American Handbook of Psychiatry

Computer Applications in Psychiatry

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COMPUTER APPLICATIONS IN PSYCHIATRY

Computer technology is being applied to practically all aspects of psychiatry. Theories of personality and of psychotherapeutic change are being subjected to computer-simulation techniques. Computers interview, diagnose and conduct therapy with real patients. Computers interpret and write psychological test reports. They compose reports of mental-status examinations.

This chapter will concentrate on practical computer applications that either currently or in the near future will have an impact on the practice of psychiatry. Much less emphasis will be placed on computer applications that are primarily of theoretical or research interest and are unlikely to affect clinical practice. We will not discuss computer applications in several areas that are not central to the practice of psychiatry such as data analysis for research studies, bookkeeping functions in hospitals or other mental-health delivery systems, routine medical laboratory tests, and systems for the exchange of information (e.g., libraries, abstracting services).

The following section is for the reader who is not familiar with basic computer concepts.

Computer Concepts

A computer is a device capable of accepting information, applying a series of predetermined operations on the information, and supplying the results of these operations. For these reasons, a calculating machine, by itself, is not a computer because it does not have the capability of automatically applying a series of predetermined operations on the data that is supplied to it. A full computer, even though it may be quite small, consists of input and output devices that accept and display information, a storage unit that holds information during processing, a unit that can perform arithmetic operations, a unit that can perform logical operations (determine the truth value of an expression) and a control unit that directs the sequence of operations.

There are two basic types of computers: analogue and digital. Analogue computers are used to study data that vary continuously over time, such as EEG activity, blood pressure or other physiological measures. The computer represents the physical process being studied by translating it into an analogous electrical process that can then be manipulated. Because analogue computers do not process symbols, their use in psychiatry has largely been limited to the study of physiological variables such as brain electrical activity.

Digital computers are used to study data that can be reduced to discrete or discontinuous form, such as numbers or other symbols. The most complicated concept, a series of operations, or any kind of digital data, is ultimately translated into a series of “off-on” bits. The physical representation of these bits varies, depending upon where in the computer the information is being stored. For example, in core memory it may be represented as a series of magnetized or demagnetized iron cores, in an arithmetic register it may be represented as a series of semiconductor circuits that are in one of two states.

The physical equipment comprising the computer is known as the hardware. The instructions that determine the specific operations to be done are the software or computer program. The instructions contained in the computer program must be introduced into the computer through an input device just as data is later brought into the computer for processing. Although the program is a list of instructions that are in sequence, when the program is actually executed, the order in which the instructions are carried out may vary as a result of some contingency. For example, a computer program for psychiatric interviewing might have an instruction: "If the subject has not been married, skip section on marital history." Although the computer can obviously respond only to contingencies that have been specified in the program, the capability for branching results in great flexibility. The contingencies need not be stated in terms of the raw input data but can also be in terms of intermediary calculations that are tested at certain points in the program.

Ultimately, all instructions to the computer hardware are in the form of binary numbers. However, since writing instructions in this form is extremely tedious and difficult, programmers make use of high-level programming languages that the machine then translates into binary form, using intermediary programs called compilers and assemblers. Thus, a single instruction in a high-level language by a programmer may result eventually in a string of hundreds of binary-machine-language instructions. Different high-level languages have been developed for different applications. FORTRAN, for example, is ideally suited for algebraic- and formula-oriented quantitative research. COBOL is business oriented and very suitable for inventory and accounting procedures. LISP is a list-processing language that processes symbols and therefore has been useful in computerized simulation of human intelligence. PL/1 combines many of the features of other languages with the aim of producing a general purpose language for business and scientific activities. It is an example of efforts to develop high-level-programming languages that approximate the form of natural language instructions.

Computers can receive information from several types of devices: punch-card readers, paper-tape readers, magnetic-tape readers, optical-scan or character readers, typewriter consoles and cathode-ray tubes (TV-type screen) that are heat or light sensitive. These devices vary in their speed, accuracy, convenience, and cost. The typewriter console and cathode-ray tube permit interaction between the computer and the person supplying the information so that there can be a dialogue. But such devices are expensive and can be used by only one person at a time. Optical-character readers are able to recognize numbers and letters written in standard form. Their practical use is limited by their high cost and the inability to read characters not written according to rigid specifications. Optical-scan readers recognize pencil marks placed in predetermined positions on a form. Their major advantage over key punching is that of speed and the ability to process the original document on which the data is collected. These advantages are offset by the frequently high error rate (reading of erasures or failing to read intended marks) and the absence of any simple procedure for detecting errors, such as the process used in checking keypunch data whereby the data is repunched and any discrepancies are readily apparent.

Computers vary in storage capacity, the speed with which information can be read in and processed, and the capacity to perform complex operations. For example, many small computers are able to perform arithmetic operations but do not have the control circuitry to perform such logical operations as comparing variable A with variable B and then performing differential operations based on the results. Because the internal speed of processing data is incredibly fast as compared with the speed of input devices, it is possible, with large computers, to have many users interacting with the computer at the same time. In actuality, the computer is accepting input from one user for a fraction of a second while it is processing the input from another user. This feature, called time sharing, has made it possible for a large central computer to be shared by many users, thus cutting the expense for each user.

