Review

The Patient-Computer Interview: A Neglected Tool That Can Aid the Clinician

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In this article, I (1) review the process of interviewing patients by computer, (2) summarize computer-interviewing work done in 1968, (3) address the weaknesses of collecting information with the traditional history-taking methods or paper questionnaires, (4) discuss commercial software designed for computer interviewing, and (5) focus on the strengths and weaknesses of interviewing patients with a computer. The strengths of this process compared with traditional interviewing are that computer interviewing allows the physician to gather more data; gives the patient more time to complete an interview; uncovers more sensitive information; provides more adaptability to non-English–speaking patients, patients with hearing impairment, or patients who are illiterate; and provides structured information for research. The weaknesses of computer interviewing are that it generates false-positive responses, is not accepted by a minority of patients, is unable to detect nonverbal behavior, and requires changes in work flow. With the advent of an electronic medical record and the financial rewards for comprehensive history recording, the gathering of history and documentation from patients is increasingly important and favors adaptation to computer interviewing.

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In 1968, the *Mayo Clinic Proceedings* published the pioneering article "Toward Automating the Medical History" by Mayne et al,[1] which described the use of an expensive, state-of-the-art mainframe computer for interviewing Mayo Clinic patients. Patients used a light pen to indicate their answers or to point at pictures on the computer screen. The average time to complete an interview was 65.7 minutes; the duration depended on the patient's health, age, and education level. The general reactions of the participants and physicians were positive (Table 1). The quality of the documentation was superior to that of written charts. The authors concluded that medical history data collected with a computerized system were reliable and acceptable to both patient and physician. Despite evidence such as that of Mayne et al[1] that computer interviewing works, the use of computer interviewing of patients is ignored in textbooks.[2-4]

This article reviews the process of interviewing patients by computer. The inadequacies of traditional history-taking methods and the use of paper questionnaires are addressed, followed by a discussion of the advantages and disadvantages of computer interviewing. In contrast to previous reviews,[5-11] this review emphasizes the insights of Mayne et al[1] and Mayo Clinic colleagues in this endeavor. Commercial software available to the clinician is reviewed.

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TRADITIONAL HISTORY TAKING: INCOMPLETE AND TIME-CONSUMING

Slack and Slack,[12] pioneers in interactive history taking, wrote of traditional history taking:

> Dialogue between doctor and patient is a time-honored process revered by the medical profession. During conversation with his patient the doctor can establish rapport, evaluate his patient's ability to engage in productive discussion, observe his patient's nonverbal behavior and collect historical information of clinical relevance.…doctors as interviewers are busy, expensive and sometimes hard to find. It seems reasonable, therefore, to look for substitutes that will serve at least some of the purposes of medical interviewing in widespread and inexpensive ways.

How good is a history taken by a physician? Observations of medical interviews show that physicians often discourage the voicing of concerns, expectations, and requests for information, an approach that results in the loss of relevant information.[13,14] For example, during the standard interview, a physician will interrupt a patient in less than 24 seconds after the patient begins talking.[15,16] Physicians often use medical terminology that is misunderstood by patients.[17] Studies show that 50% of psychosocial and psychiatric problems are missed[18] and that 54% of patient problems and 45% of patient concerns are neither elicited by the physician nor disclosed by the patient.[19] Patient and physician do not agree on the presenting complaint 50% of the time.[20] Physicians control the duration of the interview. Time is limited, and it is impossible to obtain complete medical histories regularly from all interviewees during a traditional interview.[17] A study of 134 primary care physicians showed that clini-

Table 1. **Reaction of Patients to Computer-Administered Medical Questionnaire***

Patient response	No. of patients (N=154)
It will save physician time	33
It is comprehensive	25
Prefer AMH interview to physician	16
Prefer AMH to paper-and-pencil questionnaire	6
Favorable reaction, nonspecific	97
Unfavorable reaction, nonspecific	14
No comment	11

*AMH = automated medical history. From Mayne et al.[1]

cians asked only 59% of essential history items in an ambulatory setting and concluded that other approaches should be considered to ensure that complete and accurate information is available for diagnostic and treatment plans.[21]

History gathering goes beyond the individual encounter. Clinicians find that others want to obtain data in the medical record. This additional information may be unimportant to the interviewer, but it is essential for others to aid patients. Mayne and Martin[22] discussed this issue:

> To have value, medical data must be useful; but the user determines the use. An item about an individual's health status may have one value for his physician whose primary intent is to treat him and another value for a public-health physician concerned with the health problems of society. Unless we know how the data are used, we cannot judge how much of the data we acquire is needed or how much of what is needed is acquired.

