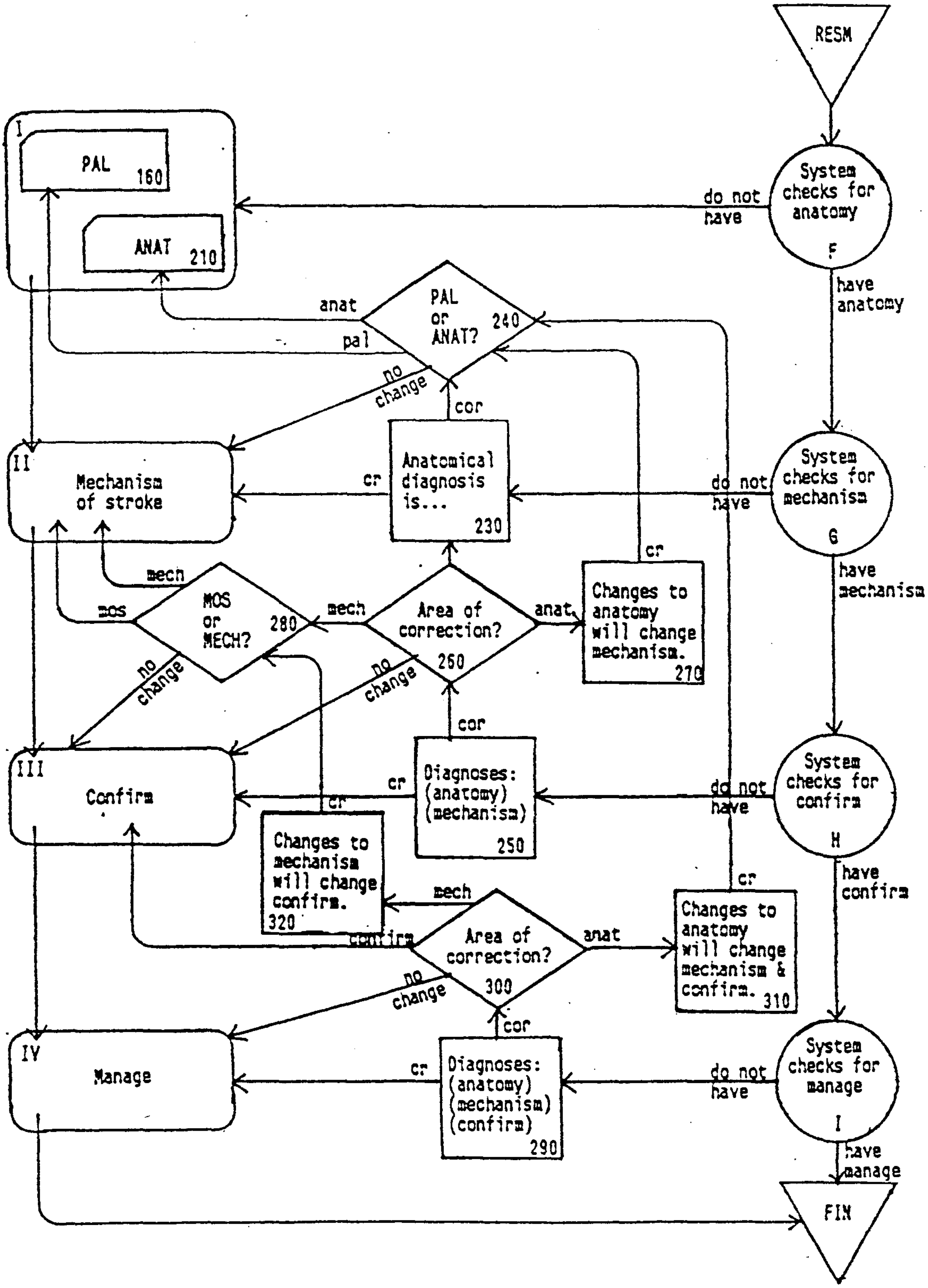
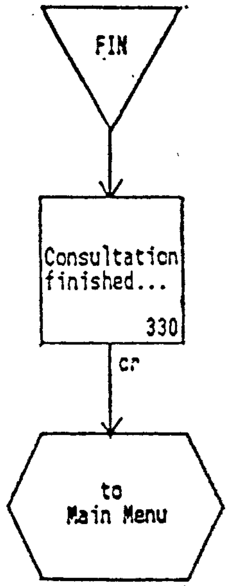
APPENDIX A

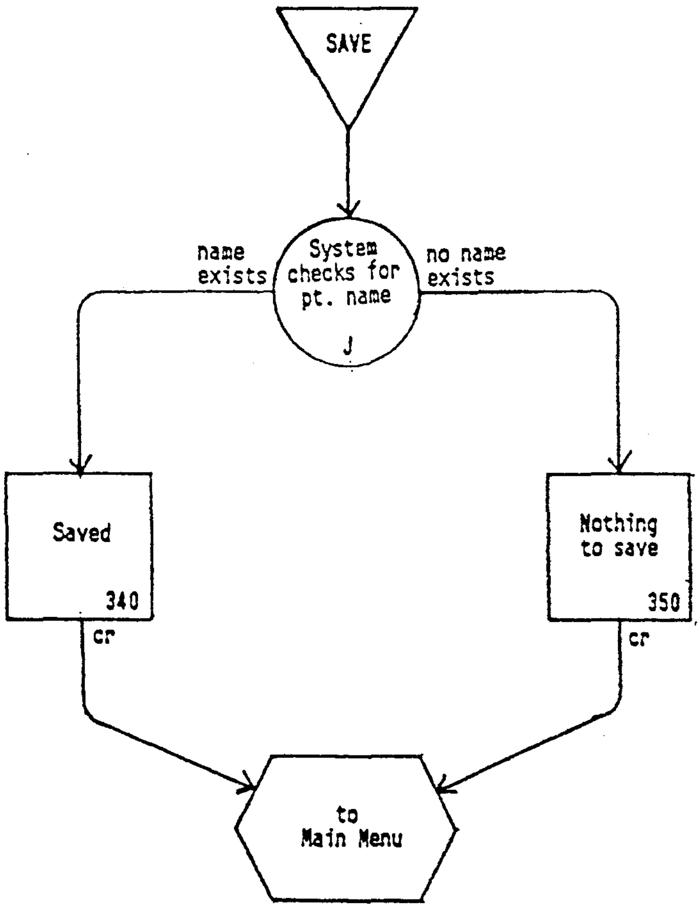

START
10
Welcome.
Instructions?
yes
no
20
Intro
file
cr
save
SAVE
help
HELP
30
sum
SUM
MAIN MENU
lit
LIT
rept
REPT
quit
QUIT
END
cons
CONS
DIAG
RESM
FIN

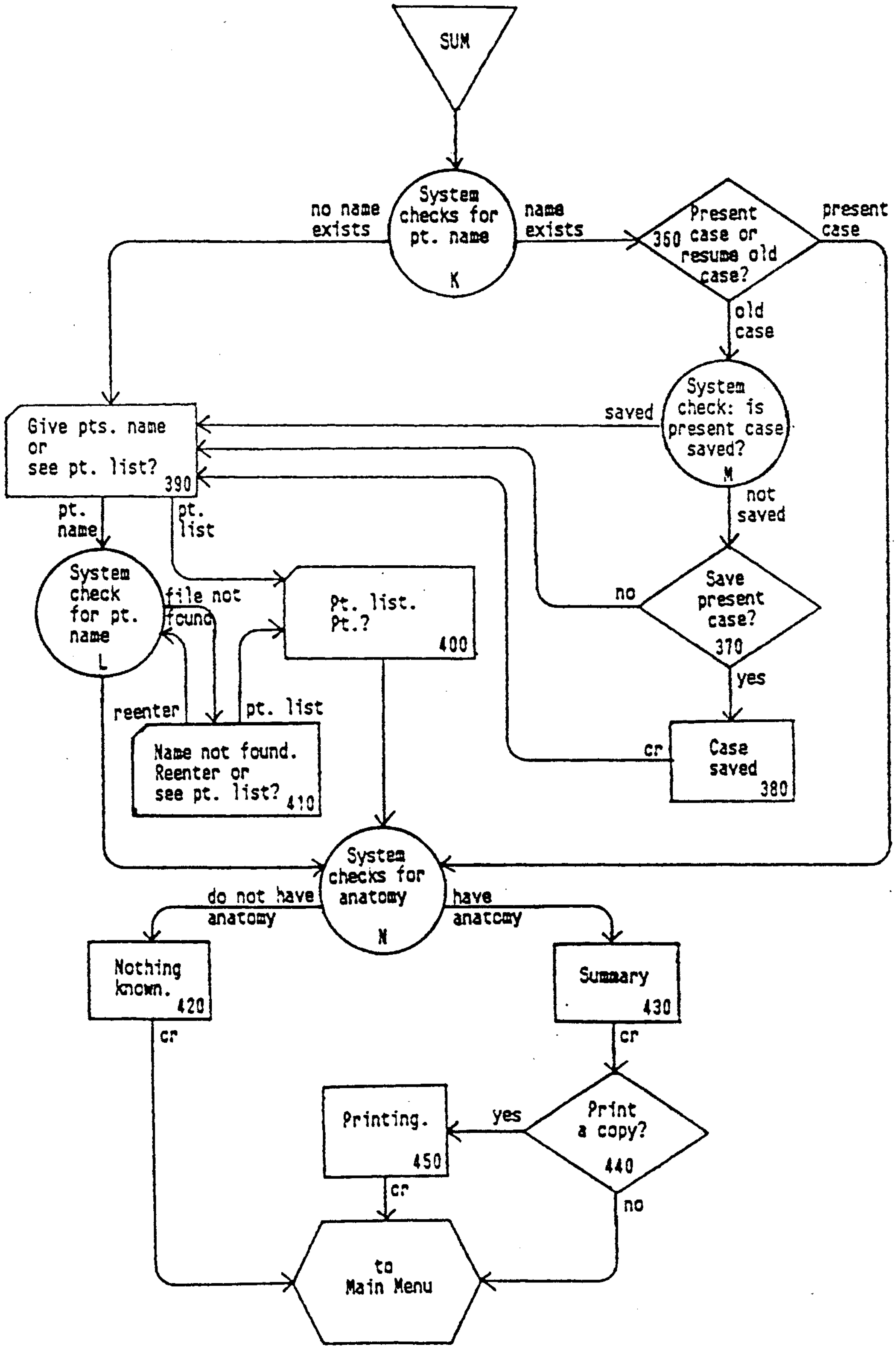

CONS
System checks for patient name A
no name exists
a name exists
Start a new case or resume an old case? 40
Want present case, new case, or resume old case? 60
present case
start new case
resume old case
Pts. name MDs. name 50
DIAG
new case or resume old case
System check: is present case saved? B
saved
not saved
start new
System check: starting new or resuming old? C
resume old
no
Save present case? 70
yes
Case saved 80
Give pts. name or see pt. list? 90
pt. list
pt. name
System check for pt. name D
file not found
Pt. list. Pt.? 100
reenter
pt. list
Name not found. Reenter or see pt. list? 110
Resuming: (pt. name) (MD name) 120
cor
Pt. name. Correction? 130
MD name. Correction? 140
RESM

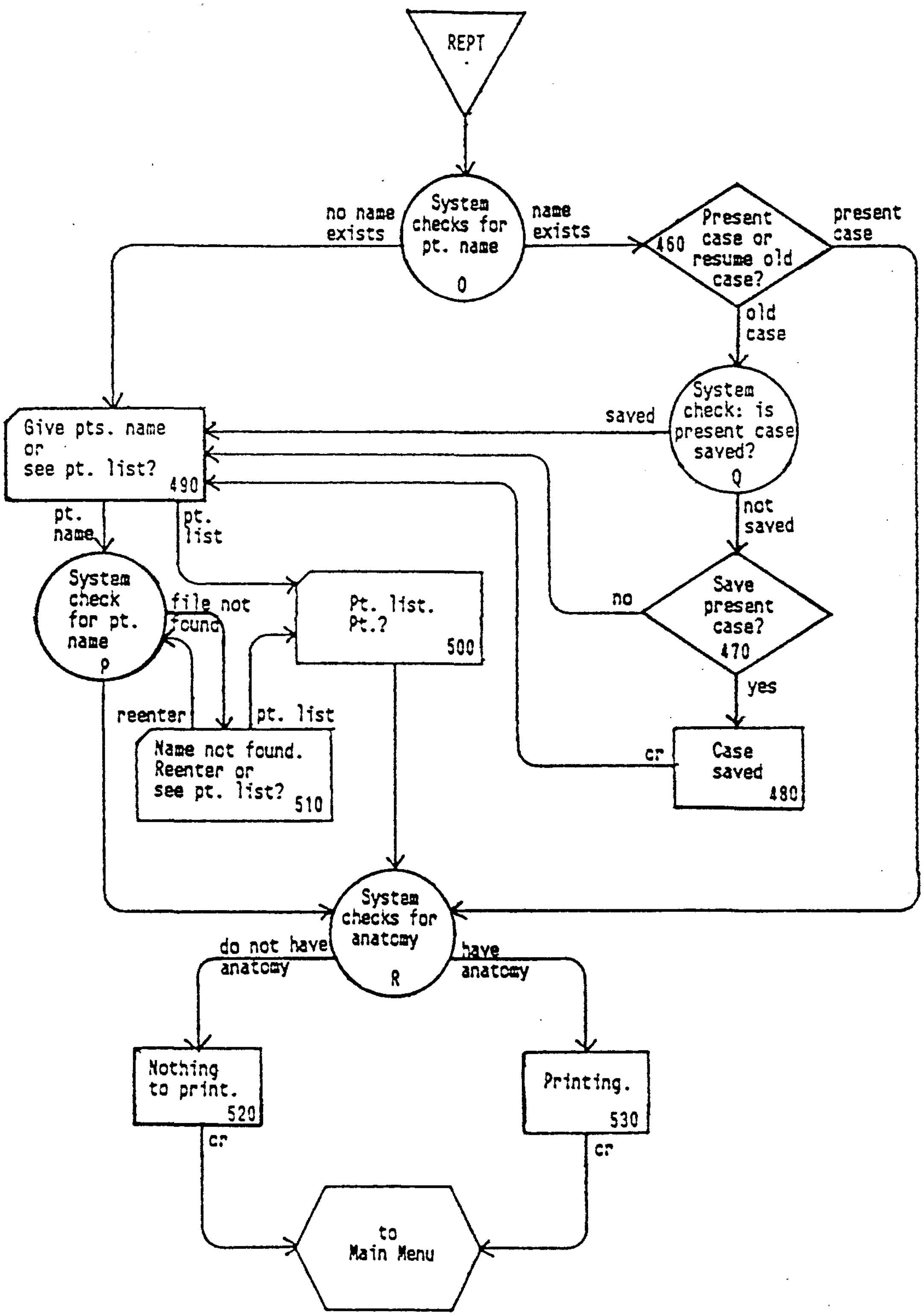

DIAG
I
MD know anat ? 150
no
yes
PAL 160
Some numbers are invalid. Reenter. 190
invalid numbers
no invalid numbers
System checks for invalid numbers. E
cor
Answer list. Errors? 170
yes
no
cor
ANAT 210
cor
Input incorrect item numbers. 180
Diagnosis is... 200
ANAT recorded 220
II
Mechanism of Stroke
III
Confirm
IV
Manage
FIN

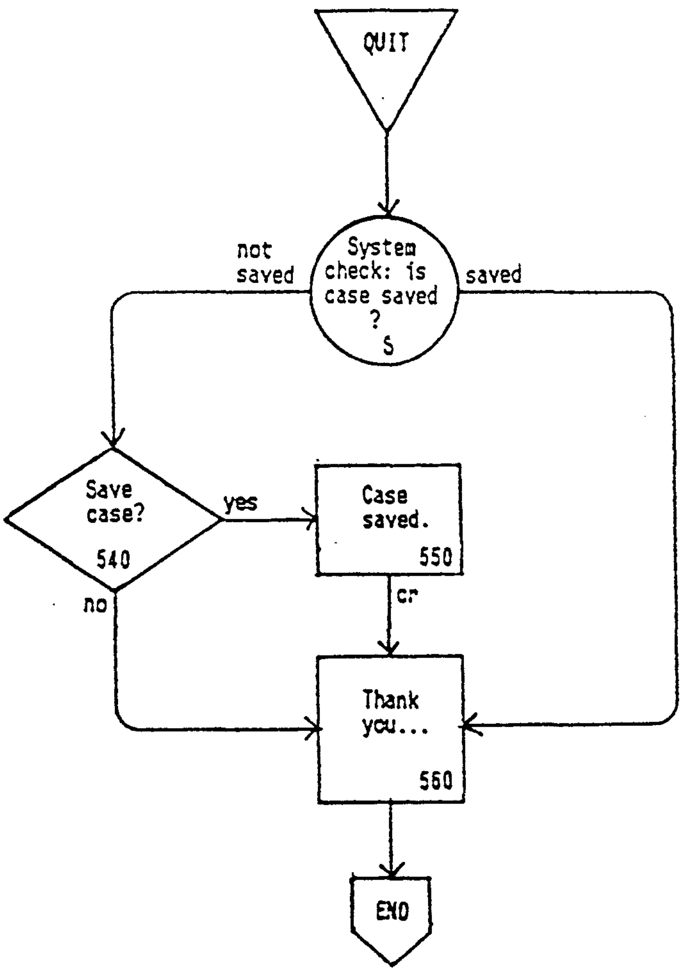

RESM
System checks for anatomy
F
do not have
have anatomy
I
PAL 160
ANAT 210
PAL or ANAT? 240
anat
pal
no change
cor
II
Mechanism of stroke
cr
Anatomical diagnosis is... 230
System checks for mechanism
G
do not have
have mechanism
cr
Changes to anatomy will change mechanism. 270
mech
mos
MOS or MECH? 280
mech
Area of correction? 260
anat
no change
no change
cor
III
Confirm
cr
Diagnoses: (anatomy) (mechanism) 250
System checks for confirm
H
do not have
have confirm
cr
Changes to mechanism will change confirm. 320
mech
confirm
Area of correction? 300
anat
cr
Changes to anatomy will change mechanism & confirm. 310
no change
cor
IV
Manage
cr
Diagnoses: (anatomy) (mechanism) (confirm) 290
System checks for manage
I
do not have
have manage
FIN