The results of a computer analysis are referred to as the output. If a permanent record is required, it can take many forms, such as punched cards, magnetic tape files, or printed paper. When a permanent record is not required, it can be presented on a visual display device, such as a cathode-ray tube, or, more recently, in the form of an audio message that simulates speech.

There have been so many new developments in computer technology in the last decade that it is difficult to envision the capabilities of computers ten years from now. However, the trends are clearly in the direction of increased speed, power, and reliability of the hardware, the development of more advanced programming languages so that the user can specify operations close to idiomatic English, and the development of relatively inexpensive terminals so that the individual user has ready access to the power of the computer.

Data Banks

The collection of data on psychiatric patients for storage in data banks involves more patients and psychiatric personnel than any other current application of computers in psychiatry. The term data bank is used here for any system involving storage and retrieval of information about patients that is pooled from multiple sources (for example, several hospitals), that is summarized or coded, and is primarily used for administrative or research purposes. Systems that use pooled data, where the emphasis is on producing a clinical record, are usually referred to as automated-recordkeeping systems and, although they always have an associated data bank, are discussed in the next section.

Most departments of mental hygiene have some form of automated system for collecting data on psychiatric patients and nearly all large systems for the delivery of mental-health services now have some form of computerized data system. The type of data entering these systems is quite variable, ranging from simple demographic data and a single psychiatric diagnosis, to such detailed information as services rendered, presenting symptomatology and disposition, and symptomatology at termination of treatment.

In most systems there is no provision for linking data on an individual patient if he receives services from more than one facility. Thus, a patient who is admitted to four different hospitals within a calendar year for treatment of alcoholism would be counted in any summary statistic as four different people. Systems that attempt to link files across facilities for individuals are called case registers. A great deal of additional effort is required to convert a data bank into a case register. A central problem for case registers is finding a unique identification number that would be used by all reporting facilities and that the patient would know himself such as his social-security number. There has been considerable resistance to the use of social-security numbers for such purposes because of the issue of confidentiality. Another major problem in case registers is getting all reporting facilities within a given system to agree on standardization of terminology and on what data is to be reported. More elaborate procedures for editing and checking the data are necessary in a case register than in a data bank. Populations with high mobility are extremely difficult to follow over long periods of time.

Summary statistics from psychiatric data banks can take many forms. Most of the systems provide for a description of the number of admissions, readmissions, and terminations from different types of services, and a description of the demographic characteristics of the population served. More complex systems can describe lengths of stay in various services, use of personnel time, and treatment outcome. Case registers can provide more powerful data that can be used in determining unduplicated patient counts, better descriptions of the types of services received, and profiles of patient populations or service patterns that might not be discernable in ordinary data banks. Case registers, and data banks, can provide administrators with information for evaluating and planning mental-health services and for justifying their work to agencies and legislatures that provide the funds.

Despite the seemingly great potential of data banks, there has been considerable opposition in the profession to participation in such efforts. The primary issues involve confidentiality and whether the high cost of maintaining such systems and the time and effort required in filling out forms by busy mental-health personnel are justified by the actual value of the systems for improving patient care or the distribution of available health resources.

The issue of confidentiality of computerized records is not unique to psychiatric records. However, the sensitive nature of psychiatric data and the possibility of misinterpreting the significance of a given bit of information makes many psychiatrists reluctant to supply any data on a patient thereby indicating that the individual was at one time a psychiatric patient. In defense of automated systems it has been argued that the confidentiality of current non-automated psychiatric records is often violated. It is sometimes possible for various persons to have ready access to the files of a psychiatric clinic or hospital by merely presenting themselves and requesting the patient's chart. With an automated system it is more feasible to put in reliable safeguards against such access by unauthorized individuals. This can be done by using code numbers instead of names, by scrambling identification numbers, and by making linkage of files (names, diagnoses, symptoms) dependent upon complex procedures known only to a few key individuals.

What concerns most mental-health professionals is not access to an individual record by an occasional unauthorized person as much as the potential access to such records on a large scale by cooperating governmental agencies. This can only be solved by legal safeguards that clearly establish the confidentiality of psychiatric data, specify the uses to which it may be put (for example, research studies by bona-fide investigators) and impose penalties for any violations. Several states have already passed such legislation. Ultimately, the issue is between the individual’s right to privacy and society’s need for information that can often be obtained in no other way and that has the potential for improving the level of health care for all.

A major problem of data banks, as well as of automated clinical-record systems, is the quality of the input data. Since in most cases the individual supplying the information receives no feedback, is often unaware of how the data will be used, and may have serious reservations because of the issue of confidentiality, he often has little motivation for supplying accurate and complete data. A further source of low motivation may be a belief that the content of the data is irrelevant for the uses to which it is intended. For example, the clinician may feel that the treatment he has offered is not reflected in the precoded categories that he has to use in reporting his services. In addition, even if he is motivated, the rater rarely has the time to study manuals that define terms on the input forms or the opportunity to participate in discussions to assure comparability of information. Another factor affecting the quality of the input data has been the proliferation of data banks that overlap, so that the clinician may have to report to several different systems, each of which has its own reporting system and group of forms. Many have questioned whether data collected under such circumstances can really be of much help in evaluating and planning services.

