

MEDATA—a new concept in medical records management*

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INTRODUCTION

The potential applications for computers in expediting medical research and improving patient care are well recognized. However, in a medical environment full exploitation of the latent powers of available electronic devices depends on one vital factor. That is, giving the physicians, research scientists, or administrators direct control of the type of information acquired and stored, how it is related, and the timing of acquisition and retrieval. From the viewpoint of these professional users, the paramount goal is to achieve such direct control without sacrificing the valuable time and effort required to become experts in the esoteric art of computer programming and systems operation. This concept of immediate control was the basis for developing MEDATA, an amalgamation of techniques which allows the user to organize, collect, store, and retrieve all types of medical data without resorting to the intricacies of formal computer science.

Organization of data

The MEDATA system does not specify the information structure but provides a framework for processing any structure required for the purposes of the user. Data are collected routinely on some form or questionnaire. Compilations such as abstracts in a library may not use printed forms, but the questions are implied by words such as Title, Author, Journal, and Abstract associated with the data.

Data on forms are usually related by headings and subheadings into a format resembling an outline. In the MEDATA system selected typewriter symbols are used as prefixes to the questions or headings which

express and preserve the relationships established by the user. A heading usually represents a broad classification of the questions following it, as illustrated in Figure 1. Occasionally the heading will be additional information to be retrieved with each question, as in Figure 2.

```
$CLIN PATH
#CBC
    @Hb:
    @WBC:
    @MORPH
        *RBC:
        *WBC:
        *PLATELETS:
#UA
    @pH:
    @Sp Gr:
    @A1b:
    @MICRO
        *RBC:
        *WBC:
        *BACT:
```

\$X-RAY

Figure 1—Sample program tape

When forms are used, the answers can vary from a numeric quantity to English prose and are frequently a combination of these. The technique of enclosing quantitative or coded data in parentheses at the beginning of the answer permits expression of any type of answer. This gives the physician opportunity for unrestricted expression and the statistician opportunity to retrieve quantitative data.¹²

Methods of data input

A programmed typewriter with an auxiliary paper tape is the input device. This procedure has several advantages. Unlimited numbers of characters may be used for entering data. The transcriber is the secre-

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W H A L E R S H O S P I T A L
New Bedford, Massachusetts
MEDICAL SUMMARY

\$ID NO:
\$NAME:
\$DATE:
\$PURPOSE OF EXAM:
#PRESENT ILLNESS:
#DIAGNOSIS:
#TREATMENT:
#COMMENTS:
\$EXAMINING FACILITY:
\$PHYSICIAN:

Figure 2—Program tape for medical summary

tary, who is accustomed to using the information and is familiar with the notations and spelling. Coding sheets, which are laborious to prepare and proofread, are eliminated. The typed copy produced simultaneously with the data tape satisfies the legal requirements for preservation of a document signed by the physician.

The programmed typewriter is used to define the hierarchical structure for the questions as well as to enter the data collected. To enter the format of a new data collection form into the system, the questions in their outline form are typed and simultaneously punched into a paper tape. This paper tape uniquely defines the collection form and is used to control the typewriter and paper tape punch each time data are collected on this questionnaire. The position of the question in the outline format is flagged by preceding it with one of the selected typewriter symbols. Questions may be grouped in subdivisions to nine levels. The typewriter characters selected to relate these subdivisions are referred to as position codes. These codes are \$, #, @, *, ?, \$, ±, ', %. A colon (:) and typewriter programming codes are entered after each question requiring data. Figure 1 is an example of part of a laboratory collection form showing several levels of subdivisions.

Any headings or typewriter formatting characters, such as the name of the form or institution, can be entered preceding the first position code and will

affect the appearance of the typed document but will not affect the storage and retrieval program. When the specific tape created for the form is used as a control tape, special headings are copied onto the paper tape being punched. Figure 2 is an example of a program tape used for medical summaries showing the outline headings and the position codes.

The position codes, the question, and the colon are copied from the control tape to the new paper tape. The question and colon are typed on the document. If data are to be entered, the typewriter programming codes after the question will cause control to be transferred to the secretary. Data entered through the keyboard will appear on the document and will be punched into the new paper tape. Quantitative or coded data are enclosed in parentheses at the beginning of the entry. Any parentheses after the first character of the data are assumed to be part of the prose data. Figures 3 and 4 are medical summaries collected using this procedure.

