A comparative evaluation of automated medical history systems

by EPHRAIM R. McLEAN with the assistance of STEFANIE V. FOOTE

University of California
Los Angeles, California

INTRODUCTION

As the practice of medicine shifts from crisis intervention to the prevention of disease and the maintenance of health, the role of the comprehensive patient medical history becomes even more important than it has been formerly.

With the need to establish a "data base" of information on the patient's general condition, the attending physician must spend anywhere from a few minutes to over an hour asking a variety of questions and recording the responses, either in long hand or by dictation (which must then be transcribed by a medical secretary).

These questions range from those pertaining to family history (e.g., father died of a heart condition) and social habits (e.g., patient smokes two packs of cigarettes a day) to the patient's own medical background (e.g., history of jaundice) and current review of systems (e.g., the cardiovascular and musculo-skeletal systems). Also included are past hospitalizations and operations, medications the patient is currently taking, and some indication of why the patient is seeking medical attention in the first place (i.e., the chief complaint or problem).

It should be noted that this history is but the first step in the fact finding and diagnostic process. In addition, the particular problem which the patient has must be explored in depth and a physical examination conducted. Based upon these findings, laboratory tests and radiological exams may be indicated. After this, there may be more questions and more tests until the physician finally arrives at his conclusions as to the nature of the ailment and the therapy and medications necessary to treat the condition. Thus the collection of the history data is more of a prelude to the actual diagnostic process than an integral part of it. This is important, for while the physician has a central role in the decision on the diagnosis, he does not necessarily have to collect all of the information on which this diagnosis is based. Indeed, there are many examples of the delegation of these tasks to residents, nurses, and lab technicians. This "division of labor" allows each member of the medical team to specialize in that phase of patient care for which he or she was trained.

It also helps define those areas in which technology can be advantageously applied.

Although the medical history is but the first step in the delivery of health care, it is a vital first step. It, in conjunction with the physical examination, provides a baseline from which to begin care and with which to gauge changes over time. This "work-up," as the patient interview and examination is called, is designed to give a complete picture of the patient's medical status, not just the problem of current concern. Unfortunately, because of the pressures of time and the desire on the part of the physician to get to the problem at hand, there is sometimes a tendency to focus exclusively on the particular problem and not ask all the routine history questions. The physician's busy schedule usually does not allow him the luxury of exploring every aspect of the patient's physical and mental condition. In every patient interview, a number of questions might be asked that would provide a more complete history, but there is simply not enough time for them. Fortunately, by training and by instinct, the experienced clinician is able to move quickly to the important facts of the patient's condition and rarely does any harm result from the few items of data that are missed. However, from the patient's standpoint, this inability of the physician to listen to all minor complaints and problems can be disconcerting.

Recently, the medical history has received attention from another quarter, that of appraisal of care. This increased scrutiny comes from two sources. First, the governmental agencies and insurance companies which function as third-party payers are concerned about the nature of the care delivered as a basis for payment. Second, the utilization review committees and Professional Standards Review Organizations (PSRO) are concerned with the appropriateness and quality of care. Both of those groups are using the medical record—of which the history is a part—as one of the prime factors in their evaluations. Thus there is increased pressure for more complete records and documentation. However, at the same time, physicians are being pressed to expand care to underserved populations and to improve care to those already being served. In the face of these competing de-
mands, it is understandable why the assistance of the computer and information processing technology is being sought.

AUTOMATED MEDICAL HISTORIES

Although the eliciting of medical history data is most usually done by the physician, there are many instances where this task is performed by residents, nurses, or other medical assistants. These individuals question the patient, record the responses, and present the completed history to the physician for his review. A logical extension of this is for the patient to record his own history directly, a role which most patients are more than willing to play. As Dr. Lawrence Weed has pointed out, the patient's time and active involvement is one of the most underutilized resources in medicine.

As with any emerging technique, there is a wide range of implementations that have been tried. Some attempt to provide a complete history for the physician, going so far as to suggest possible problems (i.e., quasi-diagnoses) and to recommend lab tests, while others perform only a basic screening or triage function or focus on a particular medical area (e.g., cardiology problems).