Automated Clinical Records

Dissatisfaction with the traditional psychiatric case record has led to many efforts to apply computer technology to improve its usefulness to clinicians, administrators, and researchers. The major impetus for automation has come from administrators and researchers who have found that the traditional clinical record is largely useless for their needs. This is because of the lack of standardization of the type and form of the information contained in the record and the difficulty in retrieving what information it may contain.

There are currently a variety of recordkeeping systems that have been in operation for a number of years and, despite many difficulties, seem to be permanently established. They vary from systems operational in a single hospital, such as the Institute of Living in Hartford, Connecticut; in a mental-health center, such as the Fort Logan Health Center in Denver, Colorado; in an entire state, such as the Missouri Standard System of Psychiatry; to facilities in a number of states, such as the Multi-State Information System for

Psychiatric Patients with a central computer facility at Rockland State Hospital, in Orangeburg, New York. Although all of the systems attempt to translate some of the usual clinical record into a form suitable for automated retrieval, monitor some aspect of patient care, provide information for administrative decisions, and assist the clinician in his understanding and treatment of the patient, they differ considerably in the strategies and methods that they employ for these purposes.

Systems vary in how much of the usual record is automated and to what degree the clinician is limited to precoded categories for describing his patient. Eiduson has developed a system, called the Psychiatric Case History Event System (PSYCHES) in which the narrative textual material of the clinical case record is coded into a form suitable for computer processing. The basic unit of the system is an "event," that is, any happening or occurrence that takes place in the life of the patient or relevant persons in his environment. It includes not only hard, objective data but subjective, impressionistic data that clinicians commonly use in describing patients. This approach assumes that the clinician will, by and large, include all relevant data. The use of coders and the storage requirements for retaining the entire clinical record make this approach unsuitable for most large facilities on the basis of cost alone.

With the exception of the PSYCHES system, all other automated-record-keeping systems require the clinician to use precoded categories to describe his patient. These categories can be simple true-false statements, scaled judgments reflecting intensity or severity of some trait, or multiple-choice items. Precoded items need not be limited to simple concepts, since any concept that can be defined can be translated into a precoded item. Some of the systems attempt to precode only basic demographic data and a small list of presenting symptoms, while others attempt to gather precoded information in all categories of the traditional clinical record (mental status, psychiatric anamnesis, nursing notes, occupational therapy notes, etc.). The systems vary in the extent to which the precoded information is a substitute and replaces parts of the traditional record. In some systems there is virtually no information in the record other than that which is precoded. Most systems retain a written record and only automate small parts of the record. In most systems the computer generates a hard copy that can be placed in the patient's chart. Usually, the material is presented in a simple tabular form. In some cases the computer generates a grammatically correct (if not elegant) narrative report in an effort to simulate the usual clinical report, using special programming languages such as NOVEL. An example of an optically scanned history form and the computer generated narrative are shown in Figures 36-1 and 36-2. To permit the clinician to describe the patient more fully, some systems permit the introduction of small amounts of free narrative text, which can be interspersed with the output of the precoded information.

Despite improvements in the readability of computer-generated narratives and reports, it is unlikely that they will ever approach the readability and individuality of a good clinical record because of the standardization of the input categories. According to some clinicians, they are not only difficult to read, but impossible to remember.

Whereas some systems have accepted the basic structure of the traditional case record, other systems have incorporated features not found in most clinical records. For example, the Fort Logan system has added goal-oriented progress notes that make provision for recording information on the goals set and the methods to be used to attain them. The data is collected not only from the staff but from the patient and community members as well. Hillside Hospital in New York City, part of the Multi-State Information System, has designed a system for allowing the clinician to state his own goals at the beginning of treatment. The computer then queries the clinician periodically as to how the patient is progressing. The Missouri system has provision for collecting precoded historical and family information from a family member.

Another important function of most automated-record systems is to facilitate the monitoring of patient status and care. One method is the Drug Monitoring System of the Multi-State Information System whereby all drug medication is ordered by using a special optical-scan form. Reasons for change and side effects are noted, in addition to the specific drug being ordered and the method of administration. This system allows the clinician to obtain the entire drug history of a patient, to review the current drug status of a group of patients, and to be cautioned if he orders a drug with a dosage that is beyond the expected range or one to which the patient has previously had a toxic reaction.

Glueck and his colleagues at the Institute of Living have an automated nursing note procedure used to monitor patient status.' Nursing reports are made on each patient twice daily (day and night) by routine nursing personnel on a form that is designed for computer scoring (Fig. 36-3). Eleven areas of patient behavior are rated, using non-inferential descriptions. The computer produces two types of output: the first is a narrative summary to be filed in the patient's record; the second is a set of factor scores describing the patient's behavior numerically as compared to the unit norm. The progress of individual patients can be charted as well as changes in an entire ward. Monitoring an entire ward has enabled clinicians to become aware of increasing tension that might not be apparent with the usual observation and reporting techniques. The factor scores can be used to derive a global measure of pathology that can be subjected to a sequential analysis to yield decisions of "significantly better," "worse," or "unchanged," in evaluating response to treatment and the need for change in treatment.

