THE CAPTURING OF MORE DETAILED MEDICAL INFORMATION IN COSTAR


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ABSTRACT

A heavy reliance on the use of narrative text to record information in the COSTAR (Computer Stored Ambulatory Record) medical record has made automated analysis of the data difficult. Front-end microprocessors and new data capturing mechanisms have made it possible to develop methods which facilitate entry of medical data in codable form. A prototype of such a system developed at the Laboratory of Computer Science is described here.

INTRODUCTION

An integral part of the COSTAR philosophy has been an emphasis on complete data recording by allowing capture and storage of medical information in the form of narrative text. This, however, has made automated retrieval and analysis of the data difficult and often impossible. With the availability of terminals supporting advanced graphics and increased processing power, it is now possible to develop techniques to facilitate entry of detailed medical information, while still retaining some of the flexibility and ease of recording inherent in narrative text format. The Laboratory of Computer Science at Massachusetts General Hospital is currently exploring physician/computer interactive tools for fast efficient capture of detailed physical findings, medications and laboratory data.

This paper will examine the need for detailed medical data and efficient ways of capturing it. Novel means for achieving computer/physician interaction through the use of front-end microprocessors, independent display windows, touch-screens and the "mouse" will be discussed. Lastly, a prototype exemplifying physical exam data capture will be presented.

THE NEED FOR DATA PRECISION

A database is a simplified model of reality. Therefore it sacrifices accuracy for simplicity, with only one meaningful measure of the success of the tradeoff - usefulness. This in turn depends on the reason for using the database. Different users have different purposes, some requiring more precision than others (and unfortunately more complexity). For example, contrast the needs of the patient's primary physician with those of a quality assurance program. The primary physician may wish to record detailed social data about the patient and minute detail of his own particular interests or subspecialty. On the other hand, a quality assurance program requires a relatively complete data base and a mechanism to recognize and correct for bias in the collection of information. A quality assurance program may also require more quantitative information and the ability to distinguish between absent and negative information. These two views of the data conflict. One seeks to impose standards, the other wants individuality and freedom of expression. The challenge is to provide a means for compromise: a method where freedom of expression is assured and where recording of precise data is literally at one's fingertips.

The COSTAR model has achieved freedom of expression by allowing the linkage of narrative textual data to user-defined encoded terms. These terms, referred to as "codes" in the COSTAR milieu, may be defined as broadly or as precisely as the practice wishes. Narrative text is used to provide recording precision. The term "FRACTURE", for example, may be recorded with the text "lower fibula, simple, healing well, stay on crutches one more week". This greatly supports ease of recording, and output reports can be designed to clearly present the information recorded. The limitation inherent in this approach, however, is that data in the form of narrative text remains inaccessible to computer analysis.

Much research has gone into natural language parsing, i.e., extracting meaning from narrative text strings, but the "intelligence" of current parsing systems is still far from being able to handle the complexity and diversity of medical content. Without this recognition capability, the computer's power cannot be utilized to automate data analysis. Consequently, in a data base such as COSTAR's, quality assurance protocols, provider feedback and automated guidance cannot be
This laboratory has frequently encountered this problem in implementing quality assurance projects for a number of its own COSTAR users. At one site, for example, a protocol was instituted for checking whether patients with throat cultures positive for Beta Hemolytic Strept Group A had been prescribed appropriate antibiotics. Throat culture results are stored in the COSTAR system at this site in the form of text, and normality or abnormality is automatically assigned via seemingly straightforward string matching strategies. (It is this determination of normality that the computer uses in carrying out quality assurance protocols.) Careful analysis of the text input revealed that out of a total of 233 positive throat cultures, 90 were falsely flagged as normal by the computer, and so would have been overlooked by any automated protocol. Additional care by data entry personnel would have helped to avoid some of these inaccuracies, but this underscores the difficulties inherent in automated comprehension and analysis of textual recording.

**DATA CAPTURE: THE USER INTERFACE**

The capturing of medical data in a manner acceptable to the physician must involve an interface that can capture more precise data with little additional work or effort by the physician. Presumably, this additional effort can be offset by new capabilities (e.g., reports, quality assurance, research) not feasible in the manual system.

To meet this criterion, medical data has traditionally been recorded into automated systems such as COSTAR by means of preprinted encounter forms. Space limitations of only a few pages on these forms, though, have discouraged the presentation of a complete list of possible encoded concepts. The tendency has been to define conceptually broad medical terms in the medical directory and to use narrative text to achieve precision. Though this method has successfully sheltered the physician from direct involvement with difficult to use computers, it has not been effective for achieving high levels of encoded data precision.

Physician/computer interactive systems have been developed to overcome the encounter form's limitations, but they have generally achieved little success. The selection of items from a hierarchically organized data structure in these systems is commonly achieved through menu-driven interfaces. The user is presented a "menu" of choices, a choice is made, a sub-menu is presented, and so on. Choices are commonly made via arrow (cursor) keys, touch-screens or light-pens supplemented by keyboard entry (e.g., entering the number corresponding to the desired choice). Menu-driven user interfaces based on touch-screen and/or light-pen technologies have encountered user resistance due to arm fatigue and difficulty with selection precision. Regardless of the input method employed, users have commonly had difficulty maintaining their frame of reference after traversing down to lower levels of the menu -- the path taken to arrive at a lower level menu is usually not apparent.

