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COMPUTERS IN PSYCHIATRY

Marjorie H. Klein
John H. Greist

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Introduction

In the five years since we wrote *Computers in Psychiatry, Promises to Keep*, cross currents of advances in computing technology and legislation mandating and regulating mental health services, payments and research, and professional attitudes have produced some striking successes in this field, as well as a simultaneous turbulence that makes future directions far from certain. Few clinicians, fewer patients, but perhaps more administrators, interact directly with computers. Most contacts have negative connotations: There is the obligation to complete forms to feed the computer, and the requirement of paying bills. It is thus still appropriate to ask whether computers have an important role in psychiatry beyond the standard fiscal and administrative services that can be adapted from business applications. Often, these fiscal services are purchased from Computer Service Bureaus, which also serve a wide variety of nonmedical business applications. Psychiatric computing remains at some distance from the promised land of integrated and demonstrably useful administrative and *clinical* computing services that we have been traveling toward for the past two decades.

Technologies that succeed quickly and broadly solve critical problems.

Often they represent first-time solutions (for example, the Salk polio vaccine) and markedly increase the quality and/or quantity of a service in a cost-effective or cost-efficient manner (for example, banking, credit card, and airline reservation services). For computers to gain a permanent franchise in psychiatry, they must address and solve important problems. They must also enter, or sometimes create, a receptive atmosphere or else they must wait for a hostile atmosphere to change. There are those who feel that many computer applications are unjustified intrusions into the humanistic practice of psychiatry. Computer applications apparently represent a paradigm shift that some professionals are incapable of making.

What are the psychiatric problems for which computer applications have been proposed and tried? What attempts, accomplishments, and failures have appeared to date? What is the short- and long-term prognosis for computer applications?

Each mental health professional (whether clinician, administrator, clerical worker, teacher, or researcher) faces unsolved professional problems. Those who have no problems (no areas in which they can make improvements) are naive or dangerous or both. Solutions to the many mental health problems may or may not involve the use of computers. But as an ethical profession, psychiatry has a responsibility to address and to attempt to solve problems of prevention and treatment, in order to provide better care for patients, which, of course, is the reason that the mental health professions exist.

Where it has been possible to show that computers have solved difficult problems for psychiatry, they have sometimes been accepted and used. Prominent examples are fiscal and administrative applications, which often reduce or eliminate hand collating and tabulating, hasten the processing of accounts receivable and posting of bills, while reducing errors and lowering costs. These programs usually operate at a discrete distance from clinicians.

Mental health researchers, who have been trained in quantitative approaches to hypothesis testing and who are required to manage data somewhat akin to those of mental health administrators, have also embraced computers.

Between these two camps of computer users remain the clinicians and their patents, who are the *raison d'etre* for all clinical and supportive staff. Will the clinical interaction in psychiatry remain so much an intuitive art or analogue phenomenon that digital machines (with their needs for dichotomous data) will not (and perhaps should not) be able to intrude? Is the language and logic of clinical psychiatry so idiosyncratic (even well-trained psychiatrists often disagree about diagnosis and management) that we cannot hope that computers can help?

We will briefly review the business (fiscal and administrative) and research applications that have secured a foothold in psychiatry. The remainder of this chapter will deal with clinical applications that have been developed and tested but not yet disseminated. As is the habit of those writing about fast-moving fields, we will conclude with predictions about the years ahead.

Definitions

A few concepts and definitions will assist the reader in understanding computers in general and their specific applications in the mental health field.

Hardware: Computing machinery consists of a central processing unit (CPU), memory, data storage devices (usually disc or tape), cathode ray tube or CRT (television screen and typewriter keyboard), optical scan (reads marks from paper) and printing typewriter terminals, card or keypunch for batch-oriented systems, and any equipment that connects terminals to the computer (acoustic couplers, modems, cables or telephone lines).

Central Processing Unit (CPU): This unit rapidly processes data and instructions read from memory.

Memory: There are two kinds of memory:

1. Fast, or main, memory, which feeds the CPU.

2. Slow, bulk, or mass storage memory, usually disk (similar to a record player—often with a stack of records or "platters") or tape (similar to a tape recorder).

Software: Operating systems that control communications, time sharing, and file storage; programming languages; and actual programs that command the computer to process data.

Computer sizes:

1. mainframes—large computers.

2. minicomputers—mid-size computers.

3. microcomputers—small computers.

All three sizes of machines process data in a similar manner, differing only in the speed

with which they proceed and the quantities of data they can store.

Medical Information System: Lindberg has provided a short, noncontroversial definition: "A set of formal arrangements by which facts concerning the health or health care of individual patients are stored and processed in computers."

Mental Health Information Systems (MHISs) are a subtype of the more general Medical Information System.

How Computers Work

While many psychiatrists now have a basic understanding of how computers work, others do not and are sometimes awed by these essentially simple machines. A computer is very much like a traditional psychiatrist's office, complete with filing cabinets (disk or tape), typewriter (terminal), telephone and interoffice communication device (intercom or some form of telecommunications equipment), and psychiatrist and secretary (central processing unit, memory, and programs).

If a psychiatrist completes a consultation and wishes to write a letter to the referring physician, he calls on the intercom (or simply asks directly) for the patient's record. The secretary remembers (with luck) where the record is stored, retrieves it from the file, and gives it to the psychiatrist. The psychiatrist (CPU) reads the record (data input), thinks about the patient, the record, and the consultation report (data processing), and creates a new data set by writing or dictating (consultation report), which can then be typed (data output).

Computers function in an analogous manner. The user commands the computer to find a record that has been put into the storage file and, if a suitable program has been written, tells the computer to process the data and type a report.

Computing Costs

Costs for computing equipment and the energy required to run computers continue to decline—a nearly unique phenomenon in our time. A comparison of one of the earliest computers with today's machines is Striking:

> Today's microcomputer, at a cost of perhaps $300, has more computing capacity than the first large electronic computer ENIAC. It is twenty times faster, has a larger memory, is thousands of times more reliable, consumes the power of a light bulb rather than of a locomotive, it occupies 1/30,000 the volume and costs 1/10,000 as much. [p. 65]

Major cost factors are processing speed, storage capacity, and reliability of storage devices. In general, faster processing speed and larger storage capacity increase cost. However, development of memory-chip technology has permitted dramatic reductions in fast memory costs at the same time capacity has increased more than tenfold. Little else can be done to improve the reliability of the present slow disk storage devices, which remain vulnerable because they turn at many hundred revolutions per minute and have arms that must move with great speed and precision to read and write data. The advent of laser-etched disk storage systems (still several years from widespread practical use) promises a tenfold reduction in storage costs and improved reliability.

Microcomputers, which are widely advertised as hobby computers, are comparatively inexpensive to purchase but suffer from two substantial limitations. Processing speed of the largest and consequently most expensive microcomputers is about one-half that of standard minicomputers. Microcomputer storage capacity on “floppy” disks is twenty to four hundred times less than that available on minicomputers. Even when the new Winchester-type fixed head disk drives with dramatically increased storage capacity are employed, storage on microcomputers usually remains smaller, and the fixed head configuration introduces a major difficulty in data backup. Standard minicomputer configurations use removable disk packs (costing $150 to $500 each), and data is stored or “dumped” nightly onto blank disk packs for several consecutive days, with additional copies kept at weekly and monthly intervals. Disk packs are reusable after their data is no longer needed for backup recovery from errors. This planned redundancy permits rapid recovery of data that might have been lost or destroyed—infrequent but possible occurrences that require careful backup in critical medical environments. Dumping from disk to disk typically requires twenty minutes to one hour and is usually done after midnight, when usage is typically low.