As mentioned previously in the discussion on data banks, all automated systems are designed to generate various summary statistics needed by local administrators in making reports and in planning services. Examples of summary statistics are distributions of patient characteristics by ward, by presenting symptoms, or by treatment given. Using such automated data, administrators are able to study trends in length of hospitalization, readmission rates, types of services being given, and changes in the characteristics of the populations being served by their facilities. In a similar fashion, the systems provide data to research investigators who previously had to depend upon clinical charts that were of limited usefulness because of missing information and the lack of standardization in terminology and coverage.

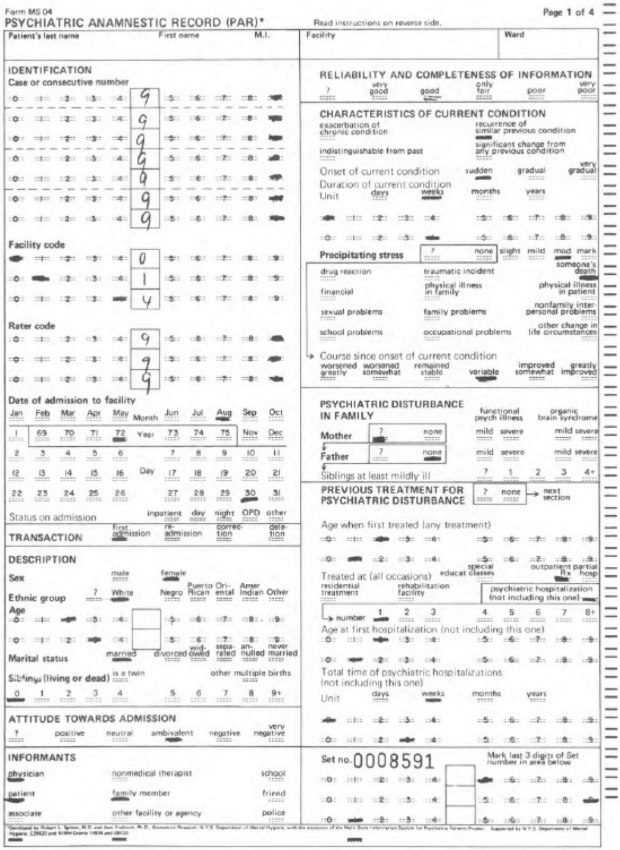


Figure 36-1.
A portion of an optically scanned history form.

PSYCHIATRIC ANAMNESTIC RECORD

IDENTIFICATION

PATIENT CASE OR CONSECUTIVE NUMBER 9999999
PATIENT'S NAME
FACILITY CODE 14
RATER CODE 999
RATER'S NAME
DATE OF PATIENT'S ADMISSION TO FACILITY AUGUST 30, 1972
PATIENT'S STATUS ON ADMISSION (MISSING)

TRANSACTION

THIS IS THE FIRST ADMISSION FOR THE PATIENT TO THIS FACILITY.

DESCRIPTION

THE PATIENT IS A 23 YEAR OLD, MARRIED, WHITE FEMALE. SHE HAS NO SIBLINGS. HER ATTITUDE TOWARD THIS ADMISSION IS AMBIVALENT. INFORMATION FOR THIS REPORT HAS BEEN OBTAINED FROM A PHYSICIAN, THE PATIENT, AND A FAMILY MEMBER. IN THE RATER'S JUDGMENT, THE RELIABILIT OF THE INFORMATION IN THIS REPORT IS GOOD.

CHARACTERISTICS OF CURRENT CONDITION

THE PATIENT'S CURRENT CONDITION IS A RECURRENCE OF A SIMILAR PREVIOUS CONDITION. HER CURRENT CONDITION DEVELOPED SUDDENLY AND HAS BEEN EVIDENT FOR 4 WEEKS. THE ONSET OF HER CURRENT CONDITION WAS APPARENTL ASSOCIATED WITH A MODERATELY STRESSFUL SITUATION INVOLVING SOMEONE'S DEATH. HER CURRENT CONDITION HAS BEEN VARIABLE SINCE ITS ONSET.