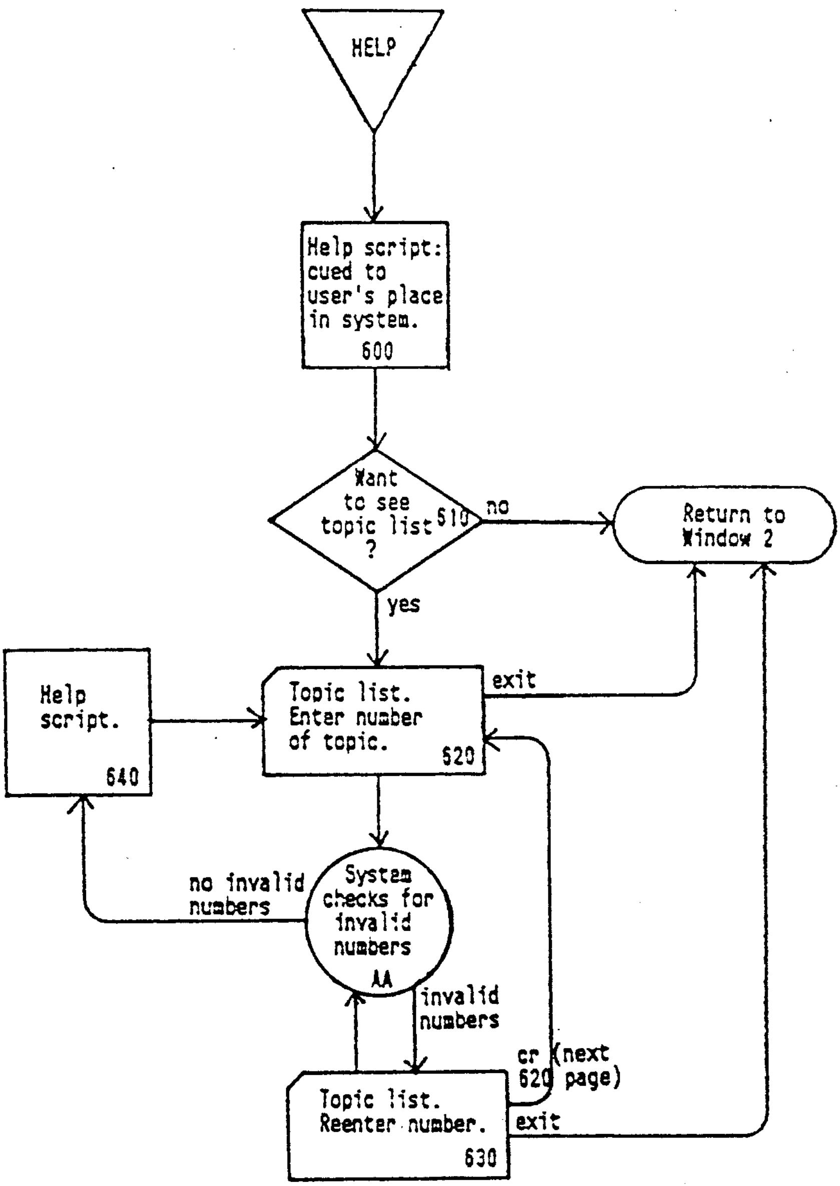

FIN
Consultation finished...
330
cr
to Main Menu

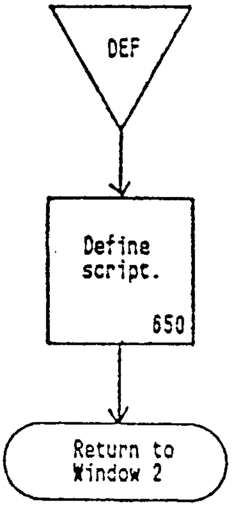

SAVE
System checks for pt. name
J
name exists
no name exists
Saved
340
cr
Nothing to save
350
cr
to Main Menu

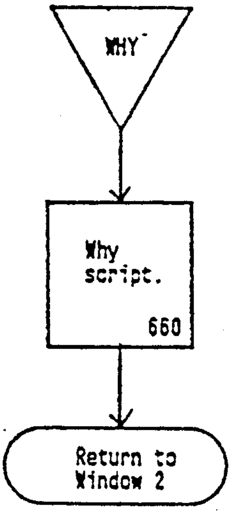

SUM
System checks for pt. name
K
no name exists
name exists
Present case or resume old case?
360
present case
old case
System check: is present case saved?
M
saved
not saved
Save present case?
370
no
yes
Case saved
380
cr
Give pts. name or see pt. list?
390
pt. name
pt. list
System check for pt. name
L
file not found
reenter
pt. list
Pt. list. Pt.?
400
Name not found. Reenter or see pt. list?
410
System checks for anatomy
N
do not have anatomy
have anatomy
Nothing known.
420
cr
Summary
430
cr
Print a copy?
440
yes
no
Printing.
450
cr
to Main Menu

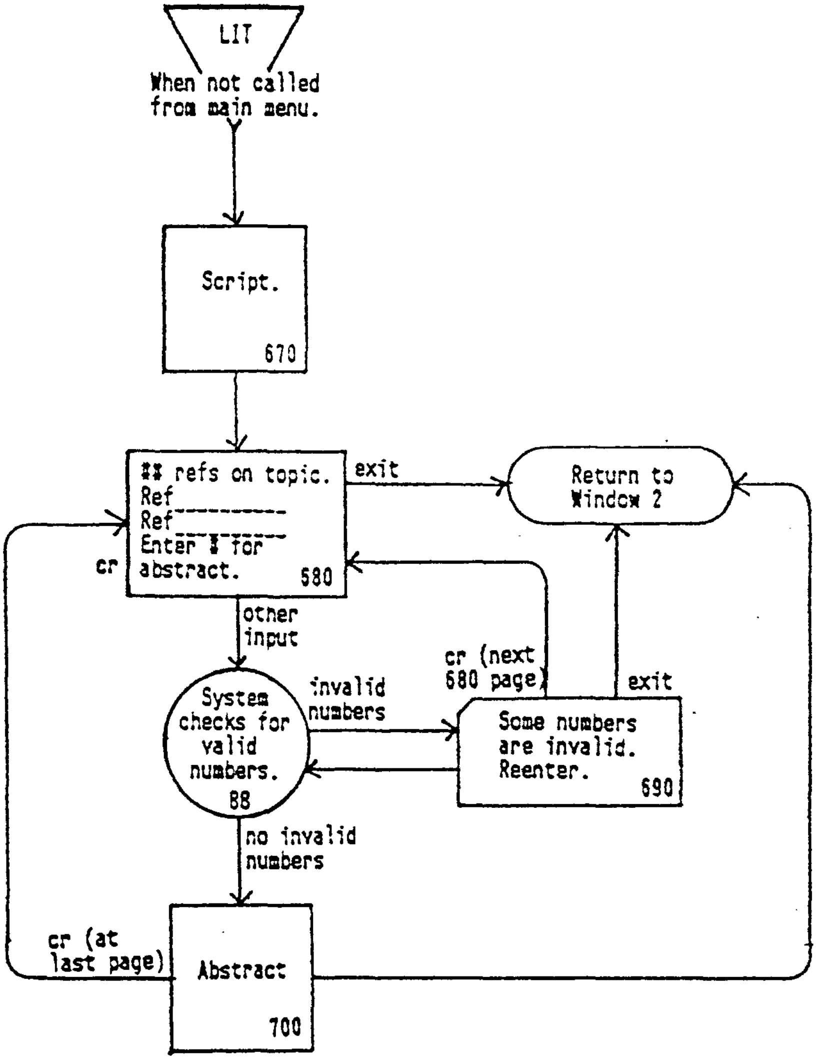

REPT
System checks for pt. name
O
no name exists
name exists
Present case or resume old case?
460
present case
old case
System check: is present case saved?
Q
saved
not saved
Save present case?
470
no
yes
Case saved
480
cr
Give pts. name or see pt. list?
490
pt. name
pt. list
System check for pt. name
P
file not found
Pt. list. Pt.?
500
reenter
pt. list
Name not found. Reenter or see pt. list?
510
System checks for anatomy
R
do not have anatomy
have anatomy
Nothing to print.
520
Printing.
530
cr
cr
to Main Menu


QUIT
not saved
System check: is case saved ? S
saved
Save case?
540
yes
Case saved.
550
no
cr
Thank you...
560
END

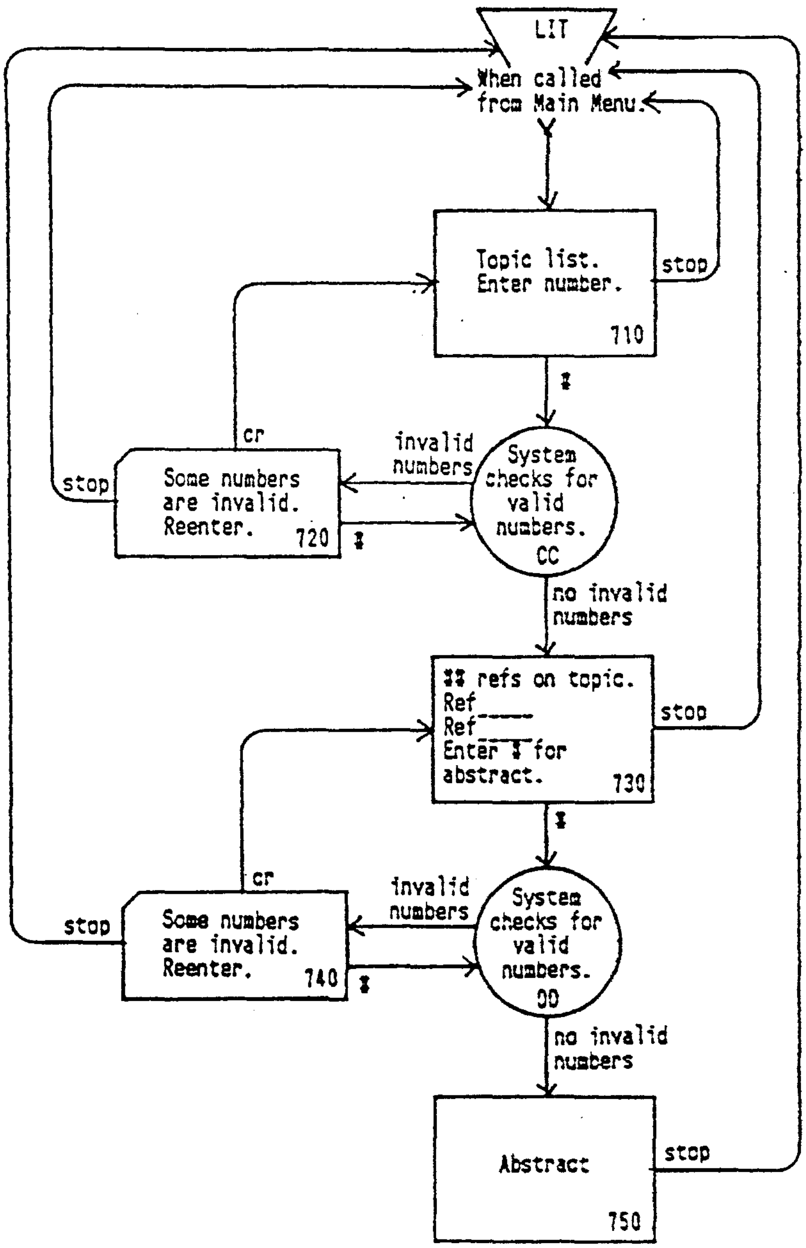

HELP
Help script:
cued to
user's place
in system.
600
Want
to see
topic list
?
510
no
Return to
Window 2
yes
Help
script.
640
Topic list.
Enter number
of topic.
620
exit
no invalid
numbers
System
checks for
invalid
numbers
AA
invalid
numbers
cr (next
620 page)
Topic list.
Reenter number.
630
exit


DEF
Define script.
650
Return to Window 2


WHY
Why script.
660
Return to Window 2



LIT
When not called from main menu.
Script.
670
refs on topic.
Ref__________
Ref__________
Enter # for abstract.
580
exit
Return to Window 2
cr
other input
System checks for valid numbers.
88
invalid numbers
cr (next 680 page)
exit
Some numbers are invalid. Reenter.
690
no invalid numbers
cr (at last page)
Abstract
700


LIT
When called from Main Menu.
Topic list. Enter number.
710
stop
#
cr
invalid numbers
System checks for valid numbers.
CC
Some numbers are invalid. Reenter.
720
stop
#
no invalid numbers
refs on topic.
Ref
Ref
Enter # for abstract.
730
stop
#
cr
invalid numbers
System checks for valid numbers.
DD
Some numbers are invalid. Reenter.
740
stop
#
no invalid numbers
Abstract
750
stop

APPENDIX B

```
Screen #10
==============================================================================

------------------------------------------------------------------------------

                              Welcome to the

                        IIT - MRH STROKE CONSULTANT


            Would you like instructions on how to use the system?

            (Type  Y for YES  or  N for NO,
             then press the "RETURN" key located on the right side
             of the keyboard.)
            >
----------------------------------------------------------------------------




==============================================================================
Screen #10




Screen #20
==============================================================================
                        IIT - MRH STROKE CONSULTANT
                               Introduction
------------------------------------------------------------------------------

     This should contain the introductory instructions to the system. The
   information should be brief, containing little more than what the user
   needs to get started on the system...




                         [press RETURN to continue]
------------------------------------------------------------------------------




==============================================================================
Screen #20
```

```
Screen #30
==============================================================================
                              Table of Options

------------------------------------------------------------------------------
    The following options are available to you at this time. Please enter
    a command from this list:

    CONS - do a stroke CONSultation
    SAVE - SAVE the information from this consultation for later use
    SUM  - SUMmarize the information obtained so far
    REPT - print out a case REPorT
    QUIT - to QUIT working with the Stroke Consultant



    >
------------------------------------------------------------------------------
    Also available:
    HELP - for HELP on how to use the system



==============================================================================
Screen #30




Screen #40
==============================================================================
  Consultation

------------------------------------------------------------------------------
  Do you want to start a consultation of a new case or resume consultation
  of a previous case?
  1 - start a new case
  2 - resume a previous case
  >






------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options


==============================================================================
Screen #40
```

```
Screen #50
==============================================================================
  Consultation
  New case
------------------------------------------------------------------------------

   Please enter the patient's name:
      (first name, middle intial, last name)

    >


   Please enter the attending physician's name:
      (first intial, last name)

    >


------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options


==============================================================================
Screen #50
```

```
Screen #60
==============================================================================
  Consultation

------------------------------------------------------------------------------
  Do you want to continue the consultation for AMELIA EARHART,
  start a new case, or resume a previous case?

  1 - continue present consultation
  2 - start a new case
  3 - resume a previous case




------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options


==============================================================================
Screen #60
```

```
Screen #70A
==========================================================================
  Consultation
  Starting a new case
--------------------------------------------------------------------------
  Before starting a new case, do you want to save the data of the present
  case for future use?
  1 - Yes
  2 - No
  >









--------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options


==========================================================================
Screen #70A
```

```
Screen #70B
==========================================================================
  Consultation
  Resuming a previous case
--------------------------------------------------------------------------
  Before resuming a case, do you want to save the data of the present
  case for future use?
  1 - Yes
  2 - No
  >









--------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options


==========================================================================
Screen #70B
```

Screen #80A

```
================================================================================
  Consultation
  Starting a new case; saving the present case
--------------------------------------------------------------------------------

  The data of AMELIA EARHART

  has been saved.




                         [press RETURN to continue]
--------------------------------------------------------------------------------
```

```
================================================================================
```
Screen #80A