To achieve identical rapid backup capability with fixed head disks would require five identical disk drives (not just disk packs) costing three to eight thousand dollars each. An alternative is to dump to cartridge or to tape, although this technique is much slower and generally less satisfactory than dumping from disk to disk.

Thus, even the largest microcomputers will not support as many users, process data as rapidly, or store as conveniently as standard minicomputers. For some limited applications where powerful computing is not required (for example, interviewing), or where slow processing speed is not a problem (batch-oriented fiscal programs), microcomputers are now suitable machines for use in mental health settings. However, they cannot support in an efficient manner the broad range of useful and available mental health computing programs. We expect in a few years that microcomputers with laser-etched disk storage systems will provide computing power and convenience comparable to today's minicomputers for costs in the $15,000 to $35,000 range instead of the $45,000 to $105,000 costs for today's minicomputers.

If one has problems the computer can already help solve, it becomes a simple exercise to calculate whether waiting is cost efficient or whether savings recoverable through program use in intervening years would justify beginning now with a minicomputer. Alternatives that could reduce the cost of owning an entire minicomputer include leasing one or more ports of access on a minicomputer so that the minicomputer's power and broad range of all programs would be available. Even more inexpensive would be access to an entire machine with eight to sixty-four ports of access, or the purchase of a microcomputer to run a more limited range of programs at a slower speed, with reduced storage capacity and less convenient storage backup.

Typical monthly charges for a medium-sized community mental health center leasing access to the Multistate Information System (MSIS), which provides admission, patient census and movement, terminations and direct service reporting, average three thousand dollars for computing, five hundred and fifty to twelve hundred dollars for terminal equipment, plus all data-processing personnel and communication costs, which vary depending on the distance from MSIS headquarters in Orangeburg, New York.

A small minicomputer system can be purchased for approximately $1500 per month (for five years) to run software from the Forest Hospital, Des Plains, Illinois. Programs include evaluations of problems (Problem Severity Scale, SCL-90, Mental Status Exam, Minnesota Multiphasic Personality Inventories, treatment planning, documenting progress, and creating an aftercare plan. This package also provides summary reports for administrative purposes from the same data base. Some of these programs are also available for microcomputers.

Human Services Computing, Madison, Wisconsin, markets twenty-three hours per day access to a minicomputer for $950 per month per port, with users paying telephone communications and terminal costs. Programs include a mental health information system customized for each setting that keeps track of patients and providers over a period of time; a single-encounter medical information system widely used in research studies; fiscal packages; scheduling program; patient interviews (symptom change based on SCL-90); mental status; suicide risk prediction; general medical history; health hazard appraisal; sexual functioning; Diagnostic and Statistical Manual of Mental Disorders, 3rd edition (DSM-III) and other clinical consultations; bibliographical retrieval and Great Paper Chase; and word processing. There is no additional charge for use of any programs, and storage of 4 million characters is included in the basic monthly port charge, with additional storage available as required. Typical community mental health centers with up to twenty-five hundred active cases lease one or two ports depending largely on the number of programs they decide to use. In-house systems are also available.

Community Mental Health Systems (CMHC) of Columbus, Ohio; Systems Technology of Atlanta, Georgia; Ravenswood Mental Health Center of Chicago, Illinois; and Psych Systems of Baltimore, Maryland, also market or plan to market computing services for use in mental health settings. The appearance of vendors specializing in mental health applications is a positive sign that computing is beginning to pay off, at least commercially.

Major considerations when acquiring computing systems and services include vendor experience with computing and mental health applications, adaptability of programs to local needs, and kinds and amounts of ongoing support available. Advice obtained from independent consultants is often valuable.

These costs seldom reflect developmental costs which are often supported by research grants. Thus, the MSIS System received approximately $10,000,000 over seven years to help support development of their mental health information system. Initial development costs of nine outpatient management information systems ranged from $230,000 to $10,000,000 with continuing modification costs between $154,000 and $539,ooo per annum. Hospital Medical Information System (MIS) development is typically more costly with the National Data Communications/Honeywell System costing $12,000,ooo and the Technicon MIS development priced at $25,000,ooo.

The Place of Psychiatric Computing within Medical Computing and Computing in General

The point has been made that mental health problems are sufficiently different from other medical problems that computer programs “must usually be designed (or redesigned) to adequately meet the needs involved.” This opinion is not necessarily valid since programming strategies over the last decade have pointed toward “dictionary driven” programs with general features of broad-scale utility that can easily be tailored to specific needs. Individualization is accomplished by constructing a dictionary to contain items relevant to a particular user. The dictionary then “drives” all other programs (that is, entry, editing, search, report, statistics, and so forth) without further intervention by a programmer. Wide-scale use of such driver programs has been made from other medical settings; for example, CONVERSE, Paper Chase, WISAR, and EPIC, which, originally written for psychiatric settings, has also been used by medical departments as varied as ophthalmology, cardiovascular medicine, rehabilitation medicine, obstetrics, gynecology, and clinical cancer. Roberts recently reported on the use of PROMIS[1] (a language previously employed for work in internal medicine, obstetrics, and gynecology) in performing a computerized diagnostic evaluation of a psychiatric problem. Psychiatry stands to gain appreciably to the extent that it can align itself with the rest of medicine in the development and sharing of general “driver” programs.

Medicine as a whole, however, is a very specialized area with needs and computing problems often quite different from industrial organizations with consistently higher levels of standardization than found in the medical arena. Computing giants such as International Business Machines (IBM) and General Electric (GE) have had difficulties with medical computing. GE’s MEDINET (Medical Network) Department was established in 1966, demonstrated its Medical Information System in 1967, and announced “nationwide availability” by early 1969. MEDINET offered hookups to a centralized computer system via a nationwide telecommunications network that General Electric used for its intracompany and commercial computer business. By late 1967 a decision was reached to emphasize business over clinical applications in an attempt to broaden the market for services. By that time, MEDINET had spent about $16,000,000 on systems development. General Electric merged its computer manufacturing business with Honeywell in 1970, and MEDINET was administratively eliminated in 1975. It appears that General Electric, having had previous experience only with banks and industrial settings with more rational, explicit, and mature management problems, seriously underestimated the complexity of the healthcare delivery system. In fact, it sometimes seems inappropriate to view health-care delivery as a "system." Standard problem-solving techniques of the computer industry include a thorough system analysis, where each component of an organization is made explicit to the point that a flow diagram can specify most, if not all, organizational functions. Medicine is far less standardized, as physicians who practice in two or more hospitals quickly realize.

Even the computer languages that work well for other tasks have not been easily applied in medicine. COBOL, the standard language used for most fiscal programs, is designed for numerical manipulations where all inputs, outputs, and intermediate storage capacities must be specified to the final digit and cent. This same specificity is a marked handicap when the variables under consideration have not been completely defined. The Massachusetts Utility Multiprogramming System (MUMPS) was developed in medical settings and has strengths in file handling, time sharing, and speed of programming, while yielding some ground to COBOL in "number crunching." MUMPS is one of only four languages for which national standards have been adopted, and MUMPS is now available in many medical settings.

Thus, medicine, and psychiatry as part of medicine, have been recognized in the computing industry as forming a difficult, even fractious marketplace. Health users comprise less than 3 percent of computer hardware sales. Having encountered unexpected difficulties on its past forays into medical computing, computer companies will probably continue to follow their major markets, where, as Willy Sutton suggested, "the money is." Medicine can and does make use of the same machines that serve very different industries but has been and will probably remain largely on its own in the development of computing languages and applications. This fact has important implications for support of training and research in computer applications in medicine and psychiatry.