W H A L E R S H O S P I T A L
New Bedford, Massachusetts
MEDICAL SUMMARY

ID NO: 12345
NAME: Mohius, Richard
DATE: 14Dec66
PURPOSE OF EXAM: Medical Complaint--Limp
PRESENT ILLNESS: Several years ago noticed severe limp after ocean voyage. PE shows absence of left lower extremity.
DIAGNOSIS: (Y902-4991-0000)* Traumatic amputation (whale bite) left lower leg, old.
TREATMENT: Tender loving care
COMMENTS: Continue follow-up
EXAMINING FACILITY: Whalers Hospital, New Bedford, Mass.
PHYSICIAN: David Jones, M.D.

Underlined words were typed automatically by programmed typewriter under the control of the program tape described in Figure 11.

*SNOP coding:	Topography	Y920	Lower left extremity
	Morphology	1472	Traumatic amputation complete
	Etiology	4991	Whale
	Function	0000	Not applicable

Figure 3—Medical summary—14 Dec 66

This subsystem for data collection has been formally titled STAT for systematized terminal acquisition technique and is being prepared in detail for publication.¹³

Storage of data

The method of storing data on the mass storage medium departs radically from current data handling techniques. Both the question and its answer are stored for each set of data. This is an extravagant use

W H A L E R S H O S P I T A L
New Bedford, Massachusetts

MEDICAL SUMMARY

ID NO: 12345

NAME: Mobius, Richard

DATE: 01Jan67

PURPOSE OF EXAM: Medical Complaint "not feeling well, Doc"

PRESENT ILLNESS: About 3 hours following consumption of one-half barrel spiced Jamaican rum, patient noticed onset of blurred vision, occasional dizziness, nausea, and acute heartburn. Exam showed elderly white male in minor distress without significant physical findings.

DIAGNOSIS: (0000-0000-0000-7236)* Acute overdose of spices

TREATMENT: Gelucil PRN
Advised patient to use unsiced rum in future.

COMMENTS: Return for follow-up one week.

EXAMINING FACILITY: Whalers Hospital, New Bedford, Mass.

PHYSICIAN: David Jones, M.D.

Underlined words were typed automatically by programmed type-writer under the control of the program tape described in Figure 11.

*SNOP coding:³

Topography	0000	Not applicable
Morphology	0000	Not applicable
Etiology	0000	Not assigned (Spices)
Function	7236	Food Intolerance

Figure 4—Medical summary—01Jan 67

of storage facilities, but it allows extreme flexibility, which is the primary objective. If the question precedes each answer, the information may be retrieved by restating the question and doing a phrase search of the mass memory. Any question can be added to the system by inserting it on the tape controlling the typewriter. No changes are required in the storage or retrieval programs. The physician and his secretary have complete control. Facsimile storage, or FACS, as this data management concept is called, will be discussed in detail elsewhere.¹³

Retrieval of data

Extraction of pertinent data from the file is as flexible as the storage of the data. The terminal typewriter or card reader is used for medical requests based on four questions: WHO?, WHAT?, WHEN?, I/O?.

WHO? may be the patient's name or ID number for medical records or the author's name for library purposes. If more than one name is required, they can be entered in a series separated by semicolons. If selected data are to be retrieved for every name in the file, the request is answered by the word "ALL."

WHAT? may have answers ranging from one item to a complete medical record. If a complete record is required, the name of that record is entered. A single item or group of items can be retrieved by entering the name of the record, a hyphen, and the name of the item

WHO 12345. MOBIUS, RICHARD.
WHAT SUM-PURPOSE OF EXAM.
WHEN ALL.
I/O TYPE.

12345 MOBIUS, RICHARD 14DEC66

MEDICAL SUMMARY

PURPOSE OF EXAM: MEDICAL COMPLAINT--LIMP

PRESENT ILLNESS: SEVERAL YEARS AGO NOTICED SEVERE LIMP AFTER OCEAN VOYAGE. PE SHOWS ABSENCE OF LEFT LOWER EXTREMITY.
(Y902-1472-4991-0000) TRAUMATIC AMPUTATION (WHALE BITE) LEFT LOWER LEG, OLD.