Screen #80B

```
================================================================================
  Consultation
  Resuming a previous case; saving the present case
--------------------------------------------------------------------------------

  The data of AMELIA EARHART

  has been saved.




                         [press RETURN to continue]
--------------------------------------------------------------------------------
```

```
================================================================================
```
Screen #80B

```
Screen #90
==============================================================================
  Consultation
  Resuming a case
------------------------------------------------------------------------------
  To resume a case, enter the patient's name (first name, last name).
  If you would like to see a list of the cases that have been saved,
  enter the word "list" instead of a patient's name.

  >







------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options


==============================================================================
Screen #90
```

```
Screen #100
==============================================================================
  Consultation
  Patient list
------------------------------------------------------------------------------
  The following list contains the names of the patients whose cases have been
  saved. To indicate the case you would like to resume, enter the NUMBER of
  the case. To see the next section of the list, press RETURN. You can enter
  the case number at any time when looking through the list.

  1 - Baggins, Bilbo                 7 - Dwarf, Happy
  2 - Baggins, Frodo                 8 - Dwarf, Sleepy
  3 - Dwarf, Bashful                 9 - Dwarf, Sleezy
  4 - Dwarf, Doc                    10 - Dwarf, Sneezy
  5 - Dwarf, Dopey                  11 - Dwarff, Luigi
  6 - Dwarf, Grumpy                 12 - Elf, Olaf

  >
------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options


==============================================================================
Screen #100
```

```
Screen #100A - Last patient list screen (if list extends beyond one screen)
===========================================================================
  Consultation
  Patient list
---------------------------------------------------------------------------
  13 - Gardner, Samwise
  14 - LeFay, Morgan

  >



  All patient names have now been listed. At this time, either enter the
  number of the case you would like to resume, or press RETURN to return
  to the beginning of the list.

---------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options


===========================================================================
Screen #100A
```

```
Screen #110
===========================================================================
  Consultation
  Resuming a case
---------------------------------------------------------------------------

  The patient file for  GERTRUDE STEIN
  has not been found.

  Either re-enter the patient's name (first name, last name), or enter the
  word "list" so that you can check the patient list to see if that case
  has been saved.

  >



---------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options


===========================================================================
Screen #110
```

```
Screen #120
================================================================================
  Consultation
  Resuming a case
--------------------------------------------------------------------------------

  Resuming the case of:   GEORGE GERSHWIN

  Attending physician:  I. BERLIN





  >                       [press RETURN to continue]

--------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options
  COR  - to CORrect data that has already been recorded by the system

================================================================================
Screen #120
```

```
Screen #130
================================================================================
  Consultation
  Resuming a case;  Correcting patient information
--------------------------------------------------------------------------------

  Resuming the case of:   GEORGE GERSHWIN

  Attending physician:  I. BERLIN


--------------------------------------------------------------------------------

  Please enter the correct name of the patient:
    (first name, middle initial, last name)
  If the current listing is correct, press RETURN to continue.


  >



================================================================================
Screen #130
```

```
Screen #140
================================================================================
  Consultation
  Resuming a case;  Correcting patient information
--------------------------------------------------------------------------------

  Resuming the case of:   GEORGE GERSHWIN

  Attending physician:  I. BERLIN



--------------------------------------------------------------------------------
  Please enter the correct name of the attending physician:
    (first initial, last name)
  If the current listing is correct, press RETURN to continue.


  >





================================================================================
Screen #140
```

```
Screen #150
================================================================================
  Consultation
  Determining the anatomical location of the stroke
--------------------------------------------------------------------------------
  Have you already determined the anatomical location of the stroke?
  1 - Yes
  2 - No
  >







--------------------------------------------------------------------------------
 Available options:
 HELP - for HELP on how to use the system
 STOP - to STOP what you're doing and return to the table of options


================================================================================
Screen #150
```

```
Screen #160 - Sample PAL screen
==============================================================================
  Determining the anatomical location of the stroke

------------------------------------------------------------------------------
  What is the patient's level of consciousness?
  1 - alert
  2 - lethargic
  3 - stuporous or comatose
  >






------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options
  COR  - to CORrect data that has already been recorded by the system
  DEF  - to DEFine terms or see criteria for making a choice
  WHY  - to see WHY the system is asking a question
==============================================================================
Screen #160 - Sample PAL screen
```

```
Screen #170
==============================================================================
  Determining the anatomical location of the stroke

------------------------------------------------------------------------------
  Here is a summary of some of the answers you have given. Please check the
  list for any errors.
    patient is alert
    no stiff neck
    right pyramidial defects
    no visual field deficits
    Brocas aphasia


 Are there any errors in this list?
 1 - Yes        2 - No
 >
------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options
  WHY  - to see WHY the system is asking a question

==============================================================================
Screen #170
```

```
Screen #180
================================================================================
  Determining the anatomical location of the stroke
  Changing incorrect information
--------------------------------------------------------------------------------
  You have indicated that one or more of the items below is incorrect. Please
  type the NUMBERS of the items that are incorrect, separating each number with
  a space; then, after all the numbers have been typed, press RETURN.

   90 - alert
  120 - no stiff neck
   67 - right pyramidial defects
   81 - no visual field deficits
  223 - Brocas aphasia


  Incorrect items: >
--------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options
  DEF  - to DEFine terms or see criteria for making a choice

================================================================================
Screen #180
```

```
Screen #190
================================================================================
  Determining the anatomical location of the stroke
  Changing incorrect information
--------------------------------------------------------------------------------
  At least one of the numbers you have entered has not been recognized as a
  number from the list below. The items that have been recognized have been
  highlighted. Please re-enter the number of any other item that is incorrect.
  (If no other item is incorrect, press RETURN to continue.)
   90 - alert
  120 - no stiff neck
   67 - right pyramidial defects
   81 - no visual field deficits
  223 - Brocas aphasia


  Incorrect items: >
--------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options
  DEF  - to DEFine terms or see criteria for making a choice

================================================================================
Screen #190
```

```
Screen #200
================================================================================
 Determining the anatomical location of the stroke

--------------------------------------------------------------------------------
   Diagnosis completed.
   The most likely anatomical location of the stroke is:

     LEFT OCCIPITAL LESION

   Of   5 cases recorded,   2 displayed symptoms similar to the current case.
   The diagnoses of these cases were:
     1 cases     LEFT OCCIPITAL LESION
     1 cases     LEFT PARIETAL LESION



     >                      [press RETURN to continue]
--------------------------------------------------------------------------------
 Available options:
 HELP - for HELP on how to use the system
 STOP - to STOP what you're doing and return to the table of options
 COR  - to CORrect data that has already been recorded by the system
 DEF  - to DEFine terms or see criteria for making a choice
 LIT  - to see LITerature references
================================================================================
Screen #200
```

```
Screen #210
================================================================================
 Asking for the anatomical location of the stroke

--------------------------------------------------------------------------------
  The following list contains 48 anatomical locations. To indicate the
  anatomy of the stroke, enter the NUMBER of one of the following locations.
  To see the next section of the list, press RETURN. You can enter the
  anatomy at any point as you look through the list.

  200 - left frontal lesion
  201 - right frontal lesion
  202 - left parietal lesion
  203 - right parietal or right temporal lesion
  204 - left occipital lesion
  205 - right occipital lesion
  206 - left temporal lesion
  >
--------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options
  LIT  - to see LITerature references


================================================================================
Screen #210
```

```
Screen #210A - Last ANAT screen
================================================================================
  Asking for the anatomical location of the stroke

--------------------------------------------------------------------------------
  300 - left frontal lesion
  301 - right frontal lesion
  302 - left parietal lesion
  303 - right parietal or right temporal lesion
  304 - left occipital lesion
  305 - right occipital lesion
  306 - left temporal lesion
  >

  All 48 anatomical locations have now been presented. At this time, either
  enter the number of the anatomical location of the stroke, or
  press RETURN to return to the beginning of the list.
--------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options
  LIT  - to see LITerature references

================================================================================
Screen #210A - Last ANAT screen
```

```
Screen #220
================================================================================
  Asking for the anatomical location of the stroke

--------------------------------------------------------------------------------

  The diagnosis for the anatomical location of the stroke has been recorded as

      LEFT FRONTAL LESION




  >                      [press RETURN to continue]

--------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options
  COR  - to CORrect data that has already been recorded by the system
  LIT  - to see LITerature references

================================================================================
Screen #220
```

```
Screen #230
===========================================================================
  Resuming a case

---------------------------------------------------------------------------
  The anatomical location of the stroke has been diagnosed as
      LEFT FRONTAL LESION


  The mechanism of the stroke will be determined next.





  >                      [press RETURN to continue]

---------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options
  COR  - to CORrect data that has already been recorded by the system

===========================================================================
Screen #230
```

```
Screen #240
===========================================================================
  Resuming a case
  Correcting anatomical location of the stroke
---------------------------------------------------------------------------
  The anatomical location of the stroke has been diagnosed as
      LEFT FRONTAL LESION




---------------------------------------------------------------------------
  Do you want to correct the diagnosis for anatomical location by:
  1 - entering this information directly
  2 - using the Stroke Consultant to aid in determining the anatomical location
  3 - this diagnosis is correct; I don't want to change it
  >




===========================================================================
Screen #240
```

```
Screen #250
==============================================================================
  Resuming a case

------------------------------------------------------------------------------
  The anatomical location of the stroke has been diagnosed as
      LEFT FRONTAL LESION

  The mechanism of the stroke has been diagnosed as
      INFARCT




  >                        [press RETURN to continue]
------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options
  COR  - to CORrect data that has already been recorded by the system

==============================================================================
Screen #250
```

```
Screen #260
==============================================================================
  Resuming a case
  Correcting information
------------------------------------------------------------------------------
  The anatomical location of the stroke has been diagnosed as
      LEFT FRONTAL LESION

  The mechanism of the stroke has been diagnosed as
      INFARCT

------------------------------------------------------------------------------
  Which of the following needs correction? (If both, correct anatomical
  location first.)
  1 - anatomical location
  2 - mechanism
  3 - these diagnoses are correct; I don't want to change either of them
  >



==============================================================================
Screen #260
```

Screen #270

Resuming a case
Correcting the diagnosis for anatomical location

The anatomical location of the stroke has been diagnosed as
LEFT FRONTAL LESION

The mechanism of the stroke has been diagnosed as
INFARCT

Changing the diagnosis for anatomical location may change the diagnosis for the mechanism of the stroke. After correcting the diagnosis for the anatomical location, additional information may be requested so that the diagnosis for the mechanism of the stroke can also be corrected.

[press RETURN to continue]

Screen #270

Screen #280

Resuming a case
Correcting the diagnosis for mechanism

The anatomical location of the stroke has been diagnosed as
LEFT FRONTAL LESION

The mechanism of the stroke has been diagnosed as
INFARCT

Do you want to correct the diagnosis for mechanism by:
1 - entering this information directly
2 - using the Stroke Consultant to aid in determining the mechanism
3 - this diagnosis is correct; I don't want to change it
>

Screen #280

```
Screen #290
==============================================================================
  Resuming a case

------------------------------------------------------------------------------
  The anatomical location of the stroke has been diagnosed as
      LEFT FRONTAL LESION

  The mechanism of the stroke has been diagnosed as
      INFARCT

  The following laboratory test results have been obtained:
    CT scan
    Angiogram
        .
        .
        .
  >                         [press RETURN to continue]
------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options
  COR  - to CORrect data that has already been recorded by the system

==============================================================================
Screen #290
```

```
Screen #300
==============================================================================
  Resuming a case
  Correcting information
------------------------------------------------------------------------------
  The anatomical location of the stroke has been diagnosed as
      LEFT FRONTAL LESION

  The mechanism of the stroke has been diagnosed as
      INFARCT

  The following laboratory test results have been obtained:
------------------------------------------------------------------------------
  Which of the following needs correction? (If more than one, correct the
  lower numbered item first. For example, if both anatomical location and
  mechanism need to be corrected, correct the diagnosis for anatomical
  location first.)
  1 - anatomical location
  2 - mechanism
  3 - laboratory test results
  4 - I don't want to change any of these
  >

==============================================================================
Screen #300
```

Screen #310

==

Resuming a case
Correcting the diagnosis for anatomical location

The anatomical location of the stroke has been diagnosed as
LEFT FRONTAL LESION

The mechanism of the stroke has been diagnosed as
INFARCT

The following laboratory tests results have been obtained:

Changing the diagnosis for anatomical location may change the diagnosis for the mechanism of the stroke and the tests needed to confirm these diagnoses. After correcting the diagnosis for anatomical location, additional information may be requested so that the diagnosis for the mechanism of the stroke can also be corrected and the test results needed for confirmation are entered.

[press RETURN to continue]

==

Screen #310

Screen #320

==

Resuming a case
Correcting the diagnosis for mechanism of the stroke

The anatomical location of the stroke has been diagnosed as
LEFT FRONTAL LESION

The mechanism of the stroke has been diagnosed as
INFARCT

The following laboratory test results have been obtained:

Changing the diagnosis for the mechanism of the stroke may require additional test results to confirm the diagnosis. After correcting the diagnosis for the mechanism, this information will be requested if required.

[press RETURN to continue]

==

Screen #320

Screen #330

Consultation

Consultation on the diagnosis and management of the stroke has been completed.

Press RETURN to return to the table of the system's available options.

Screen #330

Screen #340

Saving the case

The case of CHARLES DICKENS

has been saved.

[press RETURN to continue]

Screen #340

Screen #350

==

Saving the case

No case exists -- nothing has been saved.

[press RETURN to continue]

==

Screen #350

Screen #360

==

Summary

Would you like a summary of the present case or of a previous case?
1 - present case
2 - previous case
>

Available options:
HELP - for HELP on how to use the system
STOP - to STOP what you're doing and return to the table of options

==

Screen #360

Screen #370

```
=============================================================================
  Summary
  Resuming a previous case
-----------------------------------------------------------------------------

  The information of the present case will be lost if it is not saved before
  a summary of a previous case is given.

  Do you want to save the data on  RUDOLPH VALENTINO
  for future use?
  1 - Yes
  2 - No
  >

-----------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options

=============================================================================
Screen #370
```

Screen #380

```
=============================================================================
  Summary
  Resuming a previous case; saving the present case
-----------------------------------------------------------------------------

  The case of RUDOLPH VALENTINO

  has been saved.

                           [press RETURN to continue]
-----------------------------------------------------------------------------

=============================================================================
Screen #380
```

Screen #390

```
==============================================================================
  Summary
  Resuming a case
------------------------------------------------------------------------------
  To get a summary of a previous case, enter the patient's name (first
  name, last name).
  If you would like a see a list of the cases that have been saved,
  enter the word "list" instead of a patient's name.

  >







------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options


==============================================================================
```

Screen #390

Screen #400

```
==============================================================================
  Summary
  Patient list
------------------------------------------------------------------------------
  The following list contains the names of the patients whose cases have been
  saved. To indicate the case you would like to resume, enter the NUMBER of
  the case. To see the next section of the list, press RETURN. You can enter
  the case number at any time when looking through the list.

  1 - Chapman, Graham                  7 - Jones, Terry
  2 - Cleese, John                     8 - Milligan, Spike
  3 - Cook, Peter                      9 - Moore, Dudley
  4 - Gillian, Terry                  10 - Palin, Michael
  5 - Idle, Eric                      11 - Python, Monty
  6 - Jones, Spike                    12 - Sellers, Peter

  >
------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options


==============================================================================
```

Screen #400

Screen #400A - Last patient list screen (if list extends beyond one screen)

```
===============================================================================
  Summary
  Patient list
-------------------------------------------------------------------------------
  13 - Two, Ronnies

  >




  All patient names have now been listed. If you want a summary of a case,
  enter the number of that case. If you want to return to the beginning of
  the list, press RETURN.

-------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options


===============================================================================
Screen #400A
```

Screen #410

```
===============================================================================
  Summary
  Resuming a case
-------------------------------------------------------------------------------

  The patient file for  ALBERT EINSTEIN
  has not been found.

  Either re-enter the patient's name (first name, last name), or enter the
  word "list" so that you can check the patient list to see if that case
  has been saved.

  >



-------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options


===============================================================================
Screen #410
```

```
Screen #420
================================================================================
  Summary

--------------------------------------------------------------------------------

  Patient:  HANS C. ANDERSEN

  Attending physician:  B. GRIMM


  No other information about this case has been recorded.



                         [press RETURN to continue]

--------------------------------------------------------------------------------





================================================================================
Screen #420
```

```
Screen #430
================================================================================
                         IIT - MRH STROKE CONSULTANT
                                   Summary
--------------------------------------------------------------------------------
  Patient's name:
  Physician's name:

  The stroke was caused by (MECHANISM)
  of the (LOCATION).

  The following tests were performed, ??confirming the diagnosis??:
    CT scan
    Angiogram
      .
      .
      .

  The following treatment was recommended:
   Blah
   blah
   blah

                         [press RETURN to continue]
--------------------------------------------------------------------------------
================================================================================
Screen #430
```

Screen #440

```
================================================================================
  Summary

--------------------------------------------------------------------------------
  Would you like a printed copy of this summary?
  1 - Yes
  2 - No
  >

--------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options

================================================================================
```

Screen #440

Screen #450

```
================================================================================
  Summary

--------------------------------------------------------------------------------

      Your case summary is being printed and will be ready in a moment.

                            [press RETURN to continue]

--------------------------------------------------------------------------------

================================================================================
```

Screen #450

```
Screen #460
===========================================================================
  Case Report

---------------------------------------------------------------------------
  Would you like a case report of the present case or of a previous case?
  1 - present case
  2 - previous case
  >

---------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options

===========================================================================
Screen #460
```

```
Screen #470
===========================================================================
  Case report
  Resuming a previous case
---------------------------------------------------------------------------

  The information of the present case will be lost if it is not saved before
  a case report of a previous case is printed.

  Do you want to save the information on THOMAS HARDY
  for future use?
  1 - Yes
  2 - No
  >

---------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options

===========================================================================
Screen #470
```

```
Screen #480
================================================================================
  Case report
  Resuming a previous case; saving the present case
--------------------------------------------------------------------------------

  The case of THOMAS HARDY

  has been saved.




                         [press RETURN to continue]
--------------------------------------------------------------------------------
```

```
================================================================================
Screen #480
```

```
Screen #490
================================================================================
  Case report
  Resuming a case
--------------------------------------------------------------------------------
  To get a case report of a previous case that has been saved, enter the
  patient's name (first name, last name).
  If you would like to see a list of the cases that have been saved,
  enter the word "list" instead of a patient's name.

  >




--------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options
```

```
================================================================================
Screen #490
```

Screen #500

==

Case Report
Patient list

The following list contains the names of the patients whose cases have been saved. To indicate the case you would like to resume, enter the NUMBER of the case. To see the next section of the list, press RETURN. You can enter the case number at any time when looking through the list.