Problems Facing Psychiatry for which Computers May Prove Helpful

Psychiatry and the related mental health disciplines of psychology, social work, psychiatric nursing, and psychiatric administration face enormous challenges. Administratively, there is pressure for more complete and timely data to insure accountability and quality of care. Fiscally, there are ever stricter and more complex reporting requirements to qualify for third-party payments. Clinically, many settings must deal with inadequate staffing ratios, and in other settings specialized skills are simply not available. Educationally, there is difficulty in deciding what to learn from the welter of information presented during formal academic years and residency training. Acquired skills must be maintained as well as knowledge, and it bears remembering that education is not completed upon formal training. Researchers are often submerged by data that, while potentially useful, have become largely unmanageable. Thus, across the broad spectrum of mental health professions and practice are problems that must be faced and, in time, solved.

Clearly, many of these problems can and may be solved without computers. While recognizing this possibility, one must also ask what the relative social, professional, and economic costs of using or not using computers might be. Partial answers to this kind of question are available in some areas, and reasonable extensions of these data provide some guidance about the future impacts of computing on psychiatry.

Administrative and fiscal programs are now widespread in mental health settings where several professionals work. More than 70 percent of state departments of mental health reported some use of computers in 1977, and perhaps one-half of all community mental health centers use computing, most commonly through contracts with off-sight service bureaus, which provide fiscal services and sometimes other administrative reports. Several recent studies have indicated a need for additional computing services in fiscal-administrative areas.

These studies have found little clinical computing in any mental health settings and little appreciation of a need for clinical computing. By clinical computing is meant all programs that directly affect patient care or care issues. Examples are: (1) direct computer interviews of patients in order to gather information or to teach, monitor, or treat; (2) teaching/consultation programs for clinicians; and (3) bibliographic retrieval programs.

Part of this reason for the acceptance of computers in the fiscal services can be explained by our growing cultural familiarity with, and acceptance of, computers in the fiscal aspects of our personal lives (banks, charge cards, travel reservations, telephone number change announcements, and so on). The lack of clinical computing in mental health settings is probably attributable to resistance on the part of some mental health clinicians to technological changes. It is interesting to note that some conscientious clinicians, concerned with confidentiality and the impact certain diagnoses might have on their patient's futures, appear to substantially distort the diagnoses they report for outpatients. Payment for these "innocent" diagnoses is permitted for outpatients. Insurance coverage for inpatient treatment is often available for a more limited and generally more serious set of disorders, and the ethics of this “situation” permits more pejorative and, presumably, more accurate diagnoses. One comes to the unsavory conclusion that diagnostic reporting could be shaped by changes in disorders for which payment will be made. Hedlund captures the feeling well with quotes from two other workers:

> The thesis here is that the mental health industry (particularly the clinical services segment) is essentially pre-technological, with “an emphasis on individually provided services, a minimal number of tools, a lack of standardization, and the apprenticeship system (watching and copying craftsmen) as the major way of learning the relevant vocational skills”; and that it “construes every technical innovation as a mechanistically insensitive encroachment on medicine’s responsibility for the personal and intuitively sensitive provision of care.” As Rome also notes, such reverence for the art of clinical practice—sometimes as if it needed no justification other than its vaguely humanistic objective—has traditionally subordinated reliance on impersonal technical aids because it views them as inflexible, intrusive and as tantamount to exercising a lesser degree of professional skill.

Hedlund has also summarized factors described by different workers to represent barriers to diffusion of computer technology in mental health:

> Lack of top-level agency support;
>
> Lack of adequate funding;
>
> The difficulties of transferring research projects to operational settings including inadequate involvement of clinical operators and administrators in conceptualizing and designing of mental health information systems;

The piggy-backing of many clinical applications on statistical reporting systems;

The “softness” of mental health data;

The ambiguity of mental health goals and criteria;

The lack of an overall guiding conceptual framework for Mental Health Information Systems;

The uncritical acceptance of traditional mental health concepts and record’s procedures as models for computer applications;

The lack of a standard clinical language and an inability to gain wide acceptance for standard or highly structured clinical forms;

Complex data collection and distribution systems which have sometimes been unable to ensure either timely or reliable information return;

Duplication of clinical reporting procedures (one manual and the other computerized);

The distrust of mental health clinicians for information that has been obtained or processed “impersonally”;

Resistance related to issues of privacy and confidentiality;

The lack of clinical commitment to making computer technology work for mental health needs;

Repeated underestimation of the amount of time it takes initially to translate even relatively simple concepts into computer applications;

The lack of adequate input devices for high-volume entry from a wide variety of clinical settings;

The stereotyped nature of computer generated reports;

The frequent inaccessibility of computer stored data for special needs, [pp. 17-18]

For these reasons and perhaps because of administrators' fears of losing status and income, clinical computing has not been able to penetrate clinical practice to the extent that administrative-fiscal computing has been welcomed by administrators.

What are the justifications for introducing computer procedures into clinical psychiatry? First of all, there is a need to improve clinical services in terms of quantity, quality, cost efficiency, and effectiveness. Most clinicians acknowledge this need, but some will question the advisability of using computers to pursue these goals. Concerns expressed usually include doubts about the ability of computers to perform as well as humans, uncertainty about high costs, anxiety about possible detrimental effects of machines interacting with already disturbed patients and, as some clinicians readily admit, a global fear that computers may be too successful and displace the mental health practitioner from lucrative and satisfying work. Considerable resistance remains even though it was shown years ago in more than fifty psychiatric studies that computers consistently diagnose at least as well as clinicians; that even when poor decision models are employed, the computer still performs well; and that costs have been less than two dollars per hour on a forty hour per week basis for direct computer interviewing since 1975. Also, numerous studies have shown computer interviews to be highly acceptable to patients and sometimes preferable to interviews by clinicians.

Mental Health Information Systems

A goal of most workers in the psychiatric computing field has been the development of a comprehensive mental health information system. Hedlund has defined the mental health information system as:

> A constellation of computer hardware/software and related procedures that are intended to facilitate the collection, processing, storage and/or the display (retrieval) of information relevant to the evaluation and care of mental health patients or clients. This term is used here to refer both to general information systems that attempt to integrate information about mental health care from a number of different sources in order to satisfy a wide variety of administrative and clinical needs for such data, and to special-purpose or standalone computer applications that play a more specific, limited role in mental health patient evaluation and care.

Such a system would integrate administrative, clinical, educational, and research functions so that redundancy in data collection would be eliminated and maximum use could be made of all data collected.

Conceptually appealing, this goal has not yet been achieved in psychiatry or in other fields of medicine. The reasons for this failure are many:

1. There is a philosophical disagreement about how to proceed to the

final design. Some advocate a total system design that is application-independent as a preliminary necessity, while others favor a sequential or cumulative approach. Intermediate viewpoints, promoting a general but still flexible design that accepts, accommodates, and integrates applications as they are developed and proven, have also been advanced.

Total system designs are typically advocated by commercial organizations, which prefer to see similarities rather than differences between potential customers in hopes that a single design will achieve many sales. This view seems most justifiable in the realm of business applications. Advocates of a cumulative approach tend to come from settings where more innovative administrative and clinical computer applications are developed. As Lindberg points out in his definitive review of medical information systems, "there has been no known case in which a business office system has ever evolved into a [comprehensive] medical information system."