There is a similarly large variation in the techniques of administration. The first medical history questionnaires were merely checklists which were filled out by the patient and then given directly to the doctor for him to scan. Later, some of these questionnaires were transcribed with word processing equipment like the IBM Magnetic Tape Selectric Typewriter (MTST) or keypunched for computer processing. In this way the patient plays a more active part in the creation of his medical record, a role which immediately before the office visit. Further processing is not required, although an effort was made at one point to introduce a computer-processed version. The examining physician quickly scans the patient's responses and then proceeds with his own questioning. Since its introduction, the C.M.I. has undergone almost no changes in either its composition or in question wording. It continues to enjoy widespread popularity and it is estimated that more than 300,000 are administered annually.

Another widely used questionnaire is the one of the Department of Defense, used for screening recruits and in conjunction with periodic physical examinations for members of the armed forces. Known merely as DD Form 88 and DD Form 89, these two documents are similar in concept to the C.M.I.; and although restricted in usage to the military, they have been used extensively in this context for over twenty years.

The chief problem with manual questionnaires is their limited ability to provide for branching as a function of the results of previous questions. If there is more than one level of branching, the instructions can become quite complex and confusing. This means that particular problems cannot be explored in any great detail. Also, the physician must scan through the entire questionnaire, for there is no summarization for him. An offsetting advantage, of course, is that these manual versions are quite inexpensive, costing less than a dollar apiece.

Non-computer machine processed

In an effort to provide a neat typed summary, which is missing from the preceding, attempts have been made by Kanner and others to use word processing equipment like the IBM MTST. Inputting can be done directly from a questionnaire or in conjunction with special filmstrip equipment which is linked to an MTST. In this latter case, there are function keys which the patient uses to record his responses.

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TECHNIQUES OF ADMINISTRATION

In their comprehensive monograph on the Acquisition of the History Database, Yarnall and Wakefield identified 15 different design approaches and gave illustrations of 75 different systems. Drawing upon their study and the published results of other efforts, including those of the author, the following is a summary of the various techniques of administration. For simplicity, they can be grouped into 4 major categories: (1) manual systems, (2) non-computer machine processed, (3) off-line computer processed, and (4) on-line computer processed.

Manual systems

The first medical history questionnaire to come into general use was the Cornell Medical Index (C.M.I.). Devised by Brodman in the late 1940's, it consists of a form containing 195 questions which is given to the patient immediately before the office visit. Further processing is not required, although an effort was made at one point to introduce a computer-processed version. The examining physician quickly scans the patient's responses and then processes with his own questioning. Since its introduction, the C.M.I. has undergone almost no changes in either its composition or in question wording. It continues to enjoy widespread popularity and it is estimated that more than 300,000 are administered annually.

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* These descriptions are drawn from a number of sources, including two studies conducted by the author at the Lahey Clinic in Boston Massachusetts. For a complete list of references on the subject of techniques for administering medical histories, the author and co-author have prepared a bibliography of some 410 items, copies of which can be had by writing to him at the Graduate School of Management, UCLA.
tion of a nurse or secretary is needed. Also, the cost of the equipment must be considered; but it is not uncommon for many physicians, even in solo practice, to have word processors of some sort; and thus the cost can be shared with other applications.

**Off-line computer processed**

A logical extension of the manual questionnaires was the move to the keypunching of the responses and their subsequent batch processing. This introduces the requirement for keypunch equipment and operators as well as the need for computer processing. For most physicians this means sending the work to a service bureau, with the corresponding problems of long turnaround times, costs, and possible loss of confidentiality. And, as with all off-line modes, there is the potential source of error due to transcription mistakes. Even if the clinic or hospital is large enough to have its own computer equipment, as is true of the Lahey Clinic in Boston, there are still problems of cost (anywhere from $3.00 to over $10.00 per patient) and the inability to handle high volumes with reasonable turnaround times.