PSYCHIATRIC DISTURBANCE IN FAMILY

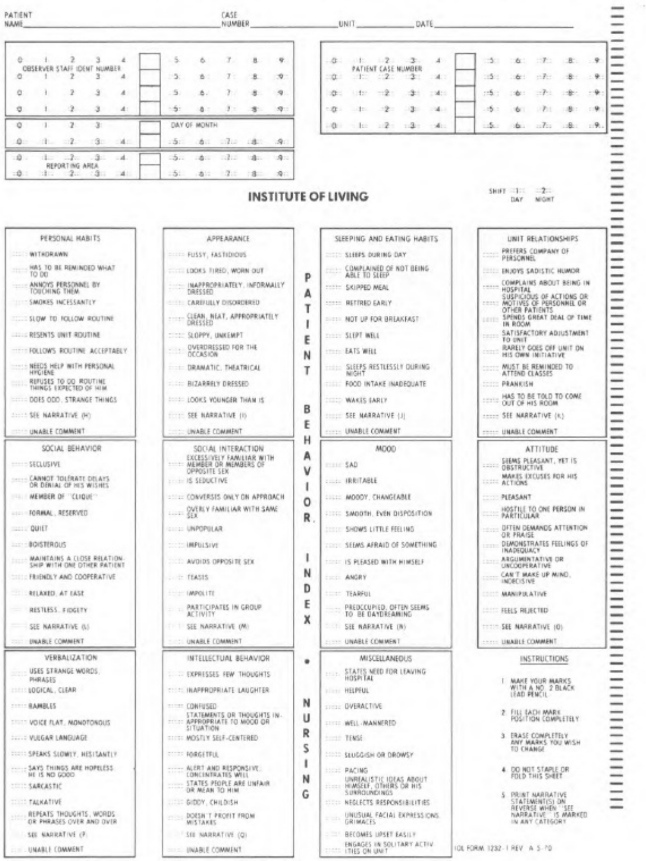
IT IS NOT KNOWN WHETHER THE PATIENT'S MOTHER HAS HAD A PSYCHIATRIC DISTURBANCE. THE PATIENT'S FATHER HAS NO HISTORY OF PSYCHIATRIC DISTURBANCE.

PREVIOUS TREATMENT FOR PSYCHIATRIC DISTURBANCE

THE PATIENT WAS FIRST TREATED FOR A PSYCHIATRIC DISTURBANCE AT AGE 21. SHE HAS HAD OUTPATIENT TREATMENT. SHE HAS HAD ONE PREVIOUS PSYCHIATRI HOSPITALIZATION, WHICH OCCURRED WHEN SHE WAS 21 YEARS OLD. SHE HAS BEEN HOSPITALIZED FOR A TOTAL OF 3 WEEKS, NOT INCLUDING THE CURRENT HOSPITALIZATION. SHE HAS BEEN TREATED WITH DRUGS AND INDIVIDUAL DYNAMIC PSYCHOTHERAPY. THE MOST LIKELY DIAGNOSIS OF THE CONDITION FO WHICH THE PATIENT WAS TREATED PREVIOUSLY IS PSYCHOTIC AFFECTIVE DISORDER.

Figure 36-2.

A portion of the narrative output for an optically scanned history form.


PATIENT NAME ____ CASE NUMBER ____ UNIT ____ DATE ____

OBSERVER STAFF IDENT NUMBER 0 1 2 3 4 5 6 7 8 9

PATIENT CASE NUMBER 0 1 2 3 4 5 6 7 8 9

DAY OF MONTH 0 1 2 3 4 5 6 7 8 9

REPORTING AREA 0 1 2 3 4 5 6 7 8 9

INSTITUTE OF LIVING

SHIFT 1 DAY 2 NIGHT

PATIENT BEHAVIOR INDEX • NURSING

PERSONAL HABITS
- WITHDRAWN
- HAS TO BE REMINDED WHAT TO DO
- ANNOYS PERSONNEL BY TOUCHING THEM
- SMOKES INCESSANTLY
- SLOW TO FOLLOW ROUTINE
- RESENTS UNIT ROUTINE
- FOLLOWS ROUTINE ACCEPTABLY
- NEEDS HELP WITH PERSONAL HYGIENE
- REFUSES TO DO ROUTINE THINGS EXPECTED OF HIM
- DOES ODD, STRANGE THINGS
- SEE NARRATIVE (H)
- UNABLE COMMENT

APPEARANCE
- FUSSY, FASTIDIOUS
- LOOKS TIRED, WORN OUT
- INAPPROPRIATELY, INFORMALLY DRESSED
- CAREFULLY DISORDERED
- CLEAN, NEAT, APPROPRIATELY DRESSED
- SLOPPY, UNKEMPT
- OVERDRESSED FOR THE OCCASION
- DRAMATIC, THEATRICAL
- BIZARRELY DRESSED
- LOOKS YOUNGER THAN IS
- SEE NARRATIVE (I)
- UNABLE COMMENT

SLEEPING AND EATING HABITS
- SLEEPS DURING DAY
- COMPLAINED OF NOT BEING ABLE TO SLEEP
- SKIPPED MEAL
- RETIRED EARLY
- NOT UP FOR BREAKFAST
- SLEPT WELL
- EATS WELL
- SLEEPS RESTLESSLY DURING NIGHT
- FOOD INTAKE INADEQUATE
- WAKES EARLY
- SEE NARRATIVE (J)
- UNABLE COMMENT

UNIT RELATIONSHIPS
- PREFERS COMPANY OF PERSONNEL
- ENJOYS SADISTIC HUMOR
- COMPLAINS ABOUT BEING IN HOSPITAL
- SUSPICIOUS OF ACTIONS OR MOTIVES OF PERSONNEL OR OTHER PATIENTS
- SPENDS GREAT DEAL OF TIME IN ROOM
- SATISFACTORY ADJUSTMENT TO UNIT
- RARELY GOES OFF UNIT ON HIS OWN INITIATIVE
- MUST BE REMINDED TO ATTEND CLASSES
- PRANKISH
- HAS TO BE TOLD TO COME OUT OF HIS ROOM
- SEE NARRATIVE (K)
- UNABLE COMMENT