DIAGNOSIS:

TREATMENT: TENDER LOVING CARE

COMMENTS: CONTINUE FOLLOW-UP

12345 MOBIUS, RICHARD 01JAN67

MEDICAL SUMMARY

PURPOSE OF EXAM: MEDICAL COMPLAINT "NOT FEELING WELL, DOC"

PRESENT ILLNESS: ABOUT 3 HOURS FOLLOWING CONSUMPTION OF ONE-HALF BARREL SPICED JAMAICAN RUM, PATIENT NOTICED ONSET OF BLURRED VISION, OCCASIONAL DIZZINESS, NAUSEA, AND ACUTE HEARTBURN. EXAM SHOWED ELDERLY WHITE MALE IN MINOR DISTRESS WITHOUT SIGNIFICANT PHYSICAL FINDINGS.

DIAGNOSIS: (0000-0000-0000-7236) ACUTE OVERDOSE OF SPICES

TREATMENT: GELUCIL PRN
ADVISED PATIENT TO USE UNSICED RUM IN FUTURE.

COMMENTS: RETURN FOR FOLLOW-UP ONE WEEK.

Figure 5—Purpose of exam retrieved

or group to be retrieved. Figure 5 illustrates the information retrieved by a request for all summary information on a patient. SUM is the name of the record of MEDICAL SUMMARY data. If a common item is to be retrieved from several records with different names, such as the diagnoses from all hospital records for the patient, the question is answered ALL-DIAGNOSIS. Figure 7 shows how an item of information can be retrieved from charts originating in several unrelated offices with no limitations imposed on any of the offices. If selected records are to be retrieved depending on content, the question is answered by the name of the record, hyphen (-), the question, colon (:), and the required series of symbols. Figure 6 shows the selection of the chart with a specified phrase in the diagnosis.

WHO ALL.
WHAT SUM-DIAGNOSIS: WHALE BITE.
WHEN 01DEC66 - 28FEB67.
I/O TYPE.

12345 MOBIUS, RICHARD 14DEC66

MEDICAL SUMMARY

PURPOSE OF EXAM: MEDICAL COMPLAINT--LIMP

DIAGNOSIS: (Y902-1472-4991-0000) TRAUMATIC AMPUTATION (WHALE BITE) LEFT LOWER LEG, OLD.

Figure 6—Diagnosis retrieved

The user-designed system of headings and sub-headings has a particular advantage in handling medical data. For example, if information on *eyes* is requested, the data are returned with all superior and inferior headings—*pupils* belonging to *eyes*, under

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WHO      MOBIUS, RICHARD.
WHAT     ALL-DIAGNOSIS.
WHEN     01JAN67 - 28FEB67.
I/O      TYPE.

12345    MOBIUS, RICHARD      03FEB67
DENTAL REPORT
DIAGNOSIS:      GUMS AND REMAINING TOOTH HEALTHY.

12345    MOBIUS, RICHARD      28FEB67
EYE EXAMINATION
DIAGNOSIS:      POOR EYES, MAY CHASE WHALES WITH GLASSES ONLY.

12345    MOBIUS, RICHARD      01JAN67
MEDICAL SUMMARY
DIAGNOSIS:      (0000-0000-0000-7236) ACUTE OVERDOSE
                  OF SPICES.

```

Figure 7—Diagnosis retrieved

the major title, *head*. This is necessary for questions like WBC (white blood cells or count) which may be found in blood, serum, urine, etc. Data on WBC are retrieved with all the headings under which it appears. Figure 8 shows the retrieval of an item and its identifiers from several sections of the chart shown in Figure 1. LAB is the record name for the LABORATORY SCREENING TESTS.

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WHO      MOBIUS, RICHARD
WHAT     LAB-WBC.
WHEN     06MAR67.
I/O      TYPE.

12345    MOBIUS, RICHARD      06MAR67
LABORATORY SCREENING TESTS
CLINICAL PATH
CBC
  WBC: 10,200
  MORPH
    WBC: NORMAL
UA
  MICRO
    WBC: NEGATIVE

```

Figure 8—WBC retrieved

WHEN? may be a specific date, a series or range of dates, or all dates. Figures 5, 6, 7, 8 illustrate this.