History taking also involves documentation by writing, typing, or dictation. Tang et al[23,24] evaluated ambulatory practices and found that clinicians spent 20% of their day writing. In Ohio family practices, dictation and charting outside of examination rooms occupied 56 minutes of an 8.2-hour workday.[25] In an antenatal clinic, two thirds of the workday was spent recording information.[26] Legal and institutional processes require signing dictated notes. In summary, documentation time is extensive and expensive and takes clinicians away from their patients.

This chore of documentation was one of the reasons that Mayne et al[1] were prompted to research the interview of patients by computer:

> …to relieve the physician from routine, although important, time-consuming activities, thereby extending his capabilities to provide medical care. If the time physicians spend in collecting, organizing, recording, and retrieving data could be reduced, at least in part, by information technology, more time would be available for actual delivery of medical care and at the same time the physician's capabilities for collecting information from patients would be extended.

In summary, traditional history taking by clinicians is often incomplete and is time-consuming not only for collecting information but also for documenting it (Table 2). A point not mentioned in the literature should be considered. Airplane pilots are entrusted with the safety of the plane and its passengers. Before takeoff, the pilot reviews a checklist to ensure that all is ready for a safe flight. For example, the pilot of a B-747 must ask 17 questions and confirm the answers.[27] It is unacceptable for the pilot to disregard the checklist and rely on memory. Human memory is fallible.[28] Even such a short list of questions could have an omission. The number of questions a clinician needs to remember in an ideal interview is large. The stakes of omitting a question have considerable implications. Weitzel et al[29] showed that 49 of 49 items were completed on mental status examinations when a checklist was used, whereas 4 of 49 were completed when no list was used. Greist et al[30] found that emergency department staff failed to verify important information that a computer interview was able to document (ie, information regarding a penicillin allergy). Green et al[31] showed there was a lack of documentation of leading factors in repeated emergency department use.

Where is the clinician's checklist in the typical clinical encounter? In a critical situation, why would anyone not use a checklist to confirm that nothing was forgotten? It happens every day in physicians' offices. With most patients, traditional interviewing is like piloting a plane without a checklist.

PATIENT QUESTIONNAIRES: ADDING STRUCTURE TO THE INTERVIEW

Patient questionnaires can be used as a checklist. In the United States, the first study that processed paper questionnaires by computer was conducted at Cornell University in 1949.[32] The Cornell Medical Index consisted of 195 questions to be answered by patients and processed by a computer into a typed history. This early study showed some positive outcomes now confirmed by other studies. The Cornell Medical Index system collected 95% more information than the clinician. Patients found the process thorough and satisfactory. A summary of the results provides the rationale for using a questionnaire processed by a computer:

> It collects for appraisal a large and comprehensive body of information about the patient's medical history at no expenditure of the physician's time; it facilitates interview by making available to the physician a preliminary survey of the patient's total medical problems; its data, being systematically arranged, are easier to review than those on conventional medical histories, and, *by calling attention to the patient's symptoms and significant items of past history, it assures that their investigation will not be overlooked because the physician lacked time to elicit them*.

Table 2. **Characteristics of History-Gathering Techniques**

Characteristic	Personal interviewing	Questionnaire	Interactive computer
Questioning	Highly unstructured	Structured	Structured
Detail inclusion	Least	Moderate	Most
Flexibility	High	Least	High (multimedia)
Branching	Yes	Limited	Yes
Documentation	Writing dictation	Scanning or attaching	Direct entry to system as data
Legibility	Variable	Good	Extremely good
Pacing	Clinician directed	Can be done at home	Patient paced
Skipping of information	Common	Common	Unusual
Cost to do only the history	Expensive	Moderate	Inexpensive
Patient reviewed	No	Yes	Yes
Barriers	Language, culture	Reading level	Reading level (unless multimedia)
Establishing rapport	Variable	Not a factor	Not a factor
False-positive information for clinician	Least likely	Highly likely	Highly likely
Coupling to patient education or diagnosis	Yes	No	Yes
Patient preparation for interview	Not applicable	Yes	Yes
Staff preparation for interview (scheduling complaints)	Not applicable	Yes, provides agenda	Yes, provides agenda
Ease of altering questions	Yes	Slow	Yes
Quantity measurements, scale adjustments	No	Sometimes	Excellent
Cost	Expensive	Variable	Inexpensive