1 - Adams, John	7 - Eisenhower, Dwight D.
2 - Adams, John Q.	8 - Garfield, James A.
3 - Arthur, Chester A.	9 - Grant, Ulysses S.
4 - Buchanan, James	10 - Harding, Warren G.
5 - Cleveland, Grover	11 - Harrison, William H.
6 - Coolidge, Calvin	12 - Hayes, Rutherford B.

>

Available options:
HELP - for HELP on how to use the system
STOP - to STOP what you're doing and return to the table of options

==

Screen #500

Screen #500A - Last patient list screen (if list extends beyond one screen)

==

Case Report
Patient list

----

27 - Roosevelt, Theodore	30 - Tyler, John
28 - Taylor, Zachary	31 - Washington, George
29 - Truman, Harry S.	32 - Wilson, Woodrow

All patient names have now been listed. To have a case report printed, enter the number of the case you want. If you want to return to the beginning of the list, press RETURN.

Available options:
HELP - for HELP on how to use the system
STOP - to STOP what you're doing and return to the table of options

==

Screen #500A

```
Screen #510
================================================================================
  Case report
  Resuming a case
--------------------------------------------------------------------------------

  The patient file for  FRANK N. STEIN
  has not been found.

  Either re-enter the patient's name (first name, last name), or enter the
  word "list" so that you can check the patient list to see if that case
  has been saved.

  >


--------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options


================================================================================
Screen #510
```

```
Screen #520
================================================================================
  Case Report

--------------------------------------------------------------------------------

  Patient:  OSCAR WILDE

  Attending physician:  J. JOYCE


  No other information about this case has been recorded. A case report will
  not be printed.


                          [press RETURN to continue]

--------------------------------------------------------------------------------



================================================================================
Screen #520
```

```
Screen #530
==============================================================================
  Case Report

------------------------------------------------------------------------------

       Your case report is being printed and will be ready in a moment.




                          [press RETURN to continue]
------------------------------------------------------------------------------



==============================================================================
Screen #530
```

```
Screen #540
==============================================================================
  Ending the consultation

------------------------------------------------------------------------------
  Do you want to save the case of VINCENT VAN GOGH
  for future use?
  1 - Yes
  2 - No
  >




------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options


==============================================================================
Screen #540
```

Screen #550

==

Ending the consultation
Saving the case

The case of VINCENT VAN GOGH

has been saved.

[press RETURN to continue]

==

Screen #550

Screen #560

==

Thank you for using the

IIT - MRH STROKE CONSULTANT

==

Screen #560

```
Screen #600
==============================================================================
  [Whatever was here when the user asked for help]
  Help
------------------------------------------------------------------------------
  [ This screen should contain the first seven lines of whatever    ]
  [ was displayed when the user asked for help.                     ]
  [                                                                 ]
  [                                                                 ]
  [                                                                 ]
  [                                                                 ]
  [                                                                 ]
------------------------------------------------------------------------------
  Help script here - cued to user's place in the system.







  >                     [press RETURN to continue]
==============================================================================
Screen #600
```

```
Screen #610
==============================================================================
  [Whatever was here when the user asked for help]
  Help
------------------------------------------------------------------------------
  [ This screen should contain the first seven lines of whatever    ]
  [ was displayed when the user asked for help.                     ]
  [                                                                 ]
  [                                                                 ]
  [                                                                 ]
  [                                                                 ]
  [                                                                 ]
------------------------------------------------------------------------------
  Would you like to see a list of topics for which help is available?
  1 - yes
  2 - no
  >






==============================================================================
Screen #610
```

```
Screen #620
================================================================================
  [Whatever was here when the user asked for help]
  Help
--------------------------------------------------------------------------------
  [ This screen should contain the first seven lines of whatever  ]
  [ was displayed when the user asked for help.                   ]
  [                                                               ]
  [                                                               ]
  [                                                               ]
  [                                                               ]
  [                                                               ]
--------------------------------------------------------------------------------
                         Help Topics
     Enter the number of the topic for which you would like help;
  or press RETURN to see the next screen of topics;
  or enter "exit" to leave help and return to the consultation.

  1. topic                        6. topic
  2. topic                        7. topic
  3. topic                        8. topic
  4. topic                        9. topic
  5. topic                       10. topic

  >         [enter a number, "exit", or press RETURN to see next screen]
================================================================================
Screen #620
```

```
Screen #630
================================================================================
  [Whatever was here when the user asked for help]
  Help
--------------------------------------------------------------------------------
  [ This screen should contain the first seven lines of whatever  ]
  [ was displayed when the user asked for help.                   ]
  [                                                               ]
  [                                                               ]
  [                                                               ]
  [                                                               ]
  [                                                               ]
--------------------------------------------------------------------------------
  The number you entered has not been recognized as a valid number of a
  help topic. Please re-enter the topic number.

  1. topic                        8. topic
  2. topic                        9. topic
  3. topic                       10. topic
  4. topic                       11. topic
  5. topic                       12. topic
  6. topic                       13. topic
  7. topic                       14. topic

  >         [enter a number, "exit", or press RETURN to see next screen]
================================================================================
Screen #630
```

```
Screen #640
==========================================================================
  [Whatever was here when the user asked for help]
  Help
--------------------------------------------------------------------------
  [ This screen should contain the first seven lines of whatever   ]
  [ was displayed when the user asked for help.                    ]
  [                                                                ]
  [                                                                ]
  [                                                                ]
  [                                                                ]
  [                                                                ]
--------------------------------------------------------------------------
  Topic - Help script..........................





  >         [press RETURN to continue or enter "exit" to leave HELP]
==========================================================================
Screen #640
```

```
Screen #650
==========================================================================
  [Whatever was here when the user asked for define]
  Define
--------------------------------------------------------------------------
  [ This screen should contain the first seven lines of whatever   ]
  [ was displayed when the user asked for define.                  ]
  [                                                                ]
  [                                                                ]
  [                                                                ]
  [                                                                ]
  [                                                                ]
--------------------------------------------------------------------------
  Define script....................





  >                    [press RETURN to continue]
==========================================================================
Screen #650
```

```
Screen #660
===========================================================================
  [Whatever was here when the user asked for why]
  Why
---------------------------------------------------------------------------
  [ This screen should contain the first seven lines of whatever  ]
  [ was displayed when the user asked for define.                 ]
  [                                                               ]
  [                                                               ]
  [                                                               ]
  [                                                               ]
  [                                                               ]
---------------------------------------------------------------------------
  Seerule script...................




  >                      [press RETURN to continue]
===========================================================================
Screen #660
```

```
Screen #670
===========================================================================
  [Whatever was here when the user asked for litref]
  Literature References
---------------------------------------------------------------------------
  [ This screen should contain the first seven lines of whatever  ]
  [ was displayed when the user asked for litref.                 ]
  [                                                               ]
  [                                                               ]
  [                                                               ]
  [                                                               ]
  [                                                               ]
---------------------------------------------------------------------------
  Litref script - cued to user's place in the system.




                       [press RETURN to continue]
===========================================================================
Screen #670
```

```
Screen #680
================================================================================
 [Whatever was here when the user asked for litref]
 Literature References
--------------------------------------------------------------------------------
 [ This screen should contain the first seven lines of whatever   ]
 [ was displayed when the user asked for litref.                  ]
 [                                                                ]
 [                                                                ]
 [                                                                ]
 [                                                                ]
 [                                                                ]
--------------------------------------------------------------------------------
 There are 12 references on this topic.
 To see the abstract of a reference, enter the number of the reference. More
 than one number can be entered at a time, but they must be separated by
 spaces. To leave LITR and return to the consultation, enter "exit".

   5. Arseni C, Samitca DC. Cysticercosis of the brain. Br Med J 1957,
      2, 494-7.
  18. Berman JD, Beaver PC, Cheever AW, Quindlen EA. Cysticercosis of
      60-milliliter volume in human brain. Am J Trop Med Hyg 1981, 30,
      616-9.

  >         [Enter a number, "exit", or press RETURN to see next screen.]
================================================================================
Screen #680
```

```
Screen #680A - second Litref screen
================================================================================
 [Whatever was here when the user asked for litref]
 Literature References
--------------------------------------------------------------------------------
 [ This screen should contain the first seven lines of whatever   ]
 [ was displayed when the user asked for litref.                  ]
 [                                                                ]
 [                                                                ]
 [                                                                ]
 [                                                                ]
 [                                                                ]
--------------------------------------------------------------------------------
  32. Greenspan G, Stevens, L. Infection with Cysticercus cellulosae;
      report of a case. N Engl J Med 1961, 264, 751-3.
  54. McCormick GF. Praziquantel therapy for cysticercosis. Arch Neurol
      1983, 40, 258.
  56. McCormick GF, Giannotta S, Zee C, Fisher M. Carotid occulsion in
      cysticercosis. Neurology (Minneap) 1983, 33, 1078-80.
  70. Pupo PP. Cysticercosis of the nervous system: clinical manifesta-
      tions. Rev Neuropsiquiatr 1964, 27, 70-82.
  93. Stepien L. Cerebral cysticercosis in Poland: clinical symptoms and
      operative results in 132 cases. J Neurosurg 1962, 19, 505-13.

  >       [Enter a number(s), "exit", or press RETURN to see next screen]
================================================================================
Screen #680A
```

```
Screen #690
================================================================================
  [Whatever was here when the user asked for litref]
  Literature References
--------------------------------------------------------------------------------
  [ This screen should contain the first seven lines of whatever   ]
  [ was displayed when the user asked for litref.                  ]
  [                                                                ]
  [                                                                ]
  [                                                                ]
  [                                                                ]
  [                                                                ]
--------------------------------------------------------------------------------
  A number you entered has not been recognized as a valid reference
  number. Please re-enter the number(s) of the reference(s) for which
  you would like to see the abstract(s).

  32. Greenspan G, Stevens, L. Infection with Cysticercus cellulosae;
      report of a case. N Engl J Med 1961, 264, 751-3.
  54. McCormick GF. Praziquantel therapy for cysticercosis. Arch Neurol
      1983, 40, 258.
  56. McCormick GF, Giannotta S, Zee C, Fisher M. Carotid occulsion in
      cysticercosis. Neurology (Minneap) 1983, 33, 1078-80.

  >        [Enter a number(s), "exit", or press RETURN to see next screen]
================================================================================
Screen #690
```

```
Screen #700
================================================================================
  [Whatever was here when the user asked for litref]
  Literature References
--------------------------------------------------------------------------------
  [ This screen should contain the first seven lines of whatever   ]
  [ was displayed when the user asked for litref.                  ]
  [                                                                ]
  [                                                                ]
  [                                                                ]
  [                                                                ]
  [                                                                ]
--------------------------------------------------------------------------------
  5. Arseni C, Samitca DC. Cysticercosis of the brain. Br Med J 1957,
     2, 494-7.

    [Abstract] Cysticerscosis is one of those unfortunate things that can
    happen to your brain if you don't take proper care of it. There are
    three main causes of cysticercosis of the brain: 1) a diet deficient in
    both zinc and magnesium; 2) a lifestyle that includes too many Three
    Stooges film festivals; 3) belief in the reality of the resiliency of
    the Coyote of the Road Runner series fame, and subsequent action
    consistent with this belief. Cysticerscosis can be treated by either

  >        [press RETURN to continue or enter "exit" to leave LITR]
================================================================================
Screen #700
```

```
Screen #710
================================================================================
  Literature References

--------------------------------------------------------------------------------
                        Literature References Topics

  Enter the number of the topic for which you would like to see references;
  press RETURN to see the next screen of topics.

   1. Abcess                           7. Congenital vascular malformation
   2. Aneurysm                         8. Corpus callosum
   3. Atherosclerosis                  9. Embolism
   4. Cerebellum                      10. Encephalitis
   5. Cerebrospinal fluid             11. Encephalomalacia
   6. Coma, hepatic                   12. Encephalomyelopathy optico

  >              [Enter a number or press RETURN to see next screen]
--------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options


================================================================================
Screen #710
```

```
Screen #720
================================================================================
  Literature References

--------------------------------------------------------------------------------
  The number you entered has not been recognized as a valid reference
  topic number. Please re-enter the topic number.

   1. Abcess                           8. Corpus callosum
   2. Aneurysm                         9. Embolism
   3. Atherosclerosis                 10. Encephalitis
   4. Cerebellum                      11. Encephalomalacia
   5. Cerebrospinal fluid             12. Encephalomyelopathy optico
   6. Coma, hepatic                   13. Glial heterotopia in subarachnoid
   7. Congential vascular                  space
        malforamtion                  14. Gliomatosis

  >              [Enter a number or press RETURN to see next screen]
--------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options


================================================================================
Screen #720
```

```
Screen #730
================================================================================
  Literature References

--------------------------------------------------------------------------------
  There are 12 references on this topic.
  To see the abstract of a reference, enter the number of the reference. More
  than one number can be entered at a time, but the numbers must be separated
  by spaces.
  To leave LITR and return to the table of options, enter "stop".

   5. Arseni C, Samitca DC. Cysticercosis of the brain. Br Med J 1957,
      2, 494-7.
  18. Berman JD, Beaver PC, Cheever AW, Quindlen EA. Cysticercosis of
      60-milliliter volume in human brain. Am J Trop Med Hyg 1981, 30,
      616-9.

  >             [Enter a number or press RETURN to see next screen]
--------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options


================================================================================
Screen #730
```

```
Screen #740
================================================================================
  Literature References

--------------------------------------------------------------------------------
  At least one number you entered has not been recognized as a valid
  reference number. Please re-enter the number(s) of the reference(s) for
  which you would like to see the abstract(s).

   5. Arseni C, Samitca DC. Cysticercosis of the brain. Br Med J 1957,
      2, 494-7.
  18. Berman JD, Beaver PC, Cheever AW, Quindlen EA. Cysticercosis of
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  >             [Enter a number or press RETURN to see next screen]
--------------------------------------------------------------------------------
  Available options:
  HELP - for HELP on how to use the system
  STOP - to STOP what you're doing and return to the table of options


================================================================================
Screen #740
```

Screen #750

==

Literature References

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5. Arseni C, Samitca DC. Cysticercosis of the brain. Br Med J 1957, 2, 494-7.

[Abstract] Cysticerscosis is one of those unfortunate things that can happen to your brain if you don't take proper care of it. There are three main causes of cysticercosis of the brain: 1) a diet deficient in both zinc and magnesium; 2) a lifestyle that includes too many Three Stooges film festivals; 3) belief in the reality of the resiliency of the Coyote of the Road Runner series fame, and subsequent action consistent with this belief. Cysticerscosis can be treated by either a full frontal lobotomy or peanut butter sandwiches. A recent study

[Press RETURN to see next screen]

Available options:
HELP - for HELP on how to use the system
STOP - to STOP what you're doing and return to the table of options

==

Screen #750

APPENDIX C

MISAR # ______

PID # ______

(PN) FORM B

SDB Stroke Data Bank
Background Information

1B. Date and time of admission:

__ __ ___ __ __ __
Day Mo Yr Hr Min

2B. Medical record number

____

3B. Data collector __
(see Center's code list)

4B. Date of birth

__ ___ __
Day Mo Yr

5B. Age ______
(computed item, *complete only if DOB not available)*

U Unknown

6B. Sex

0 Female
1 Male

7B. Race

0 White
1 Black
2 Other

8B. Handedness

1 Left
2 Right
3 Ambidextrous or switched
U Unknown

9B. Height, in inches __
U Unknown

10B. Weight, in pounds ___
U Unknown

11B. Subject interviewed

1 Patient
2 Patient's family/friend
3 Patient and family/friend
4 Nurse
5 Other

12B. If other, specify

______

13B. Date of interview

__ ___ __
Day Mo Yr

14B. Education (circle only the highest level completed)

1 Grade 8 or less
2 Grade 9-11
3 High school
4 Some college
5 College
6 Postgraduate
U Unknown

15B. Education of most recent spouse (circle only highest level completed)

1 Grade 8 or less
2 Grade 9-11
3 High school
4 Some college
5 College graduate
6 Postgraduate
A Not applicable
U Unknown

16B. Total household income (choose one)

1 Less than $5,000
2 $5,000 - $7,499
3 $7,500 - $9,999
4 $10,000 - $14,999
5 $15,000 - $19,999
6 $20,000 - 29,999
7 $30,000 - $39 999
8 $40,000 - $49,999
9 $50,000 or more
U Unknown

17B. Employment status prior to this stroke (circle one)

1 Full-time
2 Part-time
3 Homemaker
4 Student
5 Unemployed
6 Retired
U Unknown

18B. If retired, primary reason

1 Age
2 Health
3 Other
U Unknown

19B. Age at Retirement __
U Unknown

20B. Occupation - what they did most of their working career

1 Operates farm
2 Does other farm work
3 Does heavy physical work (unskilled)
4 Provides services to people
5 Operates vehicles
6 Helps manufacture, process, or service things
7 Practices skilled trade or craft
8 Does office or clerical work
9 Sells things
10 Is manager or administrator in business, organization, or government
11 Practices profession or technical specialty
12 Homemaker (housewife or househusband)
13 Student
U Unknown
A Not applicable

21B. Occupation of spouse __
(use list for 20B)

22B. Marital status

0 Never married
1 Married
2 Widowed
3 Separated
4 Divorced
U Unknown

23B. Where does patient live?