SOCIAL BEHAVIOR
- SECLUSIVE
- CANNOT TOLERATE DELAYS OR DENIAL OF HIS WISHES
- MEMBER OF "CLIQUE"
- FORMAL, RESERVED
- QUIET
- BOISTEROUS
- MAINTAINS A CLOSE RELATIONSHIP WITH ONE OTHER PATIENT
- FRIENDLY AND COOPERATIVE
- RELAXED, AT EASE
- RESTLESS, FIDGETY
- SEE NARRATIVE (L)
- UNABLE COMMENT

SOCIAL INTERACTION
- EXCESSIVELY FAMILIAR WITH MEMBER OR MEMBERS OF OPPOSITE SEX
- IS SEDUCTIVE
- CONVERSES ONLY ON APPROACH
- OVERLY FAMILIAR WITH SAME SEX
- UNPOPULAR
- IMPULSIVE
- AVOIDS OPPOSITE SEX
- TEASES
- IMPOLITE
- PARTICIPATES IN GROUP ACTIVITY
- SEE NARRATIVE (M)
- UNABLE COMMENT

MOOD
- SAD
- IRRITABLE
- MOODY, CHANGEABLE
- SMOOTH, EVEN DISPOSITION
- SHOWS LITTLE FEELING
- SEEMS AFRAID OF SOMETHING
- IS PLEASED WITH HIMSELF
- ANGRY
- TEARFUL
- PREOCCUPIED, OFTEN SEEMS TO BE DAYDREAMING
- SEE NARRATIVE (N)
- UNABLE COMMENT

ATTITUDE
- SEEMS PLEASANT, YET IS OBSTRUCTIVE
- MAKES EXCUSES FOR HIS ACTIONS
- PLEASANT
- HOSTILE TO ONE PERSON IN PARTICULAR
- OFTEN DEMANDS ATTENTION OR PRAISE
- DEMONSTRATES FEELINGS OF INADEQUACY
- ARGUMENTATIVE OR UNCOOPERATIVE
- CAN'T MAKE UP MIND, INDECISIVE
- MANIPULATIVE
- FEELS REJECTED
- SEE NARRATIVE (O)
- UNABLE COMMENT

VERBALIZATION
- USES STRANGE WORDS, PHRASES
- LOGICAL, CLEAR
- RAMBLES
- VOICE FLAT, MONOTONOUS
- VULGAR LANGUAGE
- SPEAKS SLOWLY, HESITANTLY
- SAYS THINGS ARE HOPELESS, HE IS NO GOOD
- SARCASTIC
- TALKATIVE
- REPEATS THOUGHTS, WORDS OR PHRASES OVER AND OVER
- SEE NARRATIVE (P)
- UNABLE COMMENT

INTELLECTUAL BEHAVIOR
- EXPRESSES FEW THOUGHTS
- INAPPROPRIATE LAUGHTER
- CONFUSED
- STATEMENTS OR THOUGHTS INAPPROPRIATE TO MOOD OR SITUATION
- MOSTLY SELF-CENTERED
- FORGETFUL
- ALERT AND RESPONSIVE, CONCENTRATES WELL
- STATES PEOPLE ARE UNFAIR OR MEAN TO HIM
- GIDDY, CHILDISH
- DOESN'T PROFIT FROM MISTAKES
- SEE NARRATIVE (Q)
- UNABLE COMMENT

MISCELLANEOUS
- STATES NEED FOR LEAVING HOSPITAL
- HELPFUL
- OVERACTIVE
- WELL-MANNERED
- TENSE
- SLUGGISH OR DROWSY
- PACING
- UNREALISTIC IDEAS ABOUT HIMSELF, OTHERS OR HIS SURROUNDINGS
- NEGLECTS RESPONSIBILITIES
- UNUSUAL FACIAL EXPRESSIONS, GRIMACES
- BECOMES UPSET EASILY
- ENGAGES IN SOLITARY ACTIVITIES ON UNIT

INSTRUCTIONS
1. MAKE YOUR MARKS WITH A NO. 2 BLACK LEAD PENCIL
2. FILL EACH MARK POSITION COMPLETELY
3. ERASE COMPLETELY ANY MARKS YOU WISH TO CHANGE
4. DO NOT STAPLE OR FOLD THIS SHEET
5. PRINT NARRATIVE STATEMENT(S) ON REVERSE WHEN "SEE NARRATIVE" IS MARKED IN ANY CATEGORY

IOL FORM 1232-1 REV. A 5-70

Figure 36-3.

A portion of an automated nursing note for monitoring patient status.

One aim of these systems is to improve communication between mental-health personnel by having them use a common set of defined terms. To accomplish this end, the automated clinical forms developed by the authors for use in the Multi-State System have definitions of all technical terms on the reverse side of the form so that the clinician can consult the definition if he is in doubt as to the meaning of the term. In addition, special training films have been developed to teach proper use of the forms.

The average clinician who supplies data in an automated record-keeping system has little interest in providing summary statistics for administrators or data for research studies unless the system in some way provides him with information that will help him better understand and treat his patients. At the simplest level, the computer can remind the clinician when he has failed to provide some data important for medical-legal purposes, for example, information regarding suicidal behavior. At the next level of complexity, the symptom information can be summarized into a series of scaled scores of dimensions of behavior (Figure 36-4). These scale scores can be compared with the "average" patient or some selected subsample of patients. In addition, changes in these scale scores can be displayed, comparing previous rating with the ratings for the current evaluation. Finally, changes on a given summary scale over a series of successive evaluations can be shown.