Computer-processed questionnaires were successfully implemented at Lahey Clinic Foundation,[33] Duke Medical Center,[34] and Kaiser Permanente.[35] Data retrieved from questionnaires completed by patients were reliable, and the process was acceptable to patients.[36-41] The questionnaires could become a part of the medical record, and clinicians could correct the form and add notations.[33]

Questionnaires have several advantages.[1] First, patients can complete them at their own pace at home and can consult others if they have questions. Second, questionnaires serve as prompts to remind patients of things forgotten. Third, questionnaires are inexpensive and thorough. More data are obtained from questionnaires than from the more traditional interview format.[42,43] Processed questionnaires provide an outline for the interview.[32,33]

Questionnaires do have some associated problems:

1. Not every question is answered in a questionnaire. General questionnaires usually include irrelevant questions. For example, a male patient need not answer questions related to menstrual periods. Also, patients do not complete written forms. Martin et al[44] at the Mayo Clinic, for example, found that 6% of patients skipped the section about chief complaint. Also, patients sometimes forget to return their forms.

2. Questionnaires are hard to revise if a question needs to be added or deleted. It requires removing old forms, printing new ones, and distributing them throughout an institution. The format of the questionnaire is geared for the average patient and is difficult to adapt to an individual patient's education, desires, or culture.

3. Questionnaires are too numerous. A review by the author of *American Family Physician* found that 44 questionnaires, ranging from 4 to 37 questions, were presented in the 24 issues published in the year 2000. The logistics of using each of these forms regularly and storing the data are daunting.

4. Questionnaires do not clarify symptoms. Positive responses to a question can be trivial or major. Efforts to refine responses are limited by the inability of providing follow-up questions in an easy-to-follow pattern on paper. An alternative method is to use a computer to generate additional questions based on a patient's initial responses to a questionnaire. Mayne et al[45] experimented with this method. Although the process succeeded with patients, clinicians did not find it useful.[46] As J. G. Mayne stated, "It did not branch enough and generated too many false positives" (oral communication, August 10, 2001).

5. Clinicians do not generally use questionnaires in practice. In the primary care setting, a recent survey of 116 offices and 400 physicians in Chicago found that only 53% of practices used paper questionnaires despite their proven advantages.[47] Guthmann[47] wrote:

> New-patient questionnaires might be perceived by physicians to compromise history taking—the cornerstone of primary care.

Such a position, however, reflects a misunderstanding and lack of physician education about questionnaires (which would be supported by their absence from interviewing textbooks).

In summary (Table 2), questionnaires provide general structure to an interview but are not easily personalized to the patient's unique situation and culture. They are difficult to maintain and often are not answered completely.

INTERACTIVE COMPUTING FOR THE PATIENT—BEGINNINGS

The history of interactive computing is rich, and the documentation of its effectiveness is thorough. Forty years ago, computers were in special rooms, operated with punch cards, and controlled by an information technology specialist. A major advance in the interfacing of patients with computers was reported in the 1960s by Slack et al.[48,49] Instead of using punch cards, patients looked at questions on a video terminal connected to a minicomputer (identified as LINC). The program addressed allergies. The first question was, "Have you ever had hives?" A randomly selected patient who had been hospitalized stated that he preferred the computer to physicians because "I'm deaf and have trouble hearing them."[50]

The computer was slow because its operating system could deal with only 1 question at a time before getting information from storage tapes. Mayo Clinic staff experimented with this system using teletype and telephone lines to connect the patient and computer from a distance. Slack and Van Cura[49] valued the concept of branching, which means that the answer to a question is like a fork in the road. If answered one way, it will lead to one set of questions; if answered another way, it will lead to another set of questions. Computer software that includes branching has a distinct advantage over questionnaires because the interview is individualized for each patient. This technique clarifies answers. Slack and colleagues contributed innovation and scholarship in patient-computer interaction for 30 years.

Mayne et al[1] published an article documenting the effectiveness of patient-computer interviewing in which they addressed the belief that a computer program is impersonal:

> It is claimed that the time the physician spends with his patient in obtaining the medical history is the basis for establishing the harmony and rapport needed for successful interaction. This may not necessarily be the most efficient way to develop a successful physician-patient relationship; in effect, this claim derives from an oversimplified view of this relationship.…Therefore, until there is evidence to the contrary, it seems reasonable to suppose that the time spent with a patient discussing the meaning of data pertinent to his problem, which have been collected *prior* to the interview, would provide an equally satisfactory basis for establishing the desired rapport.