1 At home
2 Retirement home - room and board rather than nursing care
3 Nursing home - sheltered or custodial home, limited nursing care
4 Skilled nursing facility (certified by Medicare/Medicaid) or part of hospital
5 Rehabilitation center
6 Other

24B. If other, specify

______

25B. Who does patient live with? (circle all that apply)

1 Lives alone
2 Spouse/partner/ significant other
3 Children
4 Parents
5 Other family/friends
6 Other

MISAR # ______
PID # ______
(PN/PI) FORM M

SDB Stroke Data Bank
Medical History

1M. Date completed

__ __ / __ __ __ / __ __
Day Mo Yr

2M. Data collector ...
(see Center's code list)

3M. Has the patient ever been diagnosed or treated for hypertension?
- 0 No, never
- 1 Yes, no treatment at time of onset
- 2 Yes, treated at time of onset
- U Unknown

4M. Has the patient ever had a myocardial infarction?
- 0 No
- 1 Yes, most recent was more than 6 months ago
- 2 Yes, indeterminate age, e g., EKG only
- 3 Yes, most recent was less than 6 months ago
- U Unknown

5M. Date of most recent myocardial infarction

__ __ / __ __ __ / __ __
Day Mo Yr

6M. History of valvular heart disease?
- 0 No
- 1 Yes
- U Unknown

If yes (6M = 1), answer 7M-9M.

7M. Types (circle all that apply)
- 1 Aortic stenosis
- 2 Aortic regurgitation
- 3 Aortic valve replaced
- 4 Mitral stenosis
- 5 Mitral regurgitation
- 6 Mitral valve replaced
- 7 Mitral valve prolapse
- 8 Mitral annulus calcification
- 9 Other
- U Unknown

8M. History of valvular surgery?
- 0 No
- 1 Yes, most recent was more than 6 months ago
- 2 Yes, most recent was less than 6 months ago
- U Unknown

9M. Date of most recent valvular surgery

__ __ / __ __ __ / __ __
Day Mo Yr

Has the patient been diagnosed or treated for

		No	Yes	Unknown
10M.	Atrial fibrillation	0	1	U
11M.	Other arrhythmias	0	1	U
12M.	Systemic emboli	0	1	U
13M.	Angina	0	1	U
14M.	Congestive failure	0	1	U
15M.	Claudication	0	1	U
16M.	Chronic obstructive pulmonary disease	0	1	U

17M. Has the patient been diagnosed or treated for diabetes?
- 0 No, never
- 1 Yes, no treatment or diet only
- 2 Yes, oral agents
- 3 Yes, insulin
- U Unknown

18M. Has the patient ever been diagnosed or treated for cancer?
- 0 No
- 1 Yes
- U Unknown

If yes (18M = 1), answer 19M.

19M. Type of cancer

____

20M. Was the patient pregnant at the time of the stroke?
- 0 No
- 1 Yes
- U Unknown

21M. Did the patient use oral contraceptives in the year preceding this stroke?
- 0 No
- 1 Yes
- U Unknown

MISAR # ______
PID # ______
(PI) FORM N

SDB Stroke Data Bank

Neurologic History

1N. Date and time of onset of present stroke (Note: *Critical item - once entered, cannot be changed*)

__ __ Day __ __ __ Mo __ __ Yr __ __ Hr __ __ Min

2N. Date completed

__ __ Day __ __ __ Mo __ __ Yr

3N. Data collector __ __ (see Center's code list)

4N. Has patient ever had a TIA?
- 0 No, never
- 1 Yes, 1-7 days ago
- 2 Yes, 8-30 days ago
- 3 Yes, 1-6 months ago
- 4 Yes, over 6 months ago
- U Unknown

If yes (4N = 1, 2, 3, or 4), answer 5N-7N.

5N. Number of TIA's
- 1 1
- 2 2-5
- 3 6-50
- 4 >50
- U Unknown

6N. Vascular territory of past TIA's
- 1 Right carotid
- 2 Left carotid
- 3 Vertebral-basilar
- 4 Multiple territories
- U Unknown

7N. Prior TIA in same territory as present stroke?
- 0 No
- 1 Yes
- U Unknown

8N. Has patient ever had a stroke before this one?
- 0 No, never
- 1 Yes, 1-7 days ago
- 2 Yes, 8-30 days ago
- 3 Yes, 1-6 months ago
- 4 Yes, over 6 months ago
- U Unknown

If yes (8N = 1, 2, 3, or 4), answer 9N-11N.

9N. Number of strokes
- 1 1
- 2 2-5
- 3 >5
- U Unknown

10N. Vascular territory
- 1 Right carotid
- 2 Left carotid
- 3 Vertebral-basilar
- 4 Multiple territories
- 5 SAH
- U Unknown

11N. Type of strokes (circle all applicable)
- 1 Ischemic
- 2 Intracerebral hemorrhage
- 3 Subarachnoid hemorrhage
- U Unknown

Anamnesis

12N. Deficit present on awakening?
- 0 No
- 1 Yes
- U Unknown

At the time of onset was there

		No	Yes	Unknown
13N.	Severe headache	0	1	U
14N.	Vomiting	0	1	U
15N.	Seizures	0	1	U
16N.	Focal deficit	0	1	U
17N.	Decreased consciousness	0	1	U
18N.	Coma	0	1	U

Codes for intervals in the first 24 hours after onset or awakening

- 0 No deficit
- 1 Improved
- 2 Baseline/same
- 3 Worse, smooth
- 4 Worse, stepwise
- 5 Worse, fluctuating
- 6 Died
- U Unknown

QuaLT Qualitative, which equals new signs or symptoms
QuaNT Quantitative exacerbation of previous deficits

	Interval:	Course: Normal	Improved	Same	Worse	Died	Unk
19N.	1-10 min	0	1	2	3 4 5	6	U
20N.	11-60 min	0	1	2	3 4 5	6	U
21N.	1-12 hrs	0	1	2	3 4 5	6	U
22N.	12-24 hrs	0	1	2	3 4 5	6	U

Type of Change:

	None	QuaNT	QuaLT	Both	Unk
23N.	0	1	2	3	U
24N.	0	1	2	3	U
25N.	0	1	2	3	U
26N.	0	1	2	3	U

27N. Were antiplatelets or anticoagulants being used at the time of the stroke?
- 0 No
- 1 Yes, antiplatelets only (e.g., aspirin or Persantine)
- 2 Yes, anticoagulants only (e.g., heparin or Coumadin)
- 3 Yes, both
- U Unknown

If anticoagulants (27N = 2), answer 28N.

28N. Date anticoagulants started

__ __ Day __ __ __ Mo __ __ Yr

29N. Was documented hypotension a possible precipitator of this stroke?
- 0 No
- 1 Yes
- U Unknown

30N. How many alcoholic beverages did the patient have within 24 hours of onset?
- 0 None
- 1 1
- 2 2-5
- 3 >5
- U Unknown

31N. How many hours before the stroke did the last glucogenic intake occur? (If less than an hour, code as 1)

__ __ Hours
U Unknown

SDB Stroke Data Bank

Neurologic Examination

MISAR # ______
PID # ______
(PI) FORM X

1X. Date and time of exam:

__ __ / __ __ __ / __ __ / __ __ / __ __
Day Mo Yr Hr Min

2X. Timing of exam (If patient evolved, fill out evolving stroke lab data)

- 0 Initial
- 1 7-10 days
- 2 3-month follow-up
- 3 6-month follow-up
- 4 1-year follow-up
- 5 2-year follow-up
- 6 None of the above

3X. Type of exam (if special protocol) Circle all that apply

- 1 Evolution
- 2 Complication
- 3 Pre surgery
- 4 Post surgery
- 5 Improvement after worsening on day 7-10

4X. Data collector __ __
(see Center's code list)

5X. Verbal response (Aphasics are untestable)

- 5 Oriented and converses
- 4 Disoriented
- 3 Inappropriate words
- 2 Incomprehensible sounds
- 1 None
- U Untestable

6X. Eye opening

- 4 Spontaneous
- 3 To speech
- 2 To pain
- 1 None
- U Untestable

7X. Motor response

- 6 Obeys
- 5 Localizes
- 4 Withdraws
- 3 Abnormal flexion
- 2 Abnormal extension
- 1 None
- U Untestable

8X. Glasgow Coma Score
(computed item)

9X. Degree of alertness

- 0 Alert
- 1 Lethargic or drowsy
- 2 Stuporous
- 3 Comatose

10X. Hunt and Hess grade
(SAH only)

- 0 Asymptomatic
- 1 Minimal headache and nuchal rigidity
- 2 Moderate headache and nuchal rigidity, no deficit except CN
- 3 Drowsy, confused or mild focal deficit
- 4 Stupor, moderate or severe deficit
- 5 Deeply comatose, decerebrate rigidity, moribund

For 11X - 78X, circle "N" in addition to the relevant number if the abnormality is *not related* to the current stroke.

11X. Remainder of neurologic exam N

- 0 Normal
- 1 Abnormal, focal
- 2 Abnormal, multifocal

12X. Relative change N

- 0 Initial
- 1 Better
- 2 Same
- 3 Worse
- U Unknown

If there is a relative change, answer 13X.

13X. Type of change N

- 1 Quantitative
- 2 Qualitative
- 3 Both
- U Unknown

14X. Weakness: N

- 0 Normal
- 1 Left hemiparesis
- 2 Right hemiparesis
- 3 Bilateral hemiparesis
- 4 Paraparesis
- U Unknown

15X. Relative change: N

- 0 Initial
- 1 Better
- 2 Same
- 3 Worse
- U Unknown

Weakness scale (For tongue and face, use only 0, 1, 2, or U):

0	Normal	3	Against gravity	U	Untestable
1	Slight weakness	4	Without gravity	N	Not related
2	Against resistance	5	No movement		

Left

16X.	Tongue	0	1	2					U	N
17X.	Face	0	1	2					U	N
18X.	Shoulder	0	1	2	3	4	5		U	N
19X.	Hand	0	1	2	3	4	5		U	N
20X.	Hip	0	1	2	3	4	5		U	N
21X.	Foot	0	1	2	3	4	5		U	N

22X. **Left weakness score** (computed item)

Right

23X.	Tongue	0	1	2					U	N
24X.	Face	0	1	2					U	N
25X.	Shld	0	1	2	3	4	5		U	N
26X.	Hand	0	1	2	3	4	5		U	N
27X.	Hip	0	1	2	3	4	5		U	N
28X.	Foot	0	1	2	3	4	5		U	N

29X. **Right weakness score** (computed item)

30X. **Total weakness score** (computed item)

31X. **Ataxia** N
- 0 Absent
- 1 Left
- 2 Right
- 3 Both
- U Untestable

32X. **Articulation** N
- 0 Normal
- 1 Impaired
- 2 Unable
- U Untestable

33X. **Swallowing** N
- 0 Normal
- 1 Impaired
- 2 Unable
- U Untestable

34X. **Extraocular movements** N
- 0 Normal
- 1 Abnormal
- U Untestable

35X. **Relative change** N
- 0 Initial
- 1 Better
- 2 Same
- 3 Worse
- U Unknown

If testable abnormality (34X = 1), answer questions 36X-44X:

36X.	**Horizontal gaze palsy**	N	0	Absent	1	Left	2	Right	3	Both	U	Unknown
37X.	**Vertical gaze palsy**	N	0	Absent	1	Up	2	Down	3	Both	U	Unknown
38X.	**Internuc ophthalmoplegia**	N	0	Absent	1	Present					U	Unknown
39X.	**CN III palsy**	N	0	Absent	1	Left	2	Right	3	Both	U	Unknown
40X.	**CN VI palsy**	N	0	Absent	1	Left	2	Right	3	Both	U	Unknown
41X.	**Skew deviation**	N	0	Absent	1	Present					U	Unknown
42X.	**Vertical nystagmus**	N	0	Absent	1	Present					U	Unknown
43X.	**Horizontal nystagmus**	N	0	Absent	1	Left	2	Right	3	Both	U	Unknown
44X.	**Fixed pupils**	N	0	None	1	Left	2	Right	3	Both	U	Unknown

---

45X. **Sensory deficits** N
(pin test)
- 0 None
- 1 Left
- 2 Right
- 3 Both
- U Untestable

46X. **Relative change** N
- 0 Initial
- 1 Better
- 2 Same
- 3 Worse
- U Unknown

Code for sensory scale:
- 0 Normal
- 1 Subjective only
- 2 Partial
- 3 Severe
- U Untestable
- N Not Related

Left			Right		
47X.	**Face**	0 1 2 3 U N	54X.	**Face**	0 1 2 3 U N
48X.	**Shoulder**	0 1 2 3 U N	55X.	**Shoulder**	0 1 2 3 U N
49X.	**Hand**	0 1 2 3 U N	56X.	**Hand**	0 1 2 3 U N
50X.	**Hip**	0 1 2 3 U N	57X.	**Hip**	0 1 2 3 U N
51X.	**Foot**	0 1 2 3 U N	58X.	**Foot**	0 1 2 3 U N
52X.	**Trunk**	0 1 2 3 U N	59X.	**Trunk**	0 1 2 3 U N

53X. **Left sensory score** (computed item)

60X. **Right sensory score** (computed item)

61X. **Total sensory score** (computed item)

62X. **Visual fields** N
- 0 Normal
- 1 Abnormal
- U Untestable

63X. **Relative change** N
- 0 Initial
- 1 Better
- 2 Same
- 3 Worse
- U Unknown

If testable abnormality (62X = 1), answer 64X-67X:

64X.	**Monocular**	N	0	Absent	1	Left	2	Right	3	Both	U	Unknown
65X.	**Quadrantanopia**	N	0	Absent	1	Left	2	Right	3	Both	U	Unknown
66X.	**Hemianopia**	N	0	Absent	1	Left	2	Right	3	Both	U	Unknown
67X.	**Hemineglect**	N	0	Absent	1	Left	2	Right	3	Both	U	Unknown

68X. **Other cognitive functions** N
└┘ 0 Normal
1 Abnormal
U Untestable

69X. **Relative change** N
0 Initial
└┘ 1 Better
2 Same
3 Worse
U Unknown

If testable abnormality (68X = 1), answer 70X-71X:

70X. **Speech content** N
0 Normal
└┘ 1 Abulic
2 Logorrheic
3 Other
U Unknown

71X. **Language** N
0 Normal
└┘ 1 Broca
2 Wernicke
3 Global
4 Anomic
5 Other
U Unknown

72X. **Dysarthria** N
0 Absent
└┘ 1 Present
U Unknown

73X. **Nuchal rigidity** N
0 No
└┘ 1 Slight
2 Severe
U Unknown

74X. **Cervical bruit** N
0 Absent
└┘ 1 Present
U Unknown

If cervical bruit is present (74X = 1), answer 75X-78X:
0 Absent 2 High pitch U Unknown
1 Low pitch 3 Very high pitch N Not related

75X. **Left carotid** 0 1 2 3 U N
76X. **Right carotid** 0 1 2 3 U N
77X. **Left subclavian** 0 1 2 3 U N
78X. **Right subclavian** 0 1 2 3 U N

Final Assessment:

79X. **Pure motor syndrome** (See Form P)
└┘ 0 No
1 Yes

80X. **Neurologic signs** (Stroke Severity Scale) due to this event
└┘ 0 Absent
1 Present

81X. **Neurologic symptoms** (Stroke Severity Scale) due to this event
└┘ 0 Absent
1 Present

82X. **Examiner believes patient is depressed**
└┘ 0 No
1 Yes
U Untestable

83X. **Examiner believes patient is demented**
└┘ 0 No
1 Yes
U Untestable

If 83X is yes, answer 84X:
84X. **Due to**
1 Alzheimer's disease
└┘ 2 Stroke
3 Other

85X. **Unusual neurologic findings** (Circle all that apply)
0 None
10 Transcortical motor aphasia
11 Transcortical sensory aphasia
12 Transcortical mixed aphasia
13 Pure alexia without agraphia
14 Anosognosia
15 Gerstmann's syndrome
16 Semantic aphasia
17 Receptive aprosody
18 Expressive aprosody
19 Dressing apraxia
20 Constructional apraxia
21 Visual agnosia
22 Prosopagnosia
23 Simultanagnosia
24 Motor impersistence
25. Lid ptosis
26 Ideomotor apraxia
27 Ideational apraxia
28 Orofacial apraxia
29 Horner's syndrome
30 Alexia with agraphia
31 Tactile extinction
32 Visual neglect
33 Denial of illness
34 Auditory neglect
35 Hemichorea
36 Hemiballism
37 Amnestic aphasic
38 Other

86X. *If other, specify*
____
____

MISAR # ______
PID # ______
(PI) FORM C

SDB Stroke Data Bank CT Scan

1C. Date and time of exam:

__ __ Day / __ __ __ Mo / __ __ Yr / __ __ Hr / __ __ Min

2C. Data collector (see Center's code list) __ __

3C. Number of lesions related to this stroke ______ (Enter 0 if none)