2. Those who have written both fiscal-administrative and clinical computer applications quickly realize that the former are far simpler to prepare and introduce into routine use. Many computer service bureaus already provide fiscal-administrative services to mental health facilities in a cost efficient manner. By contrast, clinical applications are far more difficult to conceptualize (many times the clinical process being addressed is incompletely understood, as in diagnosis, prognosis, dosage, choice, and so

forth). Integration with clinical practice patterns, which may vary widely from setting to setting and from clinician to clinician, is also a problem. An application that works well when terminals are readily available may fail completely if clinicians must walk some distance to use a terminal or if the computer running the application is overloaded and slow in responding. Underlying differences in philosophies about the practice of psychiatry can also affect program use (that is, the relative importance of somatic versus psychosocial treatments in depression and schizophrenia). Gradual progress has been made in a number of clinical areas, but a total MHIS is far from realization.

3. Many attempts at developing and integrating computer applications in psychiatry have foundered because of inadequate support that would permit full development and testing of prototypes, careful evaluations of final programs, and translation and transmission of proven products to other systems and settings. Full-scale development of a mental health information system is, at best, a time-consuming and costly endeavor.

4. Progress has also been limited at times by poor choices of hardware-software combinations. As hardware costs have tumbled, the proportion of a total mental health information system budget allocated to software development naturally rises, and some languages are inherently more economical than others. For example, a recent study comparing COBOL with

MUMPS programming languages found that MUMPS programs were prepared many times more quickly than those written in COBOL. Some COBOL programs could not be completed at all and others were impossible to modify. Also, COBOL consistently uses more storage than MUMPS. For both of these reasons, clinical applications written in COBOL are likely to be far more costly than those written in MUMPS. In fairness, it must be stated that COBOL fiscal programs, while more costly to write and requiring larger storage capacity than identical MUMPS programs, will run somewhat more quickly. However, fiscal programs (billing or accounts receivable) are usually run in batch mode so that run speed is not a critical factor. Overhead costs for COBOL are prohibitive for clinical applications where initial development and subsequent updating require numerous programming changes. Consequently, MUMPS, BASIC, PASCAL, and other efficient languages are gaining a dominant place in clinical computing.

The Institute of Living, in Hartford, Connecticut, has made considerable progress toward a comprehensive mental health information system. Operating on two PDP-15 minicomputers and using the MUMPS programming language, a large number of clinical and fiscal-administrative applications have been written. Long-term support has been available directly from the Institute of Living. Ongoing costs for this system averaged $2.50 per patient per day.

The University of Wisconsin has moved steadily toward a comprehensive mental health information system by integrating individual programs as they are developed on a minicomputer. Work began with clinical applications in computer interviewing, and added consultation, bibliographic retrieval, word processing, and an overtime data base. Data collected from patients and clinicians by computer interview or written questionnaires can be stored in EPIC[2] to provide routine reports used by clinicians, trainee supervisors, clinic administrators, clerical workers, and the hospital billing office. A general search routine permits users to ask and answer a wide range of questions for which specific reports have not been prepared. Even individuals unfamiliar with computer use can perform searches, compose reports, and request statistical tests on groups of data (the statistical test will not be performed unless the data satisfy criteria for the test requested). Data stored in EPIC can be inserted into documents prepared with the word processor, and the word processor can also access references stored in a universal reference file. This resource is being used by residents, faculty, and administrators to answer questions that were previously too time-consuming to permit completion.

What evidence is there that medical information systems will produce a payoff worth the developmental costs and difficult adjustments associated with conversion from the present human systems? By analogy, it is quite clear that many business functions could not proceed in the manner we now take for granted without computer assistance. Banking, credit cards, telephone switching, travel reservations, inventory control, and computer-controlled manufacturing processes are but a few examples.

Six evaluations of specific general hospital and ambulatory information systems and two reviews of the field have shown beneficial effects attributable to the installation of medical information systems.

Improvements typically included increased productivity of staff (up to 200 percent) and greater satisfaction with work. While cost efficiency was increased, total cost did not always decrease. Most studies found high levels of acceptance among nurses, admissions officers, and pharmacy, radiology, and laboratory departments. Physicians in one study were most resistant (only 61 percent voted to retain the system after four years) but increased their approval as time passed (80 percent of the same physicians voted for system retention after five years). Not all studies have found beneficial results, indicating the importance of evaluations of medical information systems and their constituent parts.

A study of the Kaiser-Permanente Medical Information System demonstrated a reduction in patient morbidity when the system was in use. Unfortunately, federal support for the system was withdrawn before additional studies aimed at measuring the system's effect on mortality could be completed.

In psychiatry, the work of Williams and associates has provided some idea of the potential benefits of a Mental Health Information System. Their work was focused on the admissions process where patients were interviewed by computer for up to five hours, and non-physician staff received prompts from computer terminals as they performed physical and mental status evaluations of the computerized admissions unit.

Several examinations were performed. Expert psychiatrists (faculty members from the Department of Psychiatry at the University of Utah College of Medicine), who had personally examined 195 patients and who were then given admission data collected both by computer interview and routine clinical procedure, found the computer data to be statistically better organized, more complete, more readable, and *more clinically useful* than the routine clinical data. Time and total cost (including staff and computer time) required to complete the admission process were also significantly less with the computer approach. Despite these findings, there remained resistance to these procedures, and attention will undoubtedly have to focus on factors affecting staff acceptance of these programs.

Confidentiality

Concerns about control of access to confidential information stored in computer systems has diminished in recent years, in part because no instances of violation of medical computer systems have been discovered and in part because additional legal and computing safeguards have been established to protect medical records. For example, in order to gain access to data in the EPIC Information System, one must initiate contact through a sequence of passwords, identification codes, specific user names and codes, and a unique code for each EPIC Data Base. None of this information appears on the terminal, and errors force the user to start the ten-second sequence again. Having come this far, the user is told the date and time of his or her last access, so that illicit use of an authorized user's codes could be recognized. Within EPIC, items may be identified as "confidential," and especially sensitive data may be stored in garbled format. Individual users are provided with different levels of access. Thus, most users are permitted to search and generate reports from non-confidential data while access to confidential data is restricted to those with a legitimate need to know.

While any security system can be breached and any cryptographic code broken, given enough time and resources, the EPIC system has resisted the efforts of a programmer skilled in MUMPS, the language in which it is written. Systems that do not permit telephone access from remote sites are obviously even more secure than those that do, so "in-house" systems have that advantage at the cost of being isolated from legitimate users at, for example, satellite clinics. It is far more difficult to steal information from a wellprotected computer file than to obtain a written record either by posing as a clinician or by breaking and entering the building and file cabinet containing the desired record.

It should be noted that computers have promoted access by patients to their computer records under the Privacy Act of 1974, which requires that:

1. Recordkeeping systems must not be secret.

2. Individuals must be able to learn what information his/her record contains and how it is used.

3. Information obtained for one purpose cannot be used for another purpose without the individual's consent.

4. Individuals must be permitted to correct errors in their records and

5. Organizations which create, maintain, use, or disseminate records in which individuals can be identified are responsible for both the reliability and proper use of those records.

Future Hardware and Software

Several trade-offs will need to be evaluated in the years ahead. To perform a reasonably broad range of computing services for mental health agencies or practitioners in an efficient manner, minicomputers are presently required. They are certainly needed for any mental health information system worthy of its title. Microcomputers are increasing in power and perhaps will be able to support moderate-size medical information systems within five years. If computing costs decrease sufficiently, there will even be cost incentives for small agencies to operate their own microcomputers. However, this course is not without problems, including a sizable capital outlay, maintenance and operation of the computer, and acquisition of improvements as they become available.

The most common form of computing today by mental health agencies involves the use of programs operating on a service bureau computer with data entered from punched cards. Most service bureau computers are minis or larger mainframes that provide a greater range of programs and faster processing than is available on microcomputers.