Since the Mayne et al[1] article was published, numerous studies (Table 3[1,48,51-110]) have confirmed their conclusions. The following text discusses the strengths and weaknesses of the patient-computer interview obtained from these and other studies.

Strengths of a Patient-Computer Interview

1. Patient-computer interviews are structured and provide more historical data. They never forget to ask a question. Erdman et al[111] pointed out that it is easier to structure a computer than a person. A computer always asks every question it is programmed to ask; clinicians are not so consistent.

Computer programs generally provide more documented information than physicians (Table 3). Examples include interviews related to infertility (2.8 times more data) and general gynecology (1.6 times).[77] Simmons and Miller[112] found 35% and Quaak et al[78] found 56% more information in histories gathered by computers than in charts. Schuman et al[60] discovered a program on life events that revealed 40% more important new information, and in 22% of patients this information led to improved communication. Further evidence suggests that computerized interviews reveal more data than a questionnaire.[73,84,90,113] A physician survey about a computerized general history program[96] showed that the questions that were most valuable to clinicians were those related to psychiatry (100%), alternative care (93%), review of systems (80%), occupational exposures (67%), and prevention (60%).

2. Computer interviews can be done at the patient's pace and are satisfying to patients. Just as with paper questionnaires, patients can take their time completing a computerized interview. Table 3 shows examples of time spent on computers in various studies, number of questions, areas of inquiry, etc.

3. Computers obtain sensitive information. Socially desirable reporting is the tendency of a patient to project a good front when being interviewed.[114] For example, men tend to overreport the frequency of intercourse[115] and women underreport having had an abortion.[116] Computer interviewing is effective for obtaining personal information that many people find difficult to discuss face-to-face. Mayne et al[1] explained this behavior:

> Studies have shown that a host of nonmedical factors systematically affect communication between the physician and the patient and these ultimately have profound effects on the nature of the medical care provided. These factors arise from the physician as well as from the patient. Thus, it has been shown that the patient's cultural and ethnic background influences what he defines as "illness," what he reports to the physician, and the manner in which he reports it. In turn, the physician's orientation and behavior toward his patient depend on his background, medical specialty training, and the way in which he perceives his patient.

Several reports have shown that patients confide facts to a computer that they would not confide to an interviewer. Such facts are related to suicide,[55,83,92] alcohol screening,[64] psychiatric evaluation,[71] screening for human immunodeficiency virus in blood banks,[88] and adolescent sexual behavior and drug use.[73,84] Carr et al[71] described the sensitive issues that are missed by personal interviews in a population screened for alcoholism: blackouts (26%), impotency (23%), repeated firing from work (20%), and suicide attempts (17%). Lapham et al[87] discussed an American Indian population in which 16% of women reported battering to a computer and only 1% (3 of 265) reported battering during a traditional interview process.

Several studies[107,117,118] have shown that use of computers in combination with multimedia segments detects more sensitive information than paper questionnaires.

4. Patients are better prepared for the medical interview after being interviewed by a computer.[1,60] Adang et al[85] found that 45% of patients were better able to formulate questions for physicians if they had been interviewed by a computer. On a second interview, patients generally provided better information; this effect can last up to 8 months.[119] Patients can review their histories after completing the interview and then correct errors.[120]

5. Interviewing by computer provides legible summaries and can be manipulated by an electronic medical record, or the results can be entered directly into an electronic medical record. The format is organized by a review of systems, scales, or symptoms. Patients can enter material into an electronic medical record[121] with an accuracy rate of 94% to 97%.[122] Interactive history is now interfaced with commercial electronic medical records (A. Wenner, MD, oral communication, August 10, 2001). Because of an increasing need for documentation to receive reimbursement, patient-generated data entry may be more cost-effective than dictation. Computerized outputs eliminate transcription errors because the information is not dictated.