4C. CT scan normal?
0 Normal
1 Abnormal

5C. Technical adequacy of study
0 Adequate
1 Inadequate
U Unknown

		1	2	3	4	5	6
6C.	**Lesion number**	1	2	3	4	5	6
7C.	**Side** Codes: 1 Mid, 2 Left, 3 Right, 4 Both	1 2 3 4 (M L R B)	1 2 3 4 (M L R B)	1 2 3 4 (M L R B)	1 2 3 4 (M L R B)	1 2 3 4 (M L R B)	1 2 3 4 (M L R B)
8C.	**Pathology** (circle all applicable)						
	No longer seen	0	0	0	0	0	0
	Superficial infarct	1A	1A	1A	1A	1A	1A
	Deep, small infarct	1B	1B	1B	1B	1B	1B
	Deep, large infarct	1C	1C	1C	1C	1C	1C
	Super & deep infarct	1D	1D	1D	1D	1D	1D
	Intracerebral hemorrhage	2	2	2	2	2	2
	Subarachnoid hemorrhage	3	3	3	3	3	3
	AVM	4	4	4	4	4	4
	Aneurysm	5	5	5	5	5	5
	Other	6	6	6	6	6	6
9C.	**Anatomy** (circle all applicable)						
	Frontal lobe	A1	A1	A1	A1	A1	A1
	Parietal lobe	A2	A2	A2	A2	A2	A2
	Temporal lobe	A3	A3	A3	A3	A3	A3
	Occipital lobe	A4	A4	A4	A4	A4	A4
	Operculum	A5	A5	A5	A5	A5	A5
	Insula	A6	A6	A6	A6	A6	A6
	Caudate	B1	B1	B1	B1	B1	B1
	Putamen	B2	B2	B2	B2	B2	B2
	Thalamus	B3	B3	B3	B3	B3	B3
	Anterior capsule	C1	C1	C1	C1	C1	C1
	Genu	C2	C2	C2	C2	C2	C2
	Posterior capsule	C3	C3	C3	C3	C3	C3
	Corona radiata	C4	C4	C4	C4	C4	C4
	Centrum semiovale	C5	C5	C5	C5	C5	C5
	Corpus callosum	C6	C6	C6	C6	C6	C6
	Midbrain	M1	M1	M1	M1	M1	M1
	Pons	M2	M2	M2	M2	M2	M2
	Medulla	M3	M3	M3	M3	M3	M3
	Cerebellum	M4	M4	M4	M4	M4	M4
	Ventricular space	S1	S1	S1	S1	S1	S1
	Subarachnoid space	S2	S2	S2	S2	S2	S2
	Subdural space	S3	S3	S3	S3	S3	S3
	Epidural space	S4	S4	S4	S4	S4	S4
10C.	**Volume in cc's**	____	____	____	____	____	____
11C.	**Diameter in mm's**	____	____	____	____	____	____

SDB Stroke Data Bank
Angiography

MISAR # ______
PID # ______
(PI) FORM V

1V. Date and time of angiography:
__ __ / __ __ __ / __ __ / __ __ / __ __
Day Mo Yr Hr Min

3V. Source
1 Angiography
2 Venous DSA
3 Arterial DSA

4V. Number of lesions related to this stroke: __ __
(enter 0 if none)

2V. Data collector
(see Center's code list) __ __

		1	2	3	4	5	6
5V.	**Lesion number**	1	2	3	4	5	6
6V.	**Side** (codes on back)	1 2 3 4 (M L R B)	1 2 3 4 (M L R B)	1 2 3 4 (M L R B)	1 2 3 4 (M L R B)	1 2 3 4 (M L R B)	1 2 3 4 (M L R B)
7V.	**Pathology** (circle all applicable)						
	No longer seen	0	0	0	0	0	0
	< 50% stenosis	1A	1A	1A	1A	1A	1A
	50-90% stenosis	1B	1B	1B	1B	1B	1B
	≥ 90% stenosis	1C	1C	1C	1C	1C	1C
	Occlusion	2	2	2	2	2	2
	Flat plaque	3A	3A	3A	3A	3A	3A
	Ulcerated plaque	3B	3B	3B	3B	3B	3B
	Aneurysm	4A	4A	4A	4A	4A	4A
	AVM	4B	4B	4B	4B	4B	4B
	Spasm, focal	5A	5A	5A	5A	5A	5A
	Spasm, multifocal	5B	5B	5B	5B	5B	5B
	Spasm, diffuse	5C	5C	5C	5C	5C	5C
	Dissection	6	6	6	6	6	6
	Fibromuscular dysplasia	7	7	7	7	7	7
	Embolism	8	8	8	8	8	8
	Collateral flow	9	9	9	9	9	9
8V.	**Anatomy** (circle all applicable)						
	Subclavian	S	S	S	S	S	S
	External carotid	E	E	E	E	E	E
	Common carotid	C0	C0	C0	C0	C0	C0
	ICA & bifurcation	C11	C11	C11	C11	C11	C11
	Between C1 & siphon	C12	C12	C12	C12	C12	C12
	ICA at siphon	C13	C13	C13	C13	C13	C13
	Ophthalmic	C2	C2	C2	C2	C2	C2
	Central retinal	C3	C3	C3	C3	C3	C3
	Anterior commun	C4	C4	C4	C4	C4	C4
	Anterior cerebral	C5	C5	C5	C5	C5	C5
	Anterior choroid	C6	C6	C6	C6	C6	C6
	Stem MCA	C70	C70	C70	C70	C70	C70
	Lower division MCA	C71	C71	C71	C71	C71	C71
	Lower division MCA branch	C711	C711	C711	C711	C711	C711
	Upper division MCA	C72	C72	C72	C72	C72	C72
	Upper division MCA branch	C721	C721	C721	C721	C721	C721
	Posterior commun	P1	P1	P1	P1	P1	P1
	Posterior cerebral	P2	P2	P2	P2	P2	P2
	Lenticulostriates	P3	P3	P3	P3	P3	P3
	Thalamo-perforating	P4	P4	P4	P4	P4	P4
	Superior cerebellar	P5	P5	P5	P5	P5	P5
	Basilar	B0	B0	B0	B0	B0	B0
	Basilar branch	B1	B1	B1	B1	B1	B1
	PICA	B3	B3	B3	B3	B3	B3
	AICA	B4	B4	B4	B4	B4	B4
	Vertebral	V	V	V	V	V	V
9V.	**% Occlusion/aneurysm size***	____	____	____	____	____	____
10V.	**Associated findings** (codes on back)	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
11V.	**Clinical relevance** (codes on back)	0 1 2	0 1 2	0 1 2	0 1 2	0 1 2	0 1 2

*(Percent lumen diameter for occlusive lesions, or size of largest aneurysm in mm) (U Unknown)

MISAR # ______
PID # ______
(PN) FORM H

SDB Stroke Data Bank
Summary of Hospitalization

1H. **Date completed**

__ __ / __ __ __ / __ __
Day Mo Yr

2H. **Date of discharge**

__ __ / __ __ __ / __ __
Day Mo Yr

3H. **Data collector** __ __
(see Center's code list)

4H. **Patient able to communicate**
(circle primary answer)
[ ]
0 No, sedated
1 No, aphasic
2 No, demented
3 No, language barrier (which cannot be overcome)
4 No, other
5 Yes

If other (4H = 4), answer 5H.

5H. **Specify** ______________

6H. **Type of stroke**
[ ]
1 Ischemic stroke
2 Intracerebral hemorrhage
3 Subarachnoid hemorrhage

7H. **Occurrence**
[ ]
1 First bank event
2 Second bank event
3 Third bank event

8H. **Was patient admitted for this stroke?**
[ ]
0 No
1 Yes

If no (8H = 0), answer 9H.

9H. **Specify reason for admission**
____

10H. **Major role of investigator**
[ ]
1 Primary
2 Consultant
3 Stroke study only

11H. **Location of patient service**
[ ]
1 Medicine
2 Neurology
3 Neurosurgery
4 Vascular surgery
5 General surgery
6 Other

12H. **Discharged to**
[ ]
0 Home
1 Unskilled bed nursing facility
2 Skilled bed nursing facility
3 Rehabilitation hospital
4 Other acute care hospital
5 Died
6 Other

13H. **Days in intensive care, from the onset of stroke** __ __

Procedures During Hospitalization

Verify that all data bank forms for these procedures have been completed.

14H.	**CT scans**	0	1	2	3	4	5
15H.	**Angiograms**	0	1	2	3	4	5
16H.	**Cardiovascular surgery**	0	1	2	3	4	5
17H.	**Neurovascular surgery**	0	1	2	3	4	5
18H.	**Evacuation of clot**	0	1	2	3	4	5

19H. **Was patient in a clinical trial program?**
[ ]
0 No
1 Yes

Medications

		No	During Hospitalization	Discharge Prescription	Both	Unknown
20H.	**Heparin**	0	1	2	3	U
21H.	**Steroids**	0	1	2	3	U
22H.	**Dehydrating agent (eg, mannitol)**	0	1	2	3	U
23H.	**Narcotics (eg, morphine)**	0	1	2	3	U
24H.	**Coumadin**	0	1	2	3	U
25H.	**Aspirin**	0	1	2	3	U
26H.	**Persantine**	0	1	2	3	U
27H.	**Diuretic**	0	1	2	3	U
28H.	**Antihypertensives**	0	1	2	3	U
29H.	**Anticonvulsants**	0	1	2	3	U
30H.	**Insulin**	0	1	2	3	U
31H.	**Ticlopidine/ASA**	0	1	2	3	U
32H.	**Antidepressants**	0	1	2	3	U
33H.	**Other medications**	0	1	2	3	U

If other, answer 34H.

34H. **Specify** ______________________________

Innovative medical therapy	No	Yes	Unknown
35H. Calcium blockers	0	1	U
36H. Beta blockers	0	1	U
37H. Naloxone	0	1	U
38H. Other opiate antagonists	0	1	U
39H. Barbiturates	0	1	U
40H. Prostacyclin	0	1	U
41H. Other	0	1	U

If other (41H = 1), answer 42H.

42H. Specify ______________________________

Special services required after hospitalization	No	Yes
43H. Home health aid	0	1
44H. Visiting nurse	0	1
45H. Physical therapy	0	1
46H. Speech therapy	0	1
47H. Psychological care (psychiatrist, psychologist, social worker)	0	1

48H. Rare diseases and unusual nonneurologic states (e.g., bleeding or clotting abnormalities, pregnancy, etc.) (See code list) ___
- 0 None

49H. New findings (not noted in medical history) found during hospitalization (circle all applicable)
- 0 None
- 1 Aortic stenosis
- 2 Aortic regurgitation
- 3 Aortic valve replaced
- 4 Mitral stenosis
- 5 Mitral regurgitation
- 6 Mitral valve replaced
- 7 Mitral valve prolapse
- 8 Mitral annulus calcification
- 9 Other

50H. Other conditions (circle all applicable)
- 0 None
- 1 Atrial fibrillation
- 2 Other arrhythmias
- 3 Systemic emboli
- 4 Angina
- 5 Congestive failure
- 6 Claudication
- 7 Chronic obstructive pulmonary disease
- 8 Diabetes mellitus
- 9 Cancer

Codes for intervals in the first 14 days after onset

- 0 No deficit
- 1 Improved
- 2 Baseline/same
- 3 Worse, smooth
- 4 Worse, stepwise
- 5 Worse, fluctuating
- 6 Died
- U Unknown

QuaLT Qualitative, which equals new signs or symptoms
QuaNT Quantitative exacerbation of previous deficits

	Interval:	Course: Normal	Improved	Same	Worse	Died	Unk		Type of Change: None	QuaNT	QuaLT	Both	Unk
51H.	Day 1 (onset)	0	1	2	3 4 5	6	U	55H.	0	1	2	3	U
52H.	Day 2	0	1	2	3 4 5	6	U	56H.	0	1	2	3	U
53H.	Day 3-6	0	1	2	3 4 5	6	U	57H.	0	1	2	3	U
54H.	Day 7-14	0	1	2	3 4 5	6	U	58H.	0	1	2	3	U

Blood Sugar

82H. **Within 48 hours of onset** ___
A Not applicable
U Unknown

If known, answer 83H-84H.

83H. **Date and time**

__ ___ __ __ __
Day Mo Yr Hr Min

84H. **Circumstances under which blood sugar was drawn**
[ ]
1 Fasting
2 IV glucose running
3 Postprandial
U Unknown

85H. **48 hours to less than 7 days** ___
A Not applicable
U Unknown

If known, answer 86H-87H.

86H. **Date and time**

__ ___ __ __ __
Day Mo Yr Hr Min

87H. **Circumstances under which blood sugar was drawn**
[ ]
1 Fasting
2 IV glucose running
3 Postprandial
U Unknown

88H. **7-10 days** ___
A Not applicable
U Unknown

If known, answer 89H-90H.

89H. **Date and time**

__ ___ __ __ __
Day Mo Yr Hr Min

90H. **Circumstances under which blood sugar was drawn**
[ ]
1 Fasting
2 IV glucose running
3 Postprandial
U Unknown

Serum Sodium

91H. **Admission value** ___
A Not applicable
U Unknown

If below 125mEq osmolality, answer 92H-94H.

92H. **Serum osmolality** ___

93H. **Urine osmolality** ___

94H. **Date & time**

__ ___ __ __ __
Day Mo Yr Hr Min

95H. **4 days after onset** ___
A Not applicable
U Unknown

If below 125mEq osmolality, answer 96H-98H.

96H. **Serum osmolality** ___

97H. **Urine osmolality** ___

98H. **Date & time**

__ ___ __ __ __
Day Mo Yr Hr Min

99H. **7 days after onset** ___
A Not applicable
U Unknown

If below 125mEq osmolality, answer 100H-102H.

100H. **Serum osmolality** ___

101H. **Urine osmolality** ___

102H. **Date & time**

__ ___ __ __ __
Day Mo Yr Hr Min

103H. **Was a spinal tap done?**
[ ]
0 Normal
1 Abnormal
A Not done

If done, answer 104H-105H.

104H. **Was blood present?**
[ ]
0 No, clear CSF
1 Microscopic blood (< 200 RBC's/cc)
2 Blood tinged
3 Grossly bloody, non-traumatic
4 Grossly bloody, traumatic
U Unknown

105H. **Initial pressure** ___ **mm CSF**
U Unknown

106H.
[ ] **First EKG after stroke**
0 Normal
1 Abnormal
A Not done

If abnormal (106H = 1), answer 107H-108H.

107H. **First EKG findings**
(circle all that apply)
1 Myocardial infarction
2 Ischemic changes
3 L Ventricular hypertrophy
4 Heart block
5 Sick sinus
6 Sinus arrest
7 Atrial premature beats
8 Ventricular prematures
9 Atrial fib or flutter
10 Ventricular tachycardia
11 Pacemaker
12 Other

If other (107H = 12), answer 108H.

108H. **Specify** ______

109H.
[ ] **Subsequent EKG's**
0 No new findings
1 New findings
A Not done

If new findings (109H = 1), answer 110H.

110H. **All new EKG findings** (use codes for 107H) ______

______

111H. **Holter monitor**
[ ]
0 No new findings
1 New findings
A Not done

If new findings (111H = 1), answer 112H.

112H. **All new Holter findings** (use codes for 107H) ______

______

127H. **ICP monitor**
- 0 Normal (always less than 15)
- 1 Abnormal
- A Not done

If done, answer 128H-134H.

128H. **Type and site** ______________________________

129H. **GCS at time of insertion** (Glascow Coma Score, 3-15) __ __ (U Unknown)

130H. **ICP at time of insertion** (first recorded value) __ __ __

131H. **Highest sustained ICP** (more than 10 min) __ __ __

132H. **Response of ICP to medical therapy**
- 0 Normalized ICP (less than 15 mmHg)
- 1 Improved (but again rises)
- 2 No response
- U Unknown

133H. **Medical therapies** ______________________________

134H. **Complications** ______________________________

135H. **Discharge diagnosis** ______________________________

136H. ICD-9-CM code __ __ __ __
U Unknown

137H. **Secondary diagnosis (or major complication)** ______________________________

138H. ICD-9-CM code __ __ __ __
U Unknown

Procedures

139H. ______________________________

140H. ______________________________

141H. ______________________________

142H. ______________________________

143H. ICD-9-CM code __ __ __
U Unknown

144H. ICD-9-CM code __ __ __
U Unknown

145H. ICD-9-CM code __ __ __
U Unknown

146H. ICD-9-CM code __ __ __
U Unknown

147H. **DRG number** __ __ __
U Unknown

113H. Electroencephalogram (EEG)
0 Normal
1 Abnormal
A Not done or technically unsatisfactory

If abnormal (113H = 1), answer 114H-118H using codes below

0 None
1 Left & related
2 Left & unrelated
3 Right & related
4 Right & unrelated
5 Both & related
6 Both & unrelated

		None	LR	LU	RR	RU	BR	BU
114H.	**Focal slowing**	0	1	2	3	4	5	6
115H.	**Diffuse slowing**	0	1	2	3	4	5	6
116H.	**Focal spike**	0	1	2	3	4	5	6
117H.	**Generalized epileptic**	0	1	2	3	4	5	6
118H.	**Other**	0	1	2	3	4	5	6

119H. Regional cerebral blood flow (xenon flow)
0 Normal
1 Abnormal inappropriate side — increased flow
2 Abnormal inappropriate side — reduced flow
3 Abnormal appropriate side — increased flow
4 Abnormal appropriate side — reduced flow
5 Abnormal both sides
A Not done
U Unknown

120H. Directional Doppler ultrasound
0 Normal
1 Abnormal inappropriate side — less than 75% stenosis
2 Abnormal inappropriate side — more than 75% stenosis
3 Abnormal appropriate side — less than 75% stenosis
4 Abnormal appropriate side — more than 75% stenosis
5 Abnormal both sides
A Not done
U Unknown

121H. OPG
0 Normal
1 Abnormal inappropriate side — less than 75% stenosis
2 Abnormal inappropriate side — more than 75% stenosis
3 Abnormal appropriate side — less than 75% stenosis
4 Abnormal appropriate side — more than 75% stenosis
5 Abnormal both sides
A Not done
U Unknown

122H. Real time Doppler
0 Normal both sides
1 Normal right only
3 Less than 50% stenosis, right
4 Less than 50% stenosis, left
5 More than 50% stenosis, right
6 More than 50% stenosis, left
7 Occluded right
8 Occluded left
9 Ulcerated right
10 Ulcerated left
A Not done
U Unknown

123H. Echocardiography
0 Normal
1 Abnormal
A Not done

If abnormal (123H = 1), answer 125H.