One way to resolve the keypunch problem is to move to mark sense documents. This requires specially-prepared forms (which are fairly expensive to buy and difficult to modify) and special optical scanning equipment. However, the need to transcribe is eliminated and the Lahey Clinic, which has gone to this approach, has found the error rate to be quite low while at the same time achieving same-day turnaround. In its present form, it consists of two parts: a deck of 204 prepunched cards designed for review of systems information with a single yes-or-no question printed on each card, and a pencil-and-paper questionnaire for past history. For the first part, the patient indicates his response by dropping each card into the "yes" or "no" section of a divided letter box. The positive responses are then sorted and listed immediately for the physician's review. The responses on the questionnaire form are keypunched and are added to the patient's medical record later.

A final development is the use of terminal-like devices which capture the patient's responses on magnetic cassette recorders. These units are linked to filmstrip or carousel projectors or even to audio devices for the presenting of the questions. The resulting cassette can then be either mailed in or telephoned in for processing, with the results mailed back or printed in the doctor's office at a remote terminal. The turnaround times in the latter case can be almost equivalent to an on-line system, but at a much lower cost.

**On-line computer processed**

With the growth of multiprogramming and time sharing, it now becomes feasible to consider putting the patient "on-line." In a pioneering effort at the University of Wisconsin, Slack and his coworkers developed the first on-line computer-based medical history system. Using a dedicated LINC laboratory computer, questions were presented to patients by means of a CRT display. At the end of the session, the results were summarized and printed out for the examining physician. The use of an on-line mode provided the ability to have extensive branching. The response to one question would determine, to a limited extent, the next question that was to be asked.

The use of multiple CRT devices, each under central computer control, is probably the most powerful of all approaches for collecting patient history data; but it is not without its problems. The keyboards are not typically designed for patient use, the resolution of the image on the screen may leave something to be desired, costs are high, and reliability may be a problem. As Yarnall has suggested, "Expect headaches! (That's what your grant is for!)."

At the Massachusetts General Hospital, Grossman, Barnett, and others explored the use of Teletype terminals in an interactive mode. As with Slack's work, this system also allowed extensive branching. However, because of the limited availability of terminals, the system is still on an experimental basis.

Some of the work in off-line data collection is being carried over into an on-line environment. The use of filmstrip projectors and back-projection carrousels (using either regular slides or microfilm) are now being operated under computer control. These displays offer better resolution than those of CRT's and extensive branching is still possible. With the use of minicomputers or "intelligent" terminals, this approach may prove to be the most desirable in the long run.

**EVALUATION OF AUTOMATED HISTORIES**

Recognizing these wide variations in types of histories, it is difficult to compile a single list of advantages and disadvantages that would apply to all approaches. What would be an advantage from one standpoint (e.g., low cost) might be a disadvantage from another (e.g., insufficient detail). However, to fail to make any attempt at all would be to do a disservice; and so the following list must be read with the foregoing in mind.

**Advantages**

**Time savings**

The argument given most frequently in support of self-administered histories is that they save time. If the physician takes the patient's history himself, it is the doctor's time that is being saved. If the doctor dictates the history
and thereby saves the time needed to write it out himself, there is still the time of the secretary who must transcribe the dictation. Depending upon the rate at which the doctor accounts for his time, the saving of even a few minutes could be worth several dollars. This time saving can be used to enable the doctor to see more patients or to use the extra time to delve more deeply into each patient’s particular problem or problems.

In this latter vein, there are a number of physicians who report that the patient-prepared histories give them a “head start” on their own questioning. They feel that they can go directly to the patient’s chief complaint because most of the routine questions have already been covered.

Completeness

Closely linked with the preceding is the ability of many of the automated medical history systems to give a more complete picture of the patient than is true of those generated by traditional means. This is particularly true where the doctor is pressed for time and can only concentrate on the main problem the patient has. Even in those cases where the doctor duplicates the previously-administered medical history and reasks all the questions, there is still a feeling that the patient-produced version provides a check on the doctor’s own questioning. More substantively, there are two areas where this possibility of greater completeness can be of distinct importance. The first has to do with the bringing to light of conditions which are medically important but completely unrelated to the patient’s main problem. In such cases, it is possible that the secondary conditions might be overlooked in the process of arriving at the primary diagnosis.