6. Computers calculate well and can analyze questions and produce scales that are easily interpreted by clinicians. Computerized rating scales have been reviewed.[123]

7. Patients seldom stop a computer program; therefore, all questions presented are answered. For example, in a study of 178 patients, all of the patients completed their program.[104] In contrast, skipping questions is common on a paper questionnaire.[124] Patients prefer answering a large number of questions on a computer to going through several sheets of a paper questionnaire.[71]

8. Computers allow efficient interviewing of potential contributors to the history. With traditional interviewing methods, obtaining data from family members or persons who have relevant relationships with the patient is neglected and in most instances is informal. Computerized interviewing of other family members has provided more information to staff who take care of patients and has increased the satisfaction of family members who were interviewed.[125]

9. Computers can provide questions in different languages, provide multimedia forms for patients who cannot read, and allow patients who are deaf to read or enter information in alternative ways. Considerable deficiencies have been shown when non-English speakers were interviewed with an interpreter.[126] In the 1970s, an excellent review was published of the process for a multilingual self-administered questionnaire written in 6 languages and processed into English.[127] A commercial patient-interviewing product included a Spanish version.[128] Slack and Slack[12] described computers that "voice" questions. Patients who are older generally take longer to complete a questionnaire.[129] Accuracy, however, is not impaired and may actually be better than in younger patients.[130] Even children have been successfully interviewed.[76] Hospitalized patients were able to describe up to 39 symptoms they may have experienced during the day.[108] Twenty-nine years after Mayne's study[1] with light pens, a study found that patients preferred the pen-computer system for interfacing with a computer.[101,108]

10. Research and audits are easier with computer-generated histories. If a computer is used for history taking, it is easier to set up electronic systems for data retrieval. A history obtained by a computer can be entered into an electronic medical record directly with the information in SNOMED or other coded form.[131] This technique will allow researchers to have standardized histories from patients to assess interventions and outcomes.

The patient-computer interview appears to provide an ideal checklist. Colby[132] provided an excellent summary of the advantages of computer interviewing:

> It [the computer] does not get tired, angry, or bored. It is always willing to listen and to give evidence to having heard. It can work at any time of the day or night, every day of the week, every month of the year.…Its performance does not vary from hour to hour or from day to day. It has no facial expression. It does not raise an eyebrow. It is very polite. It has a perfect memory. It need not be morally judgmental. It has no superior social status. It does not seek money. It can provide the patient with a copy of the interview to study. It does what it is supposed to and no more [and no less].

Weaknesses of a Patient-Computer Interview

1. Computers are not adept at detecting nonverbal behavior. A computer does not sense a patient's mood.

2. Patients make inadvertent errors during a computer interview because they misunderstand, forget, become

Table 3. **Studies of Computer Interviewing of Patients*†**

Reference	Subject	Time (min)	No. of questions	No. of patients	Satisfaction level (patient/physician)	Comparison of data collected
Slack et al,[48] 1966	Allergies	15-25	500‡	50	+/…	C
Peckham et al,[51] 1967	Uterine cancer	40	1145‡	93	+/+	C
Mayne et al,[1] 1968	General history	66	302‡	159	+/+	C
Coombs et al,[52] 1970	Review of system	24.1	247‡	145	…	…
Grossman et al,[53] 1971	General medicine	…	…	500	+/mixed	C
Stead et al,[54] 1972	Functional headache	…	173	50	+/saves time	C
Greist et al,[55] 1973	Suicide prevention	90	246	22	+/…	C
Pearlman et al,[56] 1973	Well baby	17.8	100‡	71	95% +/mixed	…
Evans & Gormican,[57] 1973	Diet assessment	63	365‡	50	+/…	P
Card et al,[58] 1974	Dyspepsia	…	…	72	94% +/less accurate	…
Bailey,[59] 1974	Preemployment	…	250‡	…	82% +/…	…
Schuman et al,[60] 1975	Life events	15-20	193	93	…	…
Lucas et al,[61] 1976	Dyspepsia	…	…	75	82% +/…	C
Chun et al,[62] 1976	Epilepsy	80	…	32	+/…	C
Angle et al,[63] 1977	Psychology	240-480	3000	331	+/…	…
Lucas et al,[64] 1977	Alcohol screening	26	…	36	+/mixed	C
Hastings & Whitcher,[65] 1979	Jail admissions	…	208	20	…/negative	…
Tompkins et al,[66] 1980	Preanesthesia interview	45	208‡	84	64% +, 24% neutral/+	C
Bana et al,[67] 1980	Headache	…	…	40	+/55% +	…
Rudicel & Jokl,[68] 1981	Sports examination	<30	337‡	20	…	…
Carr et al,[69] 1981	Depression scale	…	18	168	+/+	…
Lilford & Chard,[70] 1981	Prenatal visits	11-13	…	…	+/…	…
Carr et al,[71] 1983	Psychiatric history	…	250	37	83% easy/+	C
Skinner & Allen,[72] 1983	Chemical dependency	…	…	150	Mixed/…	P
Millstein & Irwin,[73] 1983	Adolescence	…	20	108	+/…	C
Lilford et al,[74] 1983	Infertility	27	330‡	200	+/…	…
Trell,[75] 1983	Prevention	15-30	269‡	10,000	+/…	…
Leviton et al,[76] 1984	Headache	…	‡	69	…	…
Bingham et al,[77] 1984	Infertility/gynecology	21-27	…	190	…/mixed	C
Quaak et al,[78,79] 1986	General medicine	60	…	99	…	C
Farrell et al,[80] 1987	CASPER	30	127‡	103	+/mixed	…
Glen et al,[81] 1989	Health quiz	11-13	300‡	262	+/…	…
Bernadt et al,[82] 1989	Alcohol screening	…	…	102	…	No difference