125H. **Echocardiographic findings** (circle all that apply)
1 Left atrial enlargement
2 Left ventricular enlargement
3 Cardiomyopathy
4 Mural thrombus
5 Aortic stenosis
6 Aortic regurgitation
7 Mitral prolapse
8 Right atrial enlargement
9 Right ventricular enlargement
10 Akinetic region
11 Ventricular aneurysm
12 Mitral stenosis
13 Mitral regurgitation
14 Mitral annulus calcification
15 Other

If other (125H = 15), answer 126H.

126H. **Specify** ______________

Surgical Treatment Summary *(Complete only if patient had surgery)*

148H. Cerebrovascular surgery
- 0 No
- 1 Yes

If yes (148H = 1), answer 149H-164H.

149H. Endarterectomy
- 0 No
- 1 Yes

150H. Date __ ___ __ (Day Mo Yr)

151H. Site
- 1 Left internal carotid bifurcation
- 2 Right internal carotid bifurcation
- 3 Left internal carotid
- 4 Right internal carotid
- 5 Left subclavian
- 6 Right subclavian
- 7 Left external carotid
- 8 Right external carotid
- 9 Left other
- 10 Right other

		No	Yes		
152H.	Ligation	0	1	*158H.*	Date __ ___ __ (Day Mo Yr)
153H.	EC/IC bypass	0	1	*159H.*	Date __ ___ __ (Day Mo Yr)
154H.	Aneurysm	0	1	*160H.*	Date __ ___ __ (Day Mo Yr)
155H.	AVM	0	1	*161H.*	Date __ ___ __ (Day Mo Yr)
156H.	Evacuation of CNS hematoma	0	1	*162H.*	Date __ ___ __ (Day Mo Yr)
157H.	Other	0	1		

If other (157H = 1), answer 163H-164H.

163H. Specify ____________

164H. Date __ ___ __ (Day Mo Yr)

165H. Cardiovascular surgery
- 0 No
- 1 Yes

If yes (165H = 1), answer 166H-170H.

		No	Yes		
166H.	Coronary bypass	0	1	*169H.*	Date __ ___ __ (Day Mo Yr)
167H.	Valve replacement	0	1	*170H.*	Date __ ___ __ (Day Mo Yr)
168H.	Other	0	1		

If other (168H = 1), answer 171H-172H.

171H. Specify ____________

172H. Date __ ___ __ (Day Mo Yr)

173H. Other surgery (not cerebro- or cardiovascular)
- 0 No
- 1 Yes

If yes (173H = 1), answer 174H-175H.

174H. Specify ____________

175H. Date __ ___ __ (Day Mo Yr)

SDB Stroke Data Bank
Diagnosis of Stroke

MISAR # ______
PID # ______
(PI) FORM J

1J. Date and time of diagnosis

__ __ / __ __ __ / __ __ / __ __ / __ __
Day Mo Yr Hr Min

2J. Data collector (see Center's code list) __ __

3J. Code single best description of primary diagnosis (using the diagnostic flow chart)

__ __ __ __ __ __ __ __ __ __ __

4J. Diagnostic source (Circle all applicable to present stroke)

1 Best guess, no lab
2 Best guess, non-confirmatory lab
3 CT scan
4 Angiogram
5 Surgery
6 Autopsy

5J. Primary diagnosis — Etiology
(see coding manual for definitions)

1 Infarction, cause unknown
2 Infarction with normal angiogram
3 Infarction with tandem arterial pathology
4 Embolism from cardiac source
5 Infarction due to atherosclerosis
6 Lacune
7 Parenchymatous hemorrhage
8 Subarachnoid hemorrhage
9 Other

If other (5J = 9), answer 6J.

6J. **Specify** ______________________

7J. Cerebral sites (Circle all applicable to present stroke)

Left		Right
20	Cerebral hemisphere (not further specified)	50
21	Frontal lobe	51
22	Parietal lobe	52
23	Insular-operculum	53
24	Occipital lobe	54
25	Temporal lobe	55
26	Putamen	56
27	Thalamus	57
28	Internal capsule	58
29	Cerebellum	59
30	Fronto-parietal lobe	60
31	Parieto-occipital lobe	61
32	Temporo-parietal lobe	62
33	Temporo-occipital lobe	63
34	Fronto-temporo-parietal lobe	64
35	Basal ganglia & capsule	65

70 Midline (3rd ventri. callosum)
80 Intracranial (not further specified)
81 Brain stem
82 Midbrain
83 Pons
84 Medulla
85 Subarachnoid space
86 Intraventricular space

8J. Primary cerebral site __ __

9J. Vascular territory (Circle all applicable to present stroke)

Left		Right
20	Common carotid	50
21	External carotid	51
22	Internal carotid	52
23	At bifurcation	53
24	Distal extracranial	54
25	Intracranial	55
26	Junction of posterior communicating	56
27	Other	57
28	Anterior cerebral	58
29	Junction of anterior communicating	59
30	Other	60
31	Middle cerebral	61
32	Penetrating or lentriculostriate	62
33	Stem	63
34	Upper branch	64
35	Lower branch	65
36	Posterior communicating	66
37	Posterior cerebral	67
38	Penetrating	68
39	Stem	69
40	Calcarine branch	70
41	Superior cerebellar	71
42	Posterior inferior cerebellar	72
43	Vertebral	73
44	Subclavian	74

80 Anterior communicating
81 Basilar
82 Penetrating
83 Full
84 Upper branch
85 Lower branch
86 Innominate
87 Unknown

10J. Primary vascular territory __ __

11J. Term that best describes syndrome (circle one)

└─┘

1 Mixed aphasia with HP/HS/HH
2 Nondom hem syndrome with HP/HS/HH
3 Baby Broca aphasia
4 Pure Wernicke aphasia
5 Conduction aphasia
6 Sylvian lip syndrome
7 Aphasia with vanishing hemiparesis
8 Anterior cerebral syndrome
9 Superior frontal syndrome
10 Callosal ideomotor apraxia
11 Pure hemianopia (PCA)
12 Hemianopia with dysnomia (LPCA)
13 Hemianopia with spatial disorientation (RPCA)
14 Pure nondominant hemisphere behavior syndrome
15 Lacune: Pure motor stroke
16 Lacune: Pure sensory stroke
17 Lacune: Sensorimotor stroke
18 Lacune: Ataxic hemiparesis
19 Lacune: Dysarth clumsy hand
20 Lacune: Hemichorea/ballism
21 Basilar branch syndrome
22 Upper basilar syndrome
23 Lower basilar syndrome
24 Major basilar syndrome
25 Wallenberg syndrome
26 Wallenberg with cerebellar infarction
27 Pure cerebellar infarction
28 Putaminal hemorrhage
29 Thalamic hemorrhage
30 Caudate hemorrhage
31 Lobar cerebral hemorrhage
32 Pontine hemorrhage
33 Cerebellar hemorrhage
34 Pure sensorimotor d/t hematoma
35 Bifrontal abulia
36 Ruptured aneurysm
37 Ruptured aneurysm with no deficit
38 Ruptured aneurysm with delayed focal deficit
39 Ruptured aneurysm with rerupture
40 Ruptured aneurysm with post-op deficit
41 AVM with focal deficit
42 AVM with hydrocephalus
43 Other

If other (11J = 43), specify ______________________

12J. Entire syndrome due to current stroke?

└─┘

0 No
1 Yes

13J. Residua of prior stroke

└─┘

0 No
1 Yes

14J. Compared with findings from CT scan, clinical syndrome is

└─┘

0 Same
1 Larger
2 Smaller

15J. Typicality of the current stroke

└─┘

0 Is defined by a term above without exceptions
1 Term selected applies except present syndrome has *fewer* elements than expected
2 Term selected applies except present syndrome has *more* elements than expected
3 More than one term would have to be selected because there are several strokes

If exceptions (15J = 1 or 2), answer 16J-17J.

16J. **Lack of signs or symptoms** (circle all applicable)

1 Impaired consciousness
2 Weakness
3 Sensory disturbance
4 Oculomotility disorder
5 Abnormal visual fields
6 Movement disorder
7 Dementia
8 Dysphasia
9 Dyspraxia
10 Nondom hemisph syndrome
11 Hemineglect
12 Abulia
13 Ataxia
14 Dysarthria
15 Dysphagia
16 Horner's syndrome
17 Lid ptosis

17J. **Addition of signs or symptoms** (circle all applicable)

1 Impaired consciousness
2 Weakness
3 Sensory disturbance
4 Oculomotility disorder
5 Abnormal visual fields
6 Movement disorder
7 Dementia
8 Dysphasia
9 Dyspraxia
10 Nondom hemisph syndrome
11 Hemineglect
12 Abulia
13 Ataxia
14 Dysarthria
15 Dysphagia
16 Horner's syndrome
17 Lid ptosis

MISAR # ______
PID # ______
(PN) FORM D

SDB Stroke Data Bank
Death Information

1D. Date and time of death

__ __ ___ __ __ __ __ __
Day Mo Yr Hr Min

2D. Data collector (see Center's code list) __ __

3D. Death related to stroke?
- **0** No, unrelated
- **1** Yes, indirectly
- **2** Yes, directly
- **U** Unknown

4D. Place of death
- **1** Home
- **2** Hospital
- **3** Other
- **U** Unknown

If other (4D = 3), answer 5D.

5D. **Specify** ______________________

6D. Autopsy
- **0** None
- **1** Without brain
- **2** With brain
- **U** Unknown

If an autopsy was performed, answer 7D and fill out Form Y, Autopsy.

7D. **Date of autopsy**

__ __ ___ __ __
Day Mo Yr

8D. Immediate cause
- **1** Stroke *(complete Form R, Recurrent Stroke)*
- **2** Myocardial infarction
- **3** Coronary heart disease
- **4** Other cardiovascular
- **5** Pulmonary
- **6** Cancer
- **7** Other
- **U** Unknown

If other (8D = 7), answer 9D.

9D. **Specify** ______________________

10D. Underlying cause
- **1** Stroke *(complete Form R, Recurrent Stroke)*
- **2** Myocardial infarction
- **3** Coronary heart disease
- **4** Other cardiovascular
- **5** Pulmonary
- **6** Cancer
- **7** Other
- **U** Unknown

If other (10D = 7), answer 11D.

11D. **Specify** ______________________

Basis for death diagnosis

		No	Yes
12D.	Family history	0	1
13D.	Doctor or hospital record	0	1
14D.	Death certificate	0	1

Autopsy comments ____

____

____

APPENDIX D

STROKE DATA BANK
STROKE SERVICE REPORT

Patient name:

Patient # 00012

Attending physician:

The patient is a 58-year-old right-handed white man admitted on Aug. 22, 1983. On admission, he was alert with right hemiparesis, impaired articulation, and right sensory deficits. At onset, he experienced a focal deficit which was present upon awakening. He worsened in a smooth manner during the first 12 hours after awakening, then stabilized during the next 12 hours.

His medical history includes one prior ischemic stroke in the left carotid territory which occurred 1 - 6 months ago. He has a history of heart disease characterized by myocardial infarction. He has been diagnosed as hypertensive and was being treated at the time of onset. There is no history of TIA or diabetes. No alcoholic beverages were consumed within 24 hours of onset.

During the examination, he was alert and oriented and able to converse. His blood pressure was 140 / 80. He had a right hemiparesis: the right shoulder and right hand were weak against resistance; and the right side of the face was slightly weak. His articulation was impaired. Cognitive functioning was normal. There were right sensory deficits. There was no ataxia, no cervical bruit, and no nuchal rigidity.

A CT scan performed the day of admission showed a superficial infarct of the left frontal lobe. A second CT scan performed Aug. 26 was unchanged. The EEG was abnormal. The EKG was normal.

The admitting diagnosis was stroke, and he spent 3 days in intensive care. An endarterectomy of the left internal carotid artery was performed on Aug. 29 and cerebrovascular surgery of an unspecified nature was performed on Aug. 30. He stabilized the first 6 days after onset, and worsened in a fluctuating manner during days 7 - 14. His worsening was due to surgical complications and the evolution of the stroke. While hospitalized, he received heparin and anticonvulsants.

The stroke was diagnosed as due to an infarction with tandem arterial pathology. The primary site of the stroke was the left frontal lobe. The primary vascular territory was the left common carotid artery. The syndrome was described as mixed aphasia with hemiparesis, hemisensory loss, and hemianopia.

He was discharged to his home on Sep. 6, 1983 with a prescription for anticonvulsants.

STROKE DATA BANK
STROKE SERVICE REPORT

Patient name:

Patient # 00009

Attending physician:

The patient is a 50-year-old right-handed black woman admitted on Jul. 12, 1983. On admission, she was alert with right hemiparesis, impaired articulation, and impaired swallowing. At onset, she experienced a focal deficit which had not been present upon awakening. She stabilized during the first 24 hours after onset.

She has been diagnosed as hypertensive and was being treated at the time of onset. She is diabetic and was being treated with insulin. There is no history of stroke, TIA or heart disease. No alcoholic beverages were consumed within 24 hours of onset.

During the examination, she was alert and oriented and able to converse. Her blood pressure was 170 / 78. She had a right hemiparesis: the right side of the tongue and right side of the face were weak against resistance; and the right hand, right hip, and right foot were slightly weak. Her articulation and swallowing were impaired. Cognitive functioning was normal. There was cervical bruit. There were no sensory deficits, no ataxia, and no nuchal rigidity.

A CT scan performed the day of admission was normal. A second CT scan performed Jul. 14 showed a deep, large infarct of the left caudate and left centrum semiovale. The spinal tap showed clear CSF. The EKG showed myocardial infarction and ischemic changes. The echocardiogram was normal.

The admitting diagnosis was stroke, and she spent 6 days in intensive care. She stabilized the first 2 days after onset, then worsened in a stepwise manner during days 3 - 6, and improved during days 7 - 14. Her worsening was due to possible clot propagation, possible collateral failure, a possible new embolus, and possible regional acidosis. While hospitalized, she received heparin, antihypertensives, and insulin.

The stroke was diagnosed as due to an infarction with a normal angiogram. The primary site of the stroke was the left basal ganglia and capsule. The primary vascular territory was the penetrating branches or lentriculostriate branches of the left middle cerebral artery. The syndrome was described as a lacune: pure motor stroke.

She was discharged to a rehabilitation hospital on Jul. 27, 1983 with a prescription for insulin.

STROKE DATA BANK
STROKE SERVICE REPORT

Patient name:

Patient # 00007

Attending physician:

The patient is a 42-year-old right-handed black woman admitted on Jul. 7, 1983. On admission, she was lethargic or drowsy with left hemiparesis, abnormal cognitive functioning, and left sensory deficits. At onset, she experienced decreased consciousness which had not been present upon awakening. She stabilized during the first 24 hours after onset.

There is no history of stroke, TIA, heart disease, hypertension or diabetes. One alcoholic beverage was consumed within 24 hours of onset.

During the examination, she was lethargic or drowsy but oriented and able to converse. Her blood pressure was 120 / 80. She exhibited visual neglect. She had a left hemiparesis: the left side of the face and left hand were slightly weak. Cranial nerve functioning was normal. There were left sensory deficits. There was no ataxia, no cervical bruit, and no nuchal rigidity.

A CT scan performed the day of admission showed a superficial infarct of the right frontal lobe, right parietal lobe, and right temporal lobe. The EEG was abnormal. The EKG was normal.

The admitting diagnosis was stroke, and she spent 4 days in intensive care. She stabilized the day of onset, and improved during days 2 - 14. While hospitalized, she received steroids, narcotics, and anticonvulsants.

The stroke was diagnosed as due to an embolism from cardiac source. The primary site of the stroke was the right parietal lobe. The primary vascular territory was the upper branch of the right middle cerebral artery.

She was discharged to her home on Jul. 19, 1983 with a prescription for anticonvulsants.

STROKE DATA BANK
STROKE SERVICE REPORT

Patient name:

Patient # 00012

Attending physician:

ADMISSION INFORMATION

The patient is a 58-year-old right-handed white man admitted on Aug. 22, 1983. On admission, he was alert with right hemiparesis, impaired articulation, and right sensory deficits. At onset, he experienced a focal deficit which was present upon awakening. He worsened in a smooth manner during the first 12 hours after awakening, then stabilized during the next 12 hours.

RELEVANT MEDICAL HISTORY

His medical history includes one prior ischemic stroke in the left carotid territory which occurred 1 - 6 months ago. He has a history of heart disease characterized by myocardial infarction. He has been diagnosed as hypertensive and was being treated at the time of onset. There is no history of TIA or diabetes. No alcoholic beverages were consumed within 24 hours of onset.

NEUROLOGICAL EXAMINATION

During the examination, he was alert and oriented and able to converse. His blood pressure was 140 / 80. He had a right hemiparesis: the right shoulder and right hand were weak against resistance; and the right side of the face was slightly weak. His articulation was impaired. Cognitive functioning was normal. There were right sensory deficits. There was no ataxia, no cervical bruit, and no nuchal rigidity.