The second is closely related to the first. With the growth of the many medical specialties, physicians are, by choice and by training, focusing more and more upon particular problems and not on the whole patient. Thus a comprehensive medical history can serve to point out other problems the patient may have which may be far removed from the doctor’s own specialty. This information can lead to the patient being referred to another physician or being rescheduled for another visit.

Legibility

The many jokes which are made about physicians’ handwriting might be funny if the subject were not such a serious one. No longer is it a case of the doctor who makes the entries in the record being the only one who has to read them. With the increasing need for a variety of physicians and health care providers to have access to the medical record, it becomes essential that it be readable. Here the computer-produced history provides a clear benefit over the handwritten version.

Patient participation

A concern which has been raised in some quarters is that although physicians may like the assistance that computer-aided medical history systems afford them, patients may not. However, studies indicate that the reverse is true. Some patients have even expressed a preference for the self-administered histories. There are a number of reasons for this attitude.

With the pencil-and-paper versions of the history questionnaires, especially those filled out at home, patients like the less hurried atmosphere and the ability to take their time and answer each question carefully. Also, family medical records can be consulted and the labels of current medications can be checked for drug names, dosage levels, and so forth. Because most patients have come to expect to be able to spend only a brief amount of time with their doctors, the carefully-completed history reassures them that the doctor will have a complete picture of all of their problems.

For the terminal-based versions, the ability to branch forwards and backwards, to have questions explained when they are unclear, and to have a complex machine patiently waiting for each response is a stimulating and exciting experience.

Finally, there are some questions which are likely to be embarrassing; and oftentimes both patient and physician are glad to have them posed in a questionnaire or on an on-line system.

Some physicians have even commented that the very act of responding to a series of history questions is beneficial, for the patient is forced to think more concretely and specifically about his medical condition and is thus better prepared to answer the doctor’s own questions. In other words, the patient becomes a better “historian” in terms of his ability to be a more effective participant in the doctor-patient dialogue.

Predictive information

As was pointed out earlier, the collection of medical history data is not designed to yield a diagnosis but to function as a prelude to this diagnostic process. However, there is evidence that some types of decisions can be made solely on the basis of the history data. These include the determination of the desirability of conducting certain laboratory tests or of scheduling appointments with other physicians (in a multiple-specialty group practice or hospital setting), both prior to seeing the doctor for the first time.

Research

For many types of medical research, the medical record serves as an essential source of data. And for retrospective studies (reviewing past records for instances of certain occurrences), the need to have clear, complete, and readable history data can be crucial. If a researcher is looking for a possible relationship between coffee drinking and certain gastrointestinal disorders, and many of the records examined have no indication of the coffee intake, the investigation becomes that much harder.
In addition to such studies across populations, there is also the need to study individuals over time. These longitudinal studies can benefit greatly by having detailed history data, particularly review of systems information, which can both provide a health status baseline and bring to light changes over time.

By having a standardized data collection instrument, with the same question being asked of all patients in the same fashion, it becomes possible to research the data collection process itself.\textsuperscript{16,17} Certain questions may not in fact have the sensitivity or specificity commonly attributed to them and should be replaced by others. Such new questions can be added to the system or questionnaire and then tested for validity.

\textbf{Utilization reviews}

In spite of the decidedly mixed reception that utilization reviews and PSRO's have received, it must be assumed that they (or something like them) will become a permanent fixture of the medical scene. Therefore, standardized histories can be helpful in enabling review committees to monitor patient care and evaluate the overall effectiveness of health care facilities.

\textit{Disadvantages}

\textbf{Costliness}

Although it is naturally hoped that one or more of the aforementioned advantages will offset the costs, it should be clearly recognized that substantial costs will be involved. If a medical site chooses to develop its own system, there are developmental costs; and federal funds are becoming increasingly more difficult to obtain in order to help underwrite this cost. In off-line systems, with multiple-page questionnaires (some with more than 50 pages), the cost of the questionnaire design and reproduction, especially for mark sense documents, can be high. In on-line systems, the program development and the design of the terminal displays may be even higher. And in both of these approaches, the time of the physician or physicians who are guiding the project must be taken into account.