careless, or lie.[133,134] If patients review their answers after the interview, they find an error rate of 3% to 7%.[71] The errors tend to be false positive and can be clarified with traditional interviewing.

3. Computers can be damaged and require supervision, which has been a problem in certain populations such as jail inmates.[65] Trained personnel should be available to answer questions and to explain how to use the program in settings in which patients are unfamiliar with computers.

4. Computers are not for everyone. Computers are generally viewed favorably by patients (Tables 1 and 3), but a minority of patients do not want to use computers to enter their history. In an urban public hospital emergency department, the nonparticipation rate was 13%.[135] The reasons for nonparticipation included patient perception of being too ill, not being able to read, and dislike of computers. None of the reviews discuss patient proxies. In a secure office environment, relatives or friends escorting the patient are capable of using the computer by reading questions aloud and answering them. Regardless, provisions need to be made for patients who do not want to use computers. The responses to questions obtained from patients with schizophrenia or psychological disorders that involve lying are inaccurate.[71]

5. Computer programs are often viewed as impersonal. Poor programming gives interactive interviewing a bad name. Results from earlier studies that found poor perfor-

Table 3. **Continued*†**

Reference	Subject	Time (min)	No. of questions	No. of patients	Satisfaction level (patient/physician)	Comparison of data collected
Levine et al,[83] 1989	Suicide prevention	…	…	102	+/…	C
Paperny et al,[84] 1990	Adolescence	…	62	3327	+/…	C
Adang et al,[85] 1991	Endoscopy	11	57‡	362	+/…	…
Lutner et al,[86] 1991	Preanesthesia interview	239	60‡	…	…	…
Lapham et al,[87] 1991	Prenatal behavior	…	…	265	+/…	…
Locke et al,[88] 1992	Blood screening	8	…	294	+/+	C
Roizen et al,[89] 1992	Prevention/preanesthesia	…	120‡	250-262	+/…	…
Robinson & West,[90] 1992	Genitourinary clinic	…	…	49	+/+	C
Wenner et al,[91] 1994	General medicine (IMH)	…	15,000‡	10,000	+/…	…
Petrie & Abell,[92] 1994	Suicide prevention	…	…	150	+/…	C
Boekeloo et al,[93] 1994	HIV risk factors	6	…	305	…	C
Slack et al,[94] 1995	Health promotion	80	…	1987	85% +/…	…
Hasley,[95] 1995	Gynecologic history	…	11	200	…	C
Wald et al,[96] 1995	General medicine	27	268‡	172	+/83% +	…
C'De Baca et al,[97] 1997	Risk factors	…	…	197	…	C
Kohlmeier et al,[98] 1997	Diet assessment	…	…	…	…	…
Kobak et al,[99] 1997	PRIME-MD	…	26	51	Neutral/mixed	C
Newell et al,[100] 1997	Chemotherapy history	15	…	229	92% +/…	…
Kim et al,[101] 1997	General medicine	…	…	112	77% +/…	…
Hunt et al,[102] 1997	Diabetes	15	…	47	…	P
McRoy et al,[103] 1998	Interview and educate	…	‡	…	…	…
Buxton et al,[104] 1998	Quality of life	7	…	178	+/…	…
Shakeshaft et al,[105] 1998	Alcohol screening	…	…	179	+/…	…
Williams et al,[106] 1998	Cancer prevention	…	…	557	…	…
Kissinger et al,[107] 1999	Screening	…	…	280	+/…	C
Reilly,[108] 1999	General medicine	…	39	72	+/…	…
Pierce,[109] 2000	General medicine (IMH)	…	15,000‡	25	+/…	…
Rhodes et al,[110] 2001	Prevention	15-18	145	248	+/…	C