Communication costs (long-distance telephone charges and equipment to connect phone lines to terminals and computers [acoustic couplers/modems]) can account for a sizable part of total computing costs for online operations on a mini or mainframe computer and may account for up to one-half of the total cost if a great distance separates the computer from the service site. Communication networks are already available and promise less expensive communications in the future. The prospect of being able to obtain the best computing services from several different vendors is a reasonable near-term goal for those with the ability to identify and evaluate good programs and who can relate effectively to the vagaries of different hardware and software combinations. In the end, however, integration of all programs into a coherent Mental Health Information System running on a single computer remains the most attractive option. Whether that machine is located “in house” or at a service bureau supporting several agencies will depend largely on the size of the agency. Although not of absolute importance, economies of scale in both computing power and programming effort appear to give the edge to minicomputers and shared services for all but the largest mental health agencies. Large operations can frequently justify the cost of operating their own minicomputer at this time.

Computer Interviewing

Introduction

Much of the data that mental health clinicians collect from patients for administrative and treatment purposes can be obtained directly by computers. The technology is clearly present: The hardware and software for interactive systems are available and have demonstrated the capacity of the computer to engage in dialogue ranging from rather routine multiple-choice question sets to very lively and life-like dialogues using branching and free text capabilities. Most researchers who have developed and tested computer interviews note their advantages.

> ... 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. It does not have family problems of its own. It is never sick or hung over. 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 or social status. It does not seek money. It can provide the patient with the copy of the interview to study. It does what it is supposed to and no more (and no less), [p. 114]

What we find, in surveying the field, is that there are many more computer information systems that are dependent upon data provided by paper-and-pencil forms from patients and other computers than there are systems that take advantage of direct computer input from patients. Thus, while various reviews of computer technology in mental health include sections describing computer interviews, it is clear that there are few places where this work is being done on more than an experimental basis, even though developers of computer interviews for patients consistently speak of the high levels of patient acceptance and the many advantages of these procedures. Apparently there is still widespread resistance on the part of clinicians and systems developers to the routine use of these methods.

Computer Medical Histories

Much of the early developmental work in direct computer interviewing of patients was done in the context of medical history-taking, an area where patient and physician acceptance has been excellent. The work of Slack and his colleagues, first at the University of Wisconsin and later at Harvard, has done much to demonstrate the attractiveness and feasibility of the method. The first interview, which focused on allergy problems, was found to elicit more complete information than medical charts. When the interview was expanded to a full medical history, patients and physicians continued to react favorably to the experience, producing higher quality information Slack, in later work, has also explored and developed ways for the computer to process nonverbal input, such as heart rate, and to facilitate actual vocal dialogue of patients with the computer program. The computer was programmed to display the questions, respond to the presence and absence of sound (talk), and to encourage the continued flow of talk by responding to silence with prompts displayed on the screen. When interviews with thirty-two male volunteers, who were instructed to talk about a variety of feelings to the computer and to a doctor (in counterbalanced design), were evaluated, it was found that while subjects may have liked talking to the doctor more and spoke more words to the doctor, the content was equivalent in most respects. When the quality of feeling-expression was judged for the two forms, it was found that while both methods elicited appropriate levels of feeling-expression, somewhat higher levels were expressed to doctors. The computer, however, was more consistent than doctors. Dialogue with doctors was more subject to experimenters and time-of-day effects.

Other explorations of the potential for medical computer interviewing have tended to confirm the findings of Slack in a number of areas such as obstetrics-gynecology," epilepsy, dietary habits, anesthesia history, headache, gastrointestinal complaints, general medical history,' and health risk. In general, patient acceptance and the accuracy-reliability of the information is high. Simmons and Miller found that for a medical history physicians tend to miss 35 percent of history items collected by a computer. Card and Lucas' investigated factors affecting patient reactions and reported that while patient acceptance is generally high (82 percent), and that 40 percent even prefer the computer to a doctor, acceptance is related to such aspects of the procedure as a visual display, simplicity of keyboard, choice of interframe speed, and so forth.

Psychiatric Interviewing

Many of the same models and procedures developed for medical interviewing have been applied with great success to interviewing for psychiatric and psychological purposes. Indeed, it is in sensitive, “personal,” and emotionally laden content areas that some of the advantages of computer interviewing (privacy, consistency, individualization) come to the fore. In 1969, Evan and Miller reported that respondents were more open to the computer for content areas described as “highly personal and possibly disturbing” than they were when faced with impersonal and neutral questions. Similar findings have emerged from studies in several sensitive areas. When questioned about drug and alcohol abuse by computer and paper-and-pencil methods, a sample of 132 high school students gave essentially similar reports, but clearly preferred the computer In another trial of computer questions on a range of socially taboo topics, using medical outpatient volunteers, preferences tended to shift toward the computer (and away from a doctor) as topics became more sensitive. This encouraged further testing that would contrast responses to a more extensive series of questions about sexual functioning versus less threatening questions about work and exercise habits. In this study, respondents were interviewed by both methods in random order. It was found that all respondents, women especially, were significantly more likely to indicate problems with sex to the computer than to a psychiatrist interviewer (even of the same sex), and women reported less embarrassment and greater preference for the computer. Because of this and other experiences in questioning psychiatric patients about sensitive material, experts are developing more computer interviews for direct mental status and diagnostic assessment. While many clinicians and researchers appear to doubt the potential of computer interviews in this area, others continue to feel that the computer's promise has not yet begun to be tapped.

The considerable ambivalence about the reliability and validity of patients as informants concerning psychiatric matters is clearly reflected in the tendency of many workers to interpose a "third party" between the patient and the computer terminal. Programs for observations of psychiatric symptoms, mental status examinations, and psychological assessment at the Institute of Living, and similar programs developed by Sletten, Hedlund, and others for a network of Missouri Mental Health agencies, as well as programs in the military, all exemplify this tendency to isolate the patient-respondent. Most of these procedures use trained clinicians, but some use clerical assistants or relatives as respondents. This means that while various forms of psychiatric assessment by computer are now integral to some of the major mental health information systems, the potential role of patients as informants about their own symptoms is largely unexplored and undeveloped.

Assessment by Computer

Another way that clinicians often achieve a sort of "distance" from the patient in mental health evaluation is to rely on standardized test batteries instead of direct questions. This approach of assessment-by-computer has typically *not* taken advantage of some of the strengths of computer interviews. Many assessment procedures depend on computer processing and interpretation of input collected on paper-and-pencil forms; they avoid direct patient interviews altogether. Other programs present test items directly to the patient, but do so in a standardized, lock-step fashion. Only a few systems are now in operation that even begin to exploit some of the strength and advantages of the computer.

One of the main benefits of computer testing is the potential power afforded by branching logic so that promising areas are covered and fruitless topics ignored. Kleinmuntz and McLean describe an attempt to develop a branched computer version of the Minnesota Multiphasic Personality Inventory (MMPI) and report somewhat mixed reliabilities when short and full versions for various scale scores are compared. Another experience with a branched version of the SCL-90 has also found that excellent reliability exists for some scales only. Much more developmental work and experimentation with branching strategies need to be done before the future of automated assessment is settled. What will stimulate growth in this area are the obvious practical advantages to busy clinicians of having test information readily available and easily integrated into data bases. This further development of psychological testing will be vastly enhanced by work now being done with imaginative response formats. Kiss describes a program that explores attitude structures and that makes good use of branching based on extreme values (to stimulus words). The program also records response latencies to gain both a broad and deep profile of attitude structures. Another creative aspect of computers involves Lang's use of his computer "Sam," which has the ability to interact with respondents in the process of scaling of affective constructs; this is done by using the visual display as feedback to confirm the subjects' intended responses.