The Missouri system has used an actuarial model to identify the likelihood of various outcomes, the knowledge of which might be of use to the clinician in planning treatment. Patients with a long hospital stay were compared to those with a shorter stay and patients who eloped compared to those who did not. Using a linear-discriminant analysis of demographic and mental-status data, they developed a method of indicating to the clinician what the chances were that his patient would be in the hospital more than three months or less than three months. Similarly, each patient is noted as having either a high risk (one chance in nine) or a low risk (one chance in thirty) of eloping.

Several systems provide the clinician with suggestions for differential diagnosis or treatment recommendations. This kind of feedback, which has the greatest potential for justifying the automated-record-keeping system to clinicians, is still in its infancy. The different approaches of recent work in this area are discussed in the next two sections.

Automated-record-keeping systems are as controversial as are data banks and case registers. In addition to the issues of confidentiality and the quality of the data, other questions are often raised regarding the value of such systems.

Are the computerized records better than the traditional records that they are replacing? A study by Klein, Honigfeld et al. clearly showed that their computerized case records at Hillside contained more bits of information than traditional case records on the same patients. However, the real issue is not the amount of information but the usefulness. It may well be that computerized records provide more bits of information, which may increase their value to administrators and researchers, but that the focused traditional record (at least in some hospitals) supplies more information of use to clinicians. Some users believe that for the first time they have records on all of their patients that meet minimal standards of completeness and are legible and of value to not only the person who supplied the information but to other personnel in the facility. Others believe that the stereotyped nature of the records makes them less adequate than the records that they have replaced.