*C = computer collects more sensitive information than person; CASPER = computerized assessment system for psychotherapy evaluation and research; HIV = human immunodeficiency virus; IMH = Instant Medical History software; P = person collects more sensitive information than computer; PRIME-MD = Primary Care of Mental Disorders questionnaire; + = favorable satisfaction level.
†Ellipses indicate values were not determined.
‡Branched questioning.

mance by older patients or patients with less education may have been affected by the computer's limited ability to ask proper questions and its slow operation speed.[52,136]

A patient or physician may view a computer as impersonal. Patients change this attitude after using the computer.[50,137] Selection of questions can make an interview more personal. Peiris et al[138] evaluated questions in programs and classified them as computerlike or humanlike. For example, the question "Snoring is a common problem and you may not be aware that you are doing it, but have you ever been told that you snore?" is more humanlike than "Do you snore?" The study showed that patients responded better and confided more information to humanlike questions that project empathy.

6. Computers require space. A major obstacle is finding a location for the computers. Setting up a stable electronic system requires supervision and knowledge of computers. One study has shown better outcomes if the computer is in the waiting room instead of in the examining room,[106] and the addition of a computer system in a lobby adds new stresses to office staff.[139]

7. Patient-computer interviewing provides false-positive information to clinicians. Physicians generally do not like listening to or addressing minor complaints.[140] A computer provides more unfiltered data to the clinician that may be irrelevant to a patient's management. In the traditional interview, clinicians interrupt the voicing of a complaint if the complaint seems unimportant.[14] With patient-

computer interviewing, patients are not interrupted, and information seen as unimportant is presented. Martin, Mayne, and others[44-46] found that clinicians grew weary of false-positive information and showed increasing discontent over time. The source for minor complaints can be understood by realizing the nature of minor complaints in a population. A study[141] of 1000 random adults found that 750 had had an injury or illness in the past month, but only 250 had seen a physician. Patients have aches, pains, and illness as a part of life and cope with these events. A computer program does not necessarily distinguish background symptoms from those leading to a visit to a physician. The physician, the patient, or the software needs to determine what is relevant. A final aspect of this issue is that what the physician views as trivial and false-positive information may be important to the patient, and the patient needs reassurance that the complaint is not a threat.[142]

8. Computer software has not been readily available to clinicians. Computer-patient studies run out of funding, the inventor moves on, or the study is difficult to replicate. In 1977, Friedman and Gustafson[143] discussed a survey of 32 computer implementers that showed that 51% of the projects had stopped, 41% were unfunded, and only 18% were continuing with patient fees. A report of English computer-patient interactive programs[144] stated that several software programs that had been successful were no longer used because the operating systems were obsolete or the creators had moved to other areas. Standardizing programs with Web language or the same computer operating systems is relatively recent.

In summary (Table 2), the downsides of computer interviewing are that some patients do not want to use the computer, it has difficulties in discriminating data, and it has not been available in a form that can be used in the office setting.

FACTORS FAVORING PATIENT-COMPUTER INTERVIEWING

Four trends favor patient-computer interviewing:

1. Clinicians are developing skills in basic computing. When Mayne et al[1] published their work, a computer was a huge investment, and its capacity was limited. These drawbacks are no longer factors, and computers are not novelties. Today, medical students are using computers on wired campuses and have the skills to use a database and word processing before they enter medical school.[145] The idea of editing a history in an electronic environment is similar to performing other daily electronic activities and is familiar. The presence of computers for clinicians is a recent phenomenon. A survey done in late 1998[146] showed that 82% of replying internists used a computer in their work or for personal use. The median duration of experience was 5 years at home and 3 years in the office. Clinical electronic functions were available in the offices of 19% of internists. Considering that Microsoft Explorer was not introduced until 1995, this trend bodes well for receiving data in an electronic form.

2. Documentation is financially rewarded. When Mayne et al[1] published their work, writing a history was standard, and reimbursement did not depend on documentation. Things are different today. Dictation is consuming a large amount of time in a clinician's day, and it provides little increase in productivity. Clinicians writing their documents will find them inadequate for defending themselves from audits or legal proceedings.