I/O is the choice of the available output units: TYPEWRITER, PRINTER, MAGNETIC TAPE, or DISK depending on the application and availability.

This data storage and retrieval system can be used as a FORTRAN subroutine in developing the data tapes for more elaborate tabular or mathematical statistical manipulations which users may wish to undertake with existing packaged statistical programs. Of course, special programming is required, but the task is more than half finished when the data are available in computer-readable form. A complete description of this natural inquiry language for retrieval is in preparation.¹³

Computer requirements

Computer requirements for the system are minimal. The system is written in an extremely basic FORTRAN using only READ, WRITE, DO statements, GO TO statements, computed GO TO statements, arithmetic IF statements, arithmetic statements, and COMMON. All communications between subroutines are done through COMMON to achieve maximum speed and minimum core requirements. As real-time multiterminal monitors become available, the FORTRAN program can be modified to accept requests from terminals.

MEDATA was developed using an SDS 930 with a console typewriter and magnetic tapes for storage. An IBM 1050 is the programmed typewriter used in this system.

Plans for use of MEDATA concepts

The system is being used for processing medical data on the astronauts at NASA Manned Spacecraft Center, Houston, Texas. The basic techniques are applicable for literature storage and retrieval, administrative records, and many other automated data processing requirements of a medical institution. Currently, the MEDATA methodology is being adopted for storage and retrieval of all personnel data for the staff of The University of Texas M.D. Anderson Hospital and Tumor Institute. Preliminary demonstrations have been conducted as the first step toward applying MEDATA techniques for all medical records in the institution.

The system has received enthusiastic support from the professional staff using the techniques and those who have participated in demonstrations. The operations are quickly assimilated by persons with no background in computer science, and the users appreciate a sense of full control.

Secretarial or clerical personnel were easily and rapidly trained to create basic master tapes from the medical records and insert initial data as well as add subsequent observations. The only prerequisites are familiarity with mechanical operation of the programmed typewriter and reasonable typing skill. Typographic errors are quickly corrected by deleting incorrect entries and typing the correct information. Querying the computer using the WHO, WHAT, WHEN, I/O technique can be accomplished by anyone—typist or not—after five minutes of training. Neither the physician nor the typist needs to learn a new language to use the computer.

Discussion

The pattern of progress in applying computer sciences to everyday problems may be likened to the

pattern of growth in an Airdale puppy. Each extremity seems to develop independently, and not until maturity is reached does the beast present an appearance of functional integrity. The advent of time-sharing technology is focusing increasing attention on the most retarded extremity of computer science—providing the unsophisticated user access to computer power. For the concept of time-sharing to realize its full potential, the computer must become a functioning part of the user's environment. The capabilities of computer connected terminals are multifold and include not only the control of central computer analyses and communication facilities but also provide significant improvements in data collection and retrieval options. The developments reported here explore the integration of new ideas and available equipment to produce a user-oriented medical data collection, storage, and retrieval system.

During the conception and embryogenesis of MEDATA, a concerted effort was made to utilize the applicable published ideas in the field. The integration of a terminal into the system for acquisition and retrieval of data by the medical user has been employed by others.^{2,9,14} The advantages of direct input by the secretarial personnel through a programmed typewriter terminal was adopted by the National Library of Medicine MEDLARS activity,¹ and elsewhere.¹² User-oriented data organization and variable field structuring are features of several medically-oriented systems,^{4,6,7,8,10} and the user-oriented retrieval language (Who, What, When) was first published by our own group a year ago.⁵ The amalgamation of these approaches to the various facets of medical records automation resulted in MEDATA, which offers new dimensions to the field.

SUMMARY

MEDATA, an automated medical records system, represents an organized approach to the collection, storage, and retrieval of medical data. This completely user-oriented system takes advantage of the background and training of the medical secretary and simultaneously by-passes the conventional keypunch operators and coders. It is capable of responding directly (in his own terminology) to the user who lacks extensive computer background. The system is inexpensive to maintain, and the programs and basic system concepts are machine independent.

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