Psychiatric Admission Unit (PAU) at the Salt Lake City Veterans Administration

The Salt Lake City VA is one place where computer interviews have been quite extensively tested and integrated into the day-today activities of a mental health care system. Originally adopted in order to increase intake staff productivity in the face of heavy service demands, the system is centered on the Patient Admitting Unit, where the staff has access to thirteen cathode-ray terminals operating off of a CDC 3200 Computer.' Patients, clinical staff, and clerical workers all interact with a set of computer programs to build each patient's information data base at admission. Because the system developers felt that it was important to have an initial assessment of each patient's ability to give valid self-reports, the patient's first contact with the computer consists of a short instructional period followed by a brief questionnaire that functions as a validity screening instrument (the Qi test).' For the vast majority of patients who pass the screening, there is a brief assessment and history interview carried out by the admitting staff, with results entered directly into the computer terminal along with physical examination findings. On the basis of the screening, the case coordinator selects a battery of psychometric tests and questionnaires appropriate for the patient's particular problem array. Assessments available for direct patient interaction by computer interview include: MMPI; an IQ test, which is a combination of the Shippley-Hartford, or a long-term memory test; the WAIS Arithmetic subtest; the Briggs Social History; and the Beck Depression Inventory. This material is combined with the results of a mental status exam and a detailed problem checklist completed on a computer by the case coordinator after interaction with the patient and psychiatric consultant. This assessment process, which, as a whole, generally takes several hours, yields a narrative report, a DSM-II Psychiatric Diagnosis, and a detailed problem list suitable for a problem-oriented record.

Since this system has been in effect, a number of evaluations have been carried out in which the results of the PAU Evaluation System are compared with "traditional" assessment procedures. In one study, 41 PAU reports were judged by an experienced psychiatrist to be superior overall to 37 reports obtained by traditional interview methods. In a second study, where traditional and computer evaluations were directly compared for 35 patients, similar results were obtained. When the reliability of the diagnosis emerging from the PAU system was compared with traditional psychiatric diagnosis, a kappa of 0.56 was obtained, which is equivalent to the agreement of clinicians with one another.

Patient acceptance and satisfaction with the PAU system is extremely high: 89 percent of 132 patients interviewed indicated that they would favor the PAU system while only 8 percent indicated dislike. Forty-six percent of the patients reported that they may have been more candid in the computer interview than they might have been with a clinical intake interviewer. This high level of patient acceptance is due, in part, to the willingness of the system developers to tailor the design to patient need and reactions. The system also has a definite impact on the efficiency and effectiveness of the admission process. In one evaluation, the developers reported less time from assessment to treatment for PAU patients, as well as less staff time devoted to intake and assessment activities. Indeed, in a detailed time-study of the admissions unit, the decrease in the percent of staff time taken up by admissions workups dropped from 13 percent to 3.5 percent. This meant that more staff time was available for treatment. On a cost basis, when assessment costs were directly compared, it was estimated that the PAU Assessment costs half of that of a traditional evaluation. In an overall assessment of the efficiency of the whole unit, the investigators found that since the assessment unit had been in existence, the "annual number of patients treated nearly doubled to about 2,000 while staff size increased only 20% and the cost of delivering services dropped 8% despite inflation." While these changes may not be directly attributable to the PAU system (note that the system was initiated in response to an increased caseload), it is clear that the system may make a great contribution.

Clinical decisions were also notably influenced by the PAU procedure. When twenty-one PAU and eighteen physician-process-intakes were compared, it was found that the same percentage of outpatient versus inpatient referrals were made by both systems, but that independent assessors more often felt that the PAU treatment disposition was the correct decision. In another study, it was also found that the PAU leads to more appropriate medication decisions and higher goal attainment. While PAU patients did not differ with respect to length of stay from traditionally evaluated patients, they did have a lower recidivism rate, presumably reflecting improved treatment.

Despite all of these advantages, clinical acceptance of the PAU system still remains the biggest stumbling block.- Of ninety-four clinicians interviewed, reactions to the PAU system ranged from neutral to negative. Whether this is a result of clinician "computer anxiety" or of the more basic fear that clinicians may be replaced by computers, it is clear that system developments must concentrate on the problem of clinical acceptance. And clinical acceptance of computerized systems in mental health care can result only from diligent planning. It is important to work on a continuous basis with staff "opinion leaders" about problems pertaining to many details of the system. Because clinician acceptance is basic to the system, it must be allotted continuing attention.

Behavioral Assessment at the Duke University Medical Center

Behavioral assessment is a natural area for computer interviewing: It is difficult for clinicians to do because the guidelines are vague, and because a wide range of problems must be assessed and probed in great detail and specificity, potentially requiring a great deal of clinician time. In their work with a behavioral assessment computer program, Angle and colleagues-- have demonstrated the superiority of the computer over the clinician in all these respects and have developed, at the Duke University Medical Center, a model behavioral assessment. Computer interview has two stages: The first, the problem screen, obtains detailed demographic information and descriptions of problem behaviors in twenty-nine life areas. Treatment motivation is also assessed. The number of questions in each area ranges from 21 to 233. Using minimal branching, most respondents get from 60 to 80 percent of the potential questions set. The second stage of the interview goes into greater detail in areas considered to be relevant to treatment, which were selected by the therapist from the report of the initial problem screen. Information collected at this second stage is used both for treatment planning (that is, considerable attention is paid to eliciting information about the situational variables that control the problematic behavior) and for outcome and follow-up assessment.

This system has been used on at least 600 patients and has been extensively evaluated. Patient acceptance is high. In one study of 331 clients, approximately 80 percent found the computer experience positive, despite its length, which ranged from four to eight hours per patient. Indeed, with respect to length, the authors of this study reported that no client refused to take the interview because of length, and only about 15 percent felt that the interview was too long. Another evidence of acceptance is the fact that approximately 80 percent of those interviewed expressed willingness to retake the interview, and about 60 percent reported some subjective preference for the computer over personal interview. With respect to the issue of candor, most clients felt that they would be equally truthful to either a computer or a human interviewer, but about one-third of those interviewed by the computer did state that they had been able to be somewhat more truthful under these conditions. In a direct comparison of human and computer interviews,- the investigator finds, as is to be expected, that the computer interview is vastly superior in the amount of both comprehensive problem coverage and detail elicited. Thus, in contrast to the computer interview, clinicians covered only 50 percent of relevant problem areas and provided only 6 percent of the detailed information that was found in the computer interview. In another comparison, roughly the same proportion of differences between human and computer interviewers was found, and a computer was successful in identifying 76 percent more of the problems judged to be critical and relevant to the patients by independent clinical interviewers. Even when session notes were reviewed in detail over four sessions, the missing information rate for the clinician-gathered-data dropped only slightly from 75 to 62 percent.

Because of the length of the computer interview and the number of areas in which detail must be obtained, the investigators have attempted to explore the possibility of using branching strategies to reduce the number of questions presented to any one patient. Assessment in two areas—sexual problems and depression—indicate that branching on patient reports of problem frequency and intensity would yield false negatives from about 20 to 25 percent of the patients, although it is not clear whether this 25 percent are individuals who have accepted and adopted their problematic behavior to the point where they no longer experience and report it as such. Presently this group is pursuing a nonbranching strategy in which most patients answer 60 to 80 percent of the total question pool. It is clear that as the question pool increases, greater reliance on branching strategies will become necessary.