If use is made of one of the several commercially-available systems, there are still the operating costs. These can include one or more of the following: computer time, supplies, keypunching, terminal rentals and communication charges, maintenance programming (not so much to correct “bugs” as to modify and improve the questioning), and the need for attendants to administer and monitor the system.

\textbf{Lack of flexibility}

There can be no question but that the most flexible approach to history taking is that involving a human being as the questioner. To achieve the benefits of standardization, the corresponding cost is the loss of flexibility. If a preprinted questionnaire or prepunched deck of cards is used, a high degree of structure with regards to the questions is imposed, even though the options for administration (e.g., at home, in the waiting room, etc.) are quite flexible. On the other hand, several of the sophisticated on-line systems are quite flexible in their questioning, but are very rigid in their need for computer terminals, typically at fixed locations and limited in their ability to handle peak loads.

\textbf{Lack of reliability}

The more sophisticated the system, the more vulnerable to interruption it is. Whether in a batch processed mode or real-time environment, if the computer “crashes,” the processing of histories stops. Where the questionnaires are keypunched or optically scanned, there is the potential for input errors. And always there is the danger lurking of the possibility of a program or system “bug.” It is quite possible, of course, that a proposed new history system is every bit as reliable (or unreliable) as the traditional approach which it is designed to replace; but a new innovation must always meet a higher standard than its well-established predecessor in order to be considered a success.

\textbf{Inaccuracy}

In determining accuracy, the question which must be raised is “Compared to what?” It is unlikely that any system for collecting history data will ever be as accurate as the best efforts of a skilled clinician. But what of the other extreme—a careless, inexperienced, or overworked doctor?

Clearly, most present systems are not as accurate as they might be. They invariably contain false positives (reported conditions which the patient does not, in fact, have) and false negatives (the report of the absence of a condition which does actually exist). Fortunately, most systems err toward the former rather than the latter.

\textbf{Wordiness}

A direct outgrowth of this “overreporting,” that is, the reporting of trivial or nonexistent conditions (so that real problems will not be overlooked), is that the resulting history tends to be longer than it might otherwise be. This greater length or “information overkill” (sometimes as much as 3 single-spaced pages of 8\textsuperscript{\textfrac{1}{2}}” X 11” print-out) naturally requires more time to read and thus tends to negate the time saving benefit. Attempts have been made to streamline the output and to suppress certain non-essential data, but such efforts must be approached with great caution so that the benefits of completeness are not lost.
Impersonalness

Although less of a problem than earlier feared, the de-personalization or dehumanization of the doctor-patient encounter is a source of concern for both parties. So long as the self-administered history serves as an adjunct to the doctor's own questioning and examining, the problem should be minimal. But if it is perceived, either correctly or incorrectly, to assume a larger role, then greater resistance to its expanded use can be expected.

Confidentiality

Many physicians and civil libertarians are alarmed at the increasing loss of privacy and lack of confidentiality which is occurring with regards to the medical record. With the advent of computer-processed history data, there is a fear that this trend may accelerate. Because there are more people involved in the process than formerly (e.g., attendants, keypunchers, operators, programmers, etc.), great care must be exercised to insure that no such feared abuses occur.

Inappropriateness

When all is said and done, it must be recognized that there will always be cases where the use of a self-administered history is simply not appropriate. Such things as situations where the patient is unconscious, emergencies where action must be taken immediately, and finally patients whose educational level or literacy make it impossible for them to understand the questions—all these are instances where the use of an automated medical history system may not be appropriate.

SUMMARY

In light of the above discussion, it is easy to see that there is still much that is unresolved with regards to medical history systems. Costs are still high and many physicians are not yet convinced that there is a corresponding benefit. But as the reliability of the emerging systems improve, both from the standpoint of the hardware as well as the questions being asked, it can be expected that greater acceptance by the medical profession will follow.

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