LABORATORY RESULTS

A CT scan performed the day of admission showed a superficial infarct of the left frontal lobe. A second CT scan performed Aug. 26 was unchanged. The EEG was abnormal. The EKG was normal.

HOSPITAL MANAGEMENT

The admitting diagnosis was stroke, and he spent 3 days in intensive care. An endarterectomy of the left internal carotid artery was performed on Aug. 29 and cerebrovascular surgery of an unspecified nature was performed on Aug. 30. He stabilized the first 6 days after onset, and worsened in a fluctuating manner during days 7 - 14. His worsening was due to surgical complications and the evolution of the stroke. While hospitalized, he received heparin and anticonvulsants.

DIAGNOSIS

The stroke was diagnosed as due to an infarction with tandem arterial pathology. The primary site of the stroke was the left frontal lobe. The primary vascular territory was the left common carotid artery. The syndrome was described as mixed aphasia with hemiparesis, hemisensory loss, and hemianopia.

OUTCOME

He was discharged to his home on Sep. 6, 1983 with a prescription for anticonvulsants.

STROKE DATA BANK
STROKE SERVICE REPORT

Patient name:

Patient # 00009

Attending physician:

ADMISSION INFORMATION

The patient is a 50-year-old right-handed black woman admitted on Jul. 12, 1983. On admission, she was alert with right hemiparesis, impaired articulation, and impaired swallowing. At onset, she experienced a focal deficit which had not been present upon awakening. She stabilized during the first 24 hours after onset.

RELEVANT MEDICAL HISTORY

She has been diagnosed as hypertensive and was being treated at the time of onset. She is diabetic and was being treated with insulin. There is no history of stroke, TIA or heart disease. No alcoholic beverages were consumed within 24 hours of onset.

NEUROLOGICAL EXAMINATION

During the examination, she was alert and oriented and able to converse. Her blood pressure was 170 / 78. She had a right hemiparesis: the right side of the tongue and right side of the face were weak against resistance; and the right hand, right hip, and right foot were slightly weak. Her articulation and swallowing were impaired. Cognitive functioning was normal. There was cervical bruit. There were no sensory deficits, no ataxia, and no nuchal rigidity.

LABORATORY RESULTS

A CT scan performed the day of admission was normal. A second CT scan performed Jul. 14 showed a deep, large infarct of the left caudate and left centrum semiovale. The spinal tap showed clear CSF. The EKG showed myocardial infarction and ischemic changes. The echocardiogram was normal.

HOSPITAL MANAGEMENT

The admitting diagnosis was stroke, and she spent 6 days in intensive care. She stabilized the first 2 days after onset, then worsened in a stepwise manner during days 3 - 6, and improved during days 7 - 14. Her worsening was due to possible clot propagation, possible collateral failure, a possible new embolus, and possible regional acidosis. While hospitalized, she received heparin, antihypertensives, and insulin.

DIAGNOSIS

The stroke was diagnosed as due to an infarction with a normal angiogram. The primary site of the stroke was the left basal ganglia and capsule. The primary vascular territory was the penetrating branches or lentriculostriate branches of the left middle cerebral artery. The syndrome was described as a lacune: pure motor stroke.

OUTCOME

She was discharged to a rehabilitation hospital on Jul. 27, 1983 with a prescription for insulin.

STROKE DATA BANK
STROKE SERVICE REPORT

Patient name:

Patient # 00007

Attending physician:

ADMISSION INFORMATION

The patient is a 42-year-old right-handed black woman admitted on Jul. 7, 1983. On admission, she was lethargic or drowsy with left hemiparesis, abnormal cognitive functioning, and left sensory deficits. At onset, she experienced decreased consciousness which had not been present upon awakening. She stabilized during the first 24 hours after onset.

RELEVANT MEDICAL HISTORY

There is no history of stroke, TIA, heart disease, hypertension or diabetes. One alcoholic beverage was consumed within 24 hours of onset.

NEUROLOGICAL EXAMINATION

During the examination, she was lethargic or drowsy but oriented and able to converse. Her blood pressure was 120 / 80. She exhibited visual neglect. She had a left hemiparesis: the left side of the face and left hand were slightly weak. Cranial nerve functioning was normal. There were left sensory deficits. There was no ataxia, no cervical bruit, and no nuchal rigidity.

LABORATORY RESULTS

A CT scan performed the day of admission showed a superficial infarct of the right frontal lobe, right parietal lobe, and right temporal lobe. The EEG was abnormal. The EKG was normal.

HOSPITAL MANAGEMENT

The admitting diagnosis was stroke, and she spent 4 days in intensive care. She stabilized the day of onset, and improved during days 2 - 14. While hospitalized, she received steroids, narcotics, and anticonvulsants.

DIAGNOSIS

The stroke was diagnosed as due to an embolism from cardiac source. The primary site of the stroke was the right parietal lobe. The primary vascular territory was the upper branch of the right middle cerebral artery.

OUTCOME

She was discharged to her home on Jul. 19, 1983 with a prescription for anticonvulsants.

STROKE DATA BANK
STROKE SERVICE REPORT

IDENTIFYING INFORMATION --

Patient name:

Patient # 00012

Attending physician:

Sex: male
Age: 58
Race: white
Handedness: right-handed

Date of admission: Aug. 22, 1983
Date of discharge: Sep. 6, 1983

RELEVANT MEDICAL HISTORY --

Prior stroke history:
   Number of prior strokes: 1
   Vascular territory: left carotid territory
   Types of strokes: ischemic
   Last stroke occurrence: 1-6 months ago

TIA history: none

Heart diseases: myocardial infarction

Hypertension: yes, treated at time of onset
Diabetes: no

Number of alcoholic beverages consumed within 24 hours of onset: none

EVOLUTION OF THE DEFICIT --

Deficit present on awakening?: yes
Symptoms present at onset: focal deficit

Course of the deficit in the first 24 hours after awakening:
     0 - 12 hrs: smooth worsening
   12 - 24 hrs: stabilized

NEUROLOGICAL EXAMINATION --

Level of consciousness: alert
Verbal response: oriented and able to converse

Blood pressure: 140 / 80

Cognitive functioning: normal

Cranial nerve functioning:
   Articulation: impaired

Motor weakness: right hemiparesis

	Right Side
Tongue:	untestable
Face:	slight weakness
Shoulder:	weak against resistance
Hand:	weak against resistance
Hip:	normal
Foot:	normal

Sensory deficits: right
Ataxia: absent
Cervical bruit: absent
Nuchal rigidity: no

LABORATORY RESULTS --

CT scans:

Date: Aug. 22, 1983
CT scan: abnormal
Findings:
1. superficial infarct of the left frontal lobe

Date: Aug. 26, 1983
CT scan: abnormal
Findings: unchanged from CT scan of Aug. 22

EKG: normal
EEG: abnormal

HOSPITAL MANAGEMENT ---

Was this stroke the admitting diagnosis?: yes
Days in intensive care, from the onset of the stroke: 3

Cerebrovascular surgery:
Aug. 29, 1983 : endarterectomy of the left internal carotid artery
Aug. 30, 1983 : other cerebrovascular surgery

Course of the deficit (first two weeks):
Days 1 - 6: stabilized
Days 7 - 14: fluctuating worsening

The patient's worsening in the hospital was due to:
surgical complications
stroke evolution

Medications during hospitalization: heparin
anticonvulsants

DIAGNOSIS ---

Etiology: infarction with tandem arterial pathology
Primary cerebral site: left frontal lobe
Primary vascular territory: left common carotid artery
Syndrome is best described as: mixed aphasia with hemiparesis, hemisensory loss, and hemianopia

OUTCOME ---

Date of discharge: Sep. 6, 1983
Discharged to: home
Discharge prescriptions: anticonvulsants

STROKE DATA BANK
STROKE SERVICE REPORT

IDENTIFYING INFORMATION

Patient name:

Patient # 00009

Attending physician:

Sex: female
Age: 50
Race: black
Handedness: right-handed

Date of admission: Jul. 12, 1983
Date of discharge: Jul. 27, 1983

RELEVANT MEDICAL HISTORY

Prior stroke history: none

TIA history: none

Heart diseases: none

Hypertension: yes, treated at time of onset
Diabetes: yes, treated with insulin

Number of alcoholic beverages consumed within 24 hours of onset: none

EVOLUTION OF THE DEFICIT

Deficit present on awakening?: no
Symptoms present at onset: focal deficit

Course of the deficit in the first 24 hours after onset:
    0 - 24 hrs: stabilized

NEUROLOGICAL EXAMINATION

Level of consciousness: alert
Verbal response: oriented and able to converse

Blood pressure: 170 / 78

Cognitive functioning: normal

Cranial nerve functioning:
   Articulation: impaired
   Swallowing: impaired

Motor weakness: right hemiparesis

	Right Side
Tongue:	weak against resistance
Face:	weak against resistance
Shoulder:	normal
Hand:	slight weakness
Hip:	slight weakness
Foot:	slight weakness

Sensory deficits: none
Ataxia: absent
Cervical bruit: present
Nuchal rigidity: no

LABORATORY RESULTS --

CT scans:

Date: Jul. 12, 1983
CT scan: normal

Date: Jul. 14, 1983
CT scan: abnormal
Findings:
1. deep, large infarct of the left caudate and left centrum semiovale

Spinal tap: no blood present, clear CSF
EKG findings: myocardial infarction
ischemic changes
Echocardiogram: normal

HOSPITAL MANAGEMENT --

Was this stroke the admitting diagnosis?: yes
Days in intensive care, from the onset of the stroke: 6

Course of the deficit (first two weeks):
Days 1 - 2: stabilized
Days 3 - 6: stepwise worsening
Days 7 - 14: improved

The patient's worsening in the hospital was due to:
possible clot propagation
possible collateral failure
possible new embolus
possible regional acidosis

Medications during hospitalization: heparin
antihypertensives
insulin

DIAGNOSIS ---

Etiology: infarction with a normal angiogram
Primary cerebral site: left basal ganglia and capsule
Primary vascular territory: penetrating branches or lentriculostriate branches of the left middle cerebral artery
Syndrome is best described as: lacune - pure motor stroke

OUTCOME ---

Date of discharge: Jul. 27, 1983
Discharged to: rehabilitation hospital
Discharge prescriptions: insulin

STROKE DATA BANK
STROKE SERVICE REPORT

IDENTIFYING INFORMATION --

Patient name:

Patient # 00007

Attending physician:

Sex: female
Age: 42
Race: black
Handedness: right-handed

Date of admission: Jul. 7, 1983
Date of discharge: Jul. 19, 1983

RELEVANT MEDICAL HISTORY --

Prior stroke history: none

TIA history: none

Heart diseases: none

Hypertension: no
Diabetes: no

Number of alcoholic beverages consumed within 24 hours of onset: one

EVOLUTION OF THE DEFICIT --

Deficit present on awakening?: no
Symptoms present at onset: decreased consciousness

Course of the deficit in the first 24 hours after onset:
0 - 12 hrs: unknown
12 - 24 hrs: stabilized

NEUROLOGICAL EXAMINATION --

Level of consciousness: lethargic or drowsy
Verbal response: oriented and able to converse

Blood pressure: 120 / 80

Cognitive functioning:
Unusual neurological findings: visual neglect

Cranial nerve functioning: normal

Motor weakness: left hemiparesis

	Left Side
Tongue:	untestable
Face:	slight weakness
Shoulder:	normal
Hand:	slight weakness
Hip:	untestable
Foot:	normal

Sensory deficits: left
Ataxia: absent
Cervical bruit: absent
Nuchal rigidity: no

LABORATORY RESULTS --

CT scan:
Date: Jul. 7, 1983
CT scan: abnormal
Findings:
1. superficial infarct of the right frontal lobe, right parietal lobe and right temporal lobe

EKG: normal
EEG: abnormal

HOSPITAL MANAGEMENT ---

Was this stroke the admitting diagnosis?: yes
Days in intensive care, from the onset of the stroke: 4

Course of the deficit (first two weeks):
Day 1 (onset): stabilized
Days 2 - 14 : improved

Medications during hospitalization: steroids
narcotics
anticonvulsants

DIAGNOSIS ---

Etiology: embolism from cardiac source
Primary cerebral site: right parietal lobe
Primary vascular territory: upper branch of the right middle cerebral artery

OUTCOME ---

Date of discharge: Jul. 19, 1983
Discharged to: home
Discharge prescriptions: anticonvulsants

APPENDIX E

Stroke Data Bank
Case Report Questionnaire

Enclosed with this questionnaire are six case reports of stroke patients. These case reports have been automatically generated by a computer using the data from the Stroke Data Bank.

The case reports have been generated in three different formats: a textual format, a textual format that contains headings, and a tabular format. The case for Patient # 00012 has been generated in all three formats. The other three case reports (one of each format) are of three different patients.

The same set of questions was used to generate all three case report formats; for any particular patient, the three different formats of the case report contain exactly the same facts. You can see this most clearly by comparing the case reports for Patient # 00012.

The questionnaire that follows is one part of the evaluation of the case reports that is now in progress. So that the computer-generated case reports can be developed to best suit your needs and take into consideration your preferences, we would like you to read the enclosed case reports carefully and answer the questions on the following pages. Return the questionnaire to us in the self-addressed, stamped return envelope that has been enclosed for your convenience.

Thank you for your cooperation.

Please return questionnaire to:
Daniel B. Hier, M.D.
Department of Neurology
Michael Reese Hospital
Chicago, Illinois 60616

Stroke Data Bank
Case Report Questionnaire

1. Is there any patient information which should be added to the reports?

2. Is there any patient information which should be deleted from the reports?

3. Are there any items that should be in a different paragraph or under a different heading than the ones in which they presently appear?

4. Should there be any change in the order in which the items are presented?

5. Do you feel that it is important for the case report to evoke in your mind an image of the patient and his/her case? (please circle one of the numbers on the scale:)

1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7
not at all important | somewhat important | very important

6a. How well does the <u>textual report</u> evoke this image?

1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7
not at all | somewhat | very well

6b. How well does the <u>textual report with headings</u> evoke this image?

1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7
not at all | somewhat | very well

6c. How well does the <u>tabular report</u> evoke this image?

1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7
not at all | somewhat | very well

7. Do you feel it is important to be able to locate specific information quickly in a case report?

1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7
not important | somewhat important | very important

8a. In which case report is information easiest to locate?

___ textual report
___ textual report with headings
___ tabular report

8b. In which case report is information hardest to locate?

___ textual report
___ textual report with headings
___ tabular report

9. Are any of the reports too long or do they take too long to read?

___ no, none are too long/take too long to read
___ yes, the following is/are too long/take too long to read:
  ___ textual report
  ___ textual report with headings
  ___ tabular report

10a. Which report would you be <u>most</u> likely to use?

___ textual report
___ textual report with headings
___ tabular report

10b. Which report would you be <u>least</u> likely to use?

___ textual report
___ textual report with headings
___ tabular report

11a. The forms that were used to generate the case reports are listed below. Not all of the items from these forms were included in the reports. If you would like additional information from these forms, please indicate whether you would prefer to have it included in the basic case report, or whether you would prefer to have it available in an optional supplemental report. Please put a check next to only those forms from which you would like additional information; please leave the others blank.

Basic Report	Supplemental Report	
___	___	B - Background Information
___	___	M - Medical History
___	___	N - Neurologic History
___	___	X - Neurologic Exam
___	___	C - CT Scan
___	___	D - Death Information
___	___	H - Summary of Hospitalization
___	___	J - Diagnosis of Stroke

11b. The following list contains the forms that were not used to generate the case reports. If you would like information from these forms made available to you, please indicate whether you would prefer to have it included in the basic case report or whether you would prefer to have it available as an optional supplemental report. Please check only those forms from which you would like information; please leave the others blank.

Basic Report	Supplemental Report	
___	___	Q - Stroke Daily Flow Sheet
___	___	S - Social History
___	___	F - Functional Assessment
___	___	V - Angiography
___	___	E - Evolving Stroke Laboratory Exam
___	___	P - Pure Motor Syndrome Daily Course Exam
___	___	K - Complications Following Stroke
___	___	Y - Autopsy
___	___	L - Follow-Up
___	___	R - Recurrent Stroke

12. Please indicate the case report form that you would like to have as a permanent feature of the Stroke Data Bank:

- ___ textual report
- ___ textual report with headings
- ___ tabular report
- ___ none of these:
  - if none, please indicate why:
    - ___ I would not use computer-generated case reports
    - ___ I would use computer-generated case reports, but I would not use any of these
    - ___ other; please explain:

Please feel free to include any other comments, recommendations, or thoughts you may have about the case reports and the different formats, or about computer-generated case reports in general.

APPROVAL SHEET

The dissertation submitted by Carol Lynn Curt has been read and approved by the following committee:

Fr. Daniel C. O'Connell, Director
Professor, Psychology, Loyola University

Dr. Martha W. Evens
Associate Professor, Computer Science, Illinois Institute of Technology

Dr. Alan Saleski
Associate Professor, Mathematical Sciences, Loyola University

Dr. Bernard Dugoni
Assistant Professor, Psychology, Loyola University

The final copies have been examined by the director of the dissertation and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the dissertation is now given final approval by the Committee with reference to content and form.

The dissertation is therefore accepted in partial fulfillment of the requirement for the degree of Doctor of Philosophy.

October 28, 1986 — Daniel C. O'Connell, S.J.

Date — Director's Signature