As at the Salt Lake City VA, clinician reactions at Duke are much more problematic than patient reactions. When thirty-four clinicians from five treatment programs were surveyed, the clinicians overwhelmingly felt that the computer interview report was superior in comprehensiveness, detail, and extent of problem identification. Nevertheless, they questioned the computers' ability to identify patients' problems better than clinicians. Clinicians were further divided with respect to their assessments of the utility of the interview. In general, hospital psychiatrists were less favorable to the computer interview data than nonpsychiatric community mental health center staff. Clearly, patient acceptance is not a sufficient condition for clinician acceptance, and the possibility remains that certain clinician groups may be particularly threatened by, and slow to accept, this new technology. In influencing clinician acceptance, the investigators found it very important to give clinicians feedback about acceptance, since clinicians are particularly concerned about experiences of dehumanization and patient reactions. Thus, once again, it was found that a computer interview data collection system is more readily accepted by patients than by clinicians.

Computing Interviewing at the University of Wisconsin

The early pioneering work of Slack and his colleagues at the University of Wisconsin in the 1960s, focusing on medical history interviews, operated with very primitive and cumbersome hardware and software. As hardware and software became more sophisticated and complex and applicable to psychiatric interviewing, it became possible to develop an interview system that was concerned with more complex assessments and with measures of changes in patient status over time. Unlike other systems, Greist and colleagues' interview system has perhaps made more use of branching and of free-text possibilities (combined with multiple choice). This was found to be important both because these options make it possible to more closely model the physician-patient interchange, and because these features make it possible to develop repeated and individualized assessments.

One of the first such interviews developed combined individualized target symptom questions with a standardized symptom inventory. The target symptom questions (up to three) encouraged the patient to "describe the most serious problems you are seeking help with today," in free text. Afterward, he was asked to make ratings on scales of frequency and intensity. Also explored, in a very limited way, was the potential of scanning these open-ended responses for key words (for example, reactions to the presence or absence of certain affect words) as a basis for additional specific questions. The SCL-90 follows in branched format, using screening questions and items presented within each cluster according to their factor loading. The interview can be presented repeatedly so that patients can be asked to reevaluate their previous complaints, which are displayed on the screen. The data from this interview were compared with paper-and-pencil and personal interviews and found to be comparable. Patient reactions were mostly favorable; some patients (sixteen) expressed misgivings about the "nonhuman" method, while others felt freed by the privacy and unhurried pace.

Another example of this flexibility is provided by Greist and Klein's social adjustment interview, which relies heavily on branching and free text responses. Branching is particularly useful early where an initial assessment of patient demographic characteristics and patient ratings of role problems lead to appropriately detailed questions about functioning in relevant life areas. It is in these intensive inquiry sections that multiple-choice responses are interspersed with free text, so that detailed descriptions of each patient's life situation and functioning are provided for the clinical summary.

Both the target system and social adjustment interviews have been evaluated in two respects: (1) a comparison of interview summaries with clinical records indicates high reliability in most areas; and (2) a specific investigation of the effect of branching on the completeness of computer-obtained records indicates that branched lines of questioning are appropriate for most, but not all, symptom areas and aspects of life functioning. One exception to this is the finding that severely disturbed patients tended to emphasize their difficulties with leisure time activities and problems relating to their illness, while clinicians placed more stress on family problems.

Other measures currently on this computer assessment system present fairly standardized question sets in a more straightforward manner. Here the advantages of the computer administration have more to do with the availability of the immediate scoring and reports; for example, Benjamin Interpersonal Checklist and suicide risk prediction. The computer administration seems to make patients more comfortable and candid than does a human interviewer; for example, interviews for sexual dysfunction, and alcohol and drug use.

Other interviews (not yet published), which also make use of direct feedback to respondents, have recently been developed for a project promoting the exchange of health (wellness) information among high school students. Programs concerned with depression, nutrition and eating habits, and contraception alternate segments where knowledge or problem levels are tested with segments that appropriately teach or counsel. The enthusiasm with which the high school students responded to these interviews exemplifies the special potential of the computer to reach and engage the attention of hard-to-reach, nonpsychological-minded populations. This is reminiscent of computer-patient experiences with sex and drug abuse data. Other studies confirm these findings with respect to alcoholics, working-class people, blacks, and other "people who are unable to participate in the usual vis-a-vis interview."

Bibliographic Organization and Retrieval

Computers, which are useful in storing, organizing, and retrieving data about patients and providers, may also be used for almost any sort of inventory control purposes. Clinicians and researchers are faced with an enormous and steadily growing volume of clinical and research information relevant to their work. A great deal of this information is contained in journal publications that clinicians and researchers subscribe to and that are stored on bookshelves in their offices. Remembering that a particular subject in question has been discussed in a journal article is difficult enough when most articles are only skimmed upon the journal's arrival. Locating the relevant reference is an even more difficult task. Consequently, a great deal of useful information remains sequestered on bookshelves rather than assisting its owner in solving problems.

One approach to this difficulty is to use the National Library of Medicine's MEDLARS/MEDLINE computer retrieval of over 2,300 biological sciences journals. Searches can be conducted from a list of more than 14,000 different subjects. Limitations of this approach are numerous: (1) a medical record librarian is required to conduct searches; (2) lists of references obtained often number in the hundreds, leaving the recipient with another sizable search and data reduction problem; (3) MEDLARS lists arrive several days after requested; and (4) the referenced articles themselves are often from journals not readily available to the person requesting information.

Personalized library systems organized around alphabetical, numerical, or darning needle identification and retrieval systems, or involving a series of folders into which relevant articles are placed, have been the best systems available to many individual clinicians and researchers. The idiosyncratic nature of these filing systems has made them difficult for even their authors to use consistently, and the limited nature or complete absence of cross-referencing has severely restricted the completeness of retrieval. Another limitation of these personal systems is that they cover only a small subset of the available and relevant literature.

Paper Chase is a program designed for direct use by clinicians and researchers that solves many of the problems presented by MEDLARS/MEDLINE and individual bibliographic systems. References (journal articles, chapters in books, books, and other documents including memoranda, letters, case notes, and so on) are quickly entered at a cathode-ray tube terminal. Written in the MIIS programming language, Paper Chase runs on Data General Eclipse, Digital Equipment, PDP 11 and PDP 15 and IBM Series 1 Computers. Entry time for each reference is approximately two minutes and includes the names of all authors, title of the referenced material, journal or publisher, specific volume, page and year of reference, and the appropriate key, index, or subject words. A modification of the program at the University of Wisconsin permits entry of abstracts or summaries. Alternatively, entire volumes of many different journals may be read into the computer from tapes obtained from the National Library of Medicine.

Once entered, references may be searched by any combination of author, title word, journal, and year and subject, and search times for registries containing several thousand references routinely average less than one minute. If the search results obtained are too general, a second search may be done immediately on the subset of references found in the first search.

In this way, specific and readily available references relevant to particular subjects can be quickly found.

One specific application of Paper Chase has been the Lithium Library, the heart of the Lithium Information Center. In the fifteen years after lithium's introduction into clinical psychiatry in 1949, forty-three articles on the biological uses of lithium were published. From 1964 through 1976, an additional 4,000 references appeared. For the three years from 1977 through 1979, 2,500 more publications were added to the literature. The task of keeping abreast of this burgeoning literature for clinical, research, and educational purposes quickly outstripped the best efforts of conscientious clinicians running the lithium clinic and consultation service in one state. References to the lithium literature were entered into Great Paper Chase and the availability of this bibliographic resource was announced in appropriate psychiatric journals. For 1978 and 1979, over five hundred requests per year were answered by the librarian of the Lithium Information Center and more than thirty sites had on-line access to the Lithium Library from computer terminals in their institutions. All reference materials are filed at the Lithium Information Center and can be quickly sent to users who request them.