Advances in microcomputer technology in recent years coupled with new user interface engineering have resulted in increases in the reliability and speed of input devices, and in powerful user-friendly graphics. Increasingly, system configurations have been moving more of the computer processing into local microcomputer devices known as "front-ends" or workstations. The combination of these factors has allowed for the affordable production of interactive approaches that were previously possible only on very expensive and complicated communications equipment. Data can now be captured locally using relatively inexpensive microprocessors and then transferred in packaged form over low cost communication lines to a "host" computer where the data base resides.

To overcome the difficulties of existing medical data capture systems, this lab is exploring highly interactive user interfaces based on what is commonly referred to as a "mouse/window environment". Developed by Xerox's Palo Alto Research Center (PARC) in the 1970's, it is currently being strongly marketed by companies such as Apple (the Lisa), VisiCorp (VisiOne) and Microsoft. These systems allow the user to view each menu within its own workspace known as a "window". Selection of an item from the window-menu causes a new window of choices to be displayed without completely overwriting the previous window. Windows may be overlapped in such a way that the path of all previous selections is visibly apparent.

The mouse, developed by Douglas Engelbart at the Stanford Research Institute, is a small hand-held device that may be moved across a flat surface to affect cursor movement on the screen. Researched heavily by Xerox and Apple Corp., the device was found by study groups to be the most natural and precise form of speedy menu selection.

**AN EXAMPLE SYSTEM**

In developing a medical data capture system for the physician, we felt that the following are necessary criteria for continued acceptance by the physician users:

* entry of data not delayed by system response time
* reliable hardware
* position in menu hierarchy obvious to user
* easy selection of terms from menus
* allow text to be appended to any item
* allow user to record to any desired level of precision
* allow order and form of presentation to be site-definable

To assure that these criteria were satisfactorily met, a "mock-up" prototype was designed by this laboratory to allow experimentation with user interface strategies. The design was prototyped on a VTR-100 with advanced video (132 columns x 24 rows) under the VAX DSM Version 2 implementation of Standard MUMPS. An eventual functional interface could be developed on a microprocessor workstation using Standard MUMPS and a mouse and/or touch-screen. Any "front-end" workstation used must contain large capacity hard-disk storage so that all screen menus, interface programs and the MUMPS operating system may reside locally. Data captured by the workstation could be packaged and then shipped via a high speed communication line to the host system (or file server).

Figures 1 and 2 are examples of the physical exam data capture prototype under study at this laboratory. It is important to note that the example screens shown are only one way of organizing terms related to physical findings; each site can design these screens to meet their own requirements.

The screen used has been divided into six windows: five vertical windows (these will be referred to, from left to right, as windows 1 through 5) and one horizontal window along the bottom. Each of the vertical windows has a section at the top for a header. Data is entered on lines below the bottom window and then appropriately redisplayed in a window above. The terminal's cursor keys are used for positioning a blinking pointer to the desired menu item. Numerous function keys are predefined in the number pad section of the keyboard to simplify the entry of data.

The initial screen presented to the physician (figure 1) uses the leftmost vertical window to display physical findings sub-categories: SKIN, HEAD/NECK, THORAX, CARDIOVASCULAR, ABDOMEN, etc.

Figure 1

For indicating higher levels of recording precision on the CARDIOVASCULAR system, the "select" function key may be used to expand a sub-menu into the next window to the right (Figure 2). Each time a term is expanded the selection chosen is highlighted in inverse video (indicated in the examples by a box) and put into the header section of the next window. In window 2 we see an upper level breakdown of CARDIOVASCULAR terms: JUGULAR VENOUS PULSE, EDEMA, APEX BEAT, HEART SOUNDS, MURMURS, etc.

Figure 2 shows how the screen would ultimately appear when recording a SYSTOLIC MURMUR. To accomplish this, the pointer is positioned to MURMURS in window 2 and the "select" function key is pressed. Window 3 will then display attributes of MURMURS: LOCATION, TIMING, GRADE, etc. The cursor is positioned to TIMING, the "select" key is pressed, and the SYSTOLIC term is ultimately chosen from window 4. The physician may append text to the systolic murmur at this time by pressing the "text" function key. In the example we see that the term "high-pitched; probably innocuous" was appended to the murmur.
When all information has been recorded at this level, the physician may use the "back" function key to clear window 4 and return to window 3. The pointer will be positioned at the next term in the menu (i.e., GRADE). If, instead, the physician desired to return all the way back to the SYSTEM level, this could be accomplished by hitting the "back" key, in this case, three times. This would return the pointer to the next SYSTEM item (i.e., ABDOMEN).

CONCLUSION

Experience with COSTAR has continually indicated the need for a richer and more fully encoded database. Traditional methods have failed to allow sufficient levels of data precision in a user-friendly manner. New user interfaces can now be designed which take advantage of the recent developments in technology and open up new possibilities for encouraging health-care providers to enter medical data directly into the computer. The prototype system developed at LCS has aided greatly in allowing the physician to define the characteristics of such an interface.

REFERENCES