3. Outcome studies show the effectiveness of computer interviewing.[147] As quality-control programs encompass more and more areas, clinicians will be rewarded for more complete histories. In the outcome study by Williams et al,[106] patients in 60 primary care practices in Virginia were interviewed with a computer on the subject of cancer prevention. The study showed an increase in screening mammography (6.6%) and clinical breast examinations (6.1%), the increase being in patients who had not had a preventive visit in the previous year. Another study[110] in inner-city Chicago showed that 95% of patients who interacted with a computer program requested prevention information and that 62%, when telephoned later, recalled prevention intervention (vs 27% in the control group). Other favorable outcomes were found for predicting suicide[148] and risk factors for pregnancy.[87,97]

4. Electronic medical records require data entry. The use of electronic medical records is growing, and one disadvantage is that they require structured data entry. Who will do the time-consuming information entry? Clinicians and medical assistants may do some, but the most cost-effective method is to have the patient provide the information to the computer directly and accurately.[121,122]

COMMERCIAL SOFTWARE

Several studies reviewed in this article used programs that are now obsolete. Consequently, criteria were developed to evaluate off-the-shelf software that a clinician can use today. The criteria include a program that has been supported for at least the past 10 years, has a Web presence, uses branching questions, is designed for patient entry, has had published evaluations of its performance, and has complexity beyond a mental health tool or health risk appraisal. Two products meet these criteria: Instant Medical History and HealthQuiz.

Instant Medical History (http://www.medicalhistory.com) is available commercially to a provider for $50 a month. The prototype was developed in 1985, and the company now has a Windows-based program that contains

more than 15,000 questions. It has a powerful engine for managing questions, and new questions can be added easily. It is excellent for patients who have vague complaints because it uses scales for conditions such as depression, anxiety, abuse, and alcoholism. It is upgraded every 3 months. Its output is easy to edit, and it has a Web presence. An excellent feature is "favorites." This allows the clinician to choose questions that will be asked of every patient, for example, when each patient should be screened for the US Preventive Services Task Force guidelines or when all women should receive domestic violence screening. Currently, the issue of questions that specialists want included and questions that generalists want included is being addressed. Specialists want more details on their specific area and less information on fields outside their specialty.

HealthQuiz (http://www.healthquiz.com/main/about.html) was introduced in 1984. This has modules that can be used in areas such as preanesthesia. The program has the advantage of being free. Patients can take this quiz over the Internet. Its biggest disadvantage is that it is not comprehensive.

CONCLUSIONS

In 1968, Mayne et al[1] stated that patient-computer interviewing was a positive experience for the clinician and the patient. Their well-controlled, documented study and conclusions have been confirmed. The strengths and weaknesses of patient-computer interviewing are established. The computer provides structure, allows a patient to provide information to the clinician, and outlines the framework for an interview. A further strength of the patient-computer interview is that it acts as a checklist.

Traditional history taking has serious deficits. Clinicians forget and miss essential historical items or record incomplete data. Questionnaires provide structure to an interview but are not comprehensive or personalized. Patients being interviewed by computers give more complete information and more sensitive information. Patients can proceed at their own pace, and the computer has the capacity to be programmed for deafness, illiteracy, foreign languages, and other special needs. Because computer interviewing provides structure, the information can be entered into a computer for research. The computer does not replace the clinician but provides a checklist. Weaknesses of computer interviews are that the computer is unable to sense a patient's nonverbal behavior and provides more false-positive information than a clinician; also, some patients refuse to use a computer.

Regulation, both governmental and nongovernmental, necessitates better means of collecting and storing medical data. Computer technologies support the collection and organization of medical histories. With the advent of electronic records, reimbursement changes, the Web, and patient empowerment, the financial rewards for obtaining more detailed information are changing. Computers are our best option for obtaining structured data.

Clinicians and computers are not competitors. The computer interview supplies clinically important information that is not generally obtained in the traditional interview. The electronic environment enhances the efficiency of the interview and improves patient care. The clinician has time to discuss the implications of the history and devise a plan customized to the patient.

Mayne et al[1] used a computer that cost about $1.5 million and a terminal that cost $13,500 (e-mail communication, September 9, 2001). It contained an operating memory of 16,384 words. Today, a computer system superior to this can be purchased for less than $500. Interactive patient-computing programs are available and are inexpensive. Duplicating Mayne's experience is now within the capacity of any clinic that has a small computer and a waiting room. The development of systems to use the data is a vital and fertile area for research.

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