Work is now underway at the University of Wisconsin to provide synopses of information about the more than 1,400 key word or subject terms used in the Lithium Library. This approach will permit clinicians with questions about specific areas to receive summary information about that area in addition to references to the primary sources upon which the summary is based. Another program under development goes still further by integrating information from the lithium literature into a coherent consultation about a patient the clinician has described. While still in rudimentary form, these programs indicate ways in which bibliographic retrieval can play a more direct role in health-care delivery.

Computer Therapy

Introduction

Simply put, computer therapy involves the use of computers to treat persons with psychiatric problems. Behind this simplistic definition lies a nascent and extremely complex field that seeks to integrate the rapid and continuing progress in computer hardware and software with prior understanding of the art of psychotherapy.

Development of the first computers made it possible to process mathematical symbols at a rapid rate. Programming languages dealing with linguistic symbols soon followed and, with steady refinement, have allowed for easy programming to process languages strings, which can express quite complex meanings. With the advent of on-line computing, immediate computer responses to user inputs became possible. Time-sharing techniques permitted single computers to interact simultaneously with many users, dramatically reducing computing costs. Harnessing the interactive computer medium to psychotherapeutic tasks seemed a natural step, and proponents prophesied widespread availability of expert and inexpensive computer therapies.

Present Status

By 1965, a program that crudely simulated Rogerian psychotherapy had been developed. Colby, who has been a seminal and steadily productive worker in this field, had begun his studies, Slack had conducted medical interviews, which had apparent psychotherapeutic effects, and other workers were beginning to apply computers to studies and treatments of psychophysiological problems. Despite this early promise, there has been neither the widespread interest in, nor extensive development of, computer therapies that many expected.

The several different techniques of proposed computer therapy in psychiatry are based on different patient problems and different conceptualizations of etiology and therapy. The hallmark of these computer therapies is a direct interaction between the patient and the computer, and it is this intimacy with, and anthropomorphization of, a machine that some find so threatening, regardless of any associated benefits.

The reactions of most psychiatric patients to computer interviews that collect past history and present symptom descriptions are strongly positive. Patients in a variety of settings have found the interview experience itself helpful and, in the words of a few, “therapeutic.” In these interviews, therapeutic education, reassurance, suggestion, modeling, support, and authorization to express emotion are all possible.

Colby’s work has gone far beyond the simple and directly linked question-answer branching of most medical computer interviews. He has developed complex models of human thought with a capacity to evolve in different directions based on continuing patient-computer interaction. A program for autistic children who had no socially useful speech was helpful in initiating speech in thirteen of seventeen patients with whom it was tried. Another Colby program has a computer simulating a paranoid patient so successfully that it becomes impossible for psychiatrists to determine whether they are interacting with a computer or a person. If one can simulate a psychiatric disorder so successfully, it seems plausible that one may be able to prepare a psychotherapeutic computer program to treat psychiatric disorders.

The biofeedback field has blossomed with the availability of small computers, which can convert the patient's physiologic functions into electronic signals, which then guide the patient in modifying those very functions. Although this field has pulled back from its overly optimistic and simplistic beginnings to a more recent and strictly focused position, the on-line computer will clearly play an important role in defining the ultimate applications of biofeedback to medical problems.

Automation of Behavioral Treatment

A number of attempts have been made to automate behavioral treatment programs. Anxiety disorder treatment programs have been prescribed for snake phobia, social and agoraphobia, and flight phobia. Automation has also been accomplished for avoidance and aversive treatment programs for pedophilia, homosexuality, and personal values. However, these automated treatments seldom use computers directly, depending more commonly on slide or movie projection or audio or videotape presentations. Most studies found comparable benefits between these automated approaches and human therapist treatments.

The Future

One of the major problems in psychotherapeutic practice and research has been to systematically define the treatment techniques so that they may be taught to other therapists and applied in a standardized fashion to patients whose disorders may respond to a particular kind of psychotherapy. By contrast, even in the face of widely variable individual drug metabolism and incomplete compliance, the standardization of psychoactive drug therapies has permitted substantial progress in that field.

Unlike psychotherapy administered by human therapists, which often varies between different therapists and even in a single therapist's treatment of different patients with the same disorder, computer psychotherapy will have the possible advantage of holding constant computer therapy statements and interpretations across a series of similar patients. Since data about the interaction can be immediately stored in computer-processable form, program deficiencies can be quickly identified and the program changed before it is used with additional patients.

Computer technologies to understand human speech are steadily being improved. Computer-controlled speech generation devices with growing vocabularies (such as those used by the telephone company for handling changed and disconnected numbers) are already fairly flexible. Yoking of these two technologies to language-processing computer programs will ultimately provide a capability for humans (who may be patients) to speak directly to computers that speak back to them.

There has been considerable criticism of the use of computers in psychiatry in general and of data collection from patients in particular, yet clearly the use of inhuman devices in medicine is far from inhumane, since technological advances in many fields have brought substantial health benefits to patients. Critics often speak on behalf of an assumed patient constituency without directly consulting it. Whenever patient-computer interactions have been evaluated *by patients,* the reaction has been strongly positive, often to the point of preferring the computer over the doctor as an interviewer.

This seems to be especially true when sensitive subject matter is being discussed, as is often the case in psychotherapy.

Too often there is an immodest over estimation of the benefits of human psychotherapy based on an absence of comparison with other treatments, and occasionally these assessments are based on simple self-interest. Compounding these deficiencies is a large public health problem that confounds, for the most part, present-day techniques. Those who criticize computer therapies are often blind to large, understaffed state hospitals and community mental health centers, which do little but triage patients, often for unavailable or ineffective therapies. The ultimate computer therapy will be, in reality, several different computer treatments that have been shown to be effective for specific patient problems as well as for styles of coping and interaction. The magnitude of the specificity problem has seriously hampered progress in human psychotherapy research, and it seems reasonable to expect that computer psychotherapies, which are totally reliable and capable of systematic modification and unthinking self-scrutiny (through the process of recording, tabulating, and analyzing each class of interactions with each patient), will bring about both an acceleration of our understanding of psychotherapy and the development of more effective human and computer psychotherapies.

Conclusion

Despite disappointments about the difficulties of developing high-quality mental health computer applications, a great deal has been accomplished in the past five years. Computing hardware continues to increase in speed and storage capacity while costs paradoxically decline. Programming languages have become more powerful and more efficient. These technological advances in medicine and psychiatry represent the thin edge of a wedge that can provide the leverage to dramatically improve clinical, administrative, fiscal, research, and clerical aspects of mental health services.

Harnessing this powerful potential to appropriate applications is complicated by the diversity of the mental health field and the complexity of the problems this field deals with. Many systems and problems remain poorly defined and in need of help. Computing has been most helpful where system designs can be clearly specified and where the problem progression presently favors fiscal over administrative over clerical over research over clinical areas. Clinical computing has made a good start in patient computer interviewing, but clinician and patient education and consultation is barely underway. Computer-administrated therapies are now being conceived, and some will be tested in the years just ahead.

The next five years should produce an acceleration in progress in all areas of mental health computer applications. It will become feasible for solo practitioners to use a microcomputer to advantage in many areas of their practice. However, broad-scale acceptance of this advance will probably lag several years behind its availability. As Max Planck sadly but sagely observed, “a new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it.”

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Notes

1 This is an acronym for Problem-Oriented Medical Information System.

2This is a data base management system that runs in the MIIS dialect of the MUMPS programming language.