Does automation of clinical records cut down the amount of time spent by clinicians and other mental-health personnel? In systems where the automated record substitutes for portions of the usual written or dictated record, clinicians save some time by checking precoded categories rather than composing English narratives. However, systems using optical-scan or key-punched forms require a tremendous amount of clerical checking and computer personnel for processing.

```
MSER GRAPH** PATIENT NO.9999999, 8/30/72,FACILITY NO. 14,RATER NO.999

     SUMMARY SCALES                   CLINICAL EQUIVALENTS      PER-
                                                                CEN-
                                NONE MIN  MILD MOD  SEV  EXTRM  TILE   T

DEPRESSIVE IDEATION AND MOOD. .  XXXXXXXXXXXXXXXXXXXX             82  57
SUICIDE . . . . . . . . . . . .  XXXXXXXXXXXXXXXXXXXX             94  70
SLEEP-APPETITE DISTURBANCE. . .  XXXXXXXXXXXXXXXXXXXX             92  65
SOMATIC CONCERN . . . . . . . .  X                                71  45
ANXIETY . . . . . . . . . . . .  XXXXXXXXXXXXXXX                  72  53
INAPPROPRIATE APPEARANCE. . . .  X                                62  44
DISORIENTATION-MEMORY . . . . .  X                                68  45
COGNITIVE DISORGANIZATION . . .  X                                32  42
HALLUCINATIONS. . . . . . . . .  X                                75  45
UNUSUAL THOUGHTS-DELUSIONS. . .  X                                51  43
SUSPICIOUSNESS. . . . . . . . .  XXXXXXXXXXXXXXXXXXXX             89  61
ANGER-NEGATIVISM. . . . . . . .  XXXXXXXXXXXXXXXXXXXX             82  57
VIOLENCE IDEATION . . . . . . .  X                                71  45
DENIAL OF ILLNESS . . . . . . .  X                                16  36
EXCITEMENT. . . . . . . . . . .  XXXXXXXXXXXXXXX                  83  55
RETARDATION-EMOTIONAL WITHDRAWL  XXXXXXXXXXXXXXXXXXXX             85  59
ALCOHOL ABUSE . . . . . . . . .  X                                80  45
DRUG ABUSE. . . . . . . . . . .  X                                86  46

                                VERY      ONLY      VERY EXTRM
                                GOOD GOOD FAIR POOR POOR POOR
JUDGEMENT . . . . . . . . . . .  XXXXXXXXXXX                      43  46

                                UNRE AVER QUI-      UNUS EXTRE
                                MARK AGE  TE   VERY UALY MELY
LIKEABLE. . . . . . . . . . . .  XXXXXXXXXXX                      72  49

    **THE SUMMARY SCALES ARE MADE UP OF ITEMS GROUPED ON THE BASIS OF A
     FACTOR ANALYSIS OF A REFERENCE GROUP OF 2001 NEWLY ADMITTED
     INPATIENTS.  THE CLINICAL EQUIVALENTS ARE ESTIMATES OF THE LEVELS
     OF SEVERITY OF EACH DIMENSION.  THE PERCENTILE IS THE PERCENT OF
     PATIENTS IN THE REFERENCE GROUP THAT HAVE A SCORE EQUAL TO OR
     BELOW THIS SUBJECT.  T SCORES ARE STANDARDIZED SCORES WITH A MEAN
     OF 50 AND A STANDARD DEVIATION OF 10 FOR THE REFERENCE GROUP.
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Figure 36-4.

Graphic output of scale scores of an automated mental-status examination form.

Does automation make the record more quickly available in contrast to the frequent delays in processing dictated or written records, which often need to be typed, corrected, and retyped? Unfortunately, in some facilities the time from completion of the input form to the availability of the computer-generated record is disappointingly long. In addition, the ability to get at the data for an individual patient or for research or administrative study of groups of patients is often more difficult than anticipated when the system is being designed. When such systems are designed, it is often impossible to anticipate the kinds of analyses that administrators or research investigators will need. New programs have to be written and debugged as the need arises.

It is no surprise, therefore, that administrators seem to be the most satisfied with automated-record-keeping systems. Researchers are divided: some are excited by the potential and have made use of data already collected; others are skeptical and doubt that the systems will be of much use to research because of the variable quality of the input data and the limitations of the data for treatment evaluation in the absence of controlled experimental design. Clinicians seem to be the least satisfied because most systems provide little output that is useful to clinical personnel in improving patient care. Improved patient care will mainly result from computer analysis that provides the clinician with information he finds useful in his understanding and treatment of the patient, such as differential diagnosis, treatment recommendations, and anticipated management problems and course of illness. This kind of output requires further research. As the next sections on computerized diagnosis and treatment recommendations indicate, there is good reason to be optimistic regarding future developments.

Computerized Diagnosis

The well-known limitations of the clinical method for arriving at a psychiatric diagnosis, especially its unreliability, have led to several efforts to utilize computers for integrating clinical observations into psychiatric diagnoses. In these efforts, the basic observations of signs and symptoms are made by clinicians. These are the raw data that either a clinician or a computer can use to arrive at a diagnosis. There are several advantages to computer-generated diagnoses. First of all, there is the value of necessarily perfect reliability in the sense that given the same data, the computer program will always yield the same diagnosis. Secondly, the computer program can utilize rules developed from a larger and more diverse sample of actual patients than any single clinician can command. In addition, the rules by which a computer assigns a diagnosis are explicit and public. Finally, empirically based rules constitute at least potential advances in our scientific understanding of the complex relationship between symptom characteristics and diagnosis.

Three basic models have been used in developing computer algorithms for translating the input symptom (and in some cases, demographic) data into diagnoses. Two of these models are statistical methods—Bayes and discriminant function—and utilize data on a sample of patients for each of whom the diagnosis is known and for each of whom a series of measures are available. From this sample, generally referred to as the "developmental" sample, an empirical classification scheme is devised. Using each subject's observed series of scores, the scheme quantifies (as a probability by the

Bayes method and as a distance by the discriminant-function method) how "close" the subject is to each diagnostic group. The subject is assigned the diagnosis to which he is "closest." Because both of these methods derive their constants from a specific set of data, they capitalize on accidental features of the developmental sample and, therefore, their validation demands their application to new samples. The Bayes method has been applied to psychiatric classification by Birnbaum and Maxwell, Overall and Gorham, and Smith. The discriminant-function method has been used by Rao and Slater, Melrose, Stroebel, and Glueck, and Sletten, Altman, and Ulett. The latter group has applied this method to data from five hospitals in the Missouri automated-record-keeping system and developed a system for classifying patients into one of twelve diagnostic groups. The overall agreement between computer classification and clinical diagnosis was sufficiently high for them to make the system operational in the Missouri Standard System of Psychiatry used in Missouri state hospitals.

A third model, called the logical decision-tree approach, has been employed by the authors. In this model the computer program consists of a sequence of questions, each of which is either true or false. The truth or falsity of each question rules out one or more diagnoses and determines which question is to be examined next. Some questions may specify the presence of a single sign or symptom, others may specify that a numeric score is in a certain range, and still others may specify a complex pattern of both signs and scores. This approach is similar to the differential diagnostic method used by clinicians in making a psychiatric diagnosis. It has the obvious advantage over the two statistical models in that it does not require a data base and is not dependent upon the specific characteristics of a developmental sample.

So that the reader can have an understanding of the potential complexity of the logical decision-tree approach, a portion of the first computer program for psychiatric diagnosis that we developed, DIAGNO I, is shown (in English rather than FORTRAN):

Decision 11. If (Delusions-Hallucinations > 2) or (Retardation-Withdrawal > 4) or (Inappropriate-Bizarre Appearance or Behavior + Retardation-Withdrawal + Speech Disorganization > 7) or (Elation >0 or Grandiosity > 2) and (Agitation-Excitement > 2) or (Speech Disorganization >3) or (Social Isolation > 7 and Alcohol Abuse < 5) true, go to 12; if false, go to 20. This tests for psychosis.

Decision 12. If (Visual Hallucinations + Elation = o) and (Speech Disorganization < 4) and (Depression-Suicide + Guilt > 4 or Depression-Suicide > 3) and not (Guilt = 0 and Auditory Hallucinations > o) and (Age >25) and (Retardation-Withdrawal > 2 or Depression-Anxiety > 20 or Total Score > 50 or Agitation-Excitement > 2) true, go to 13; if false, go to 14. This tests for a psychotic depressive illness.

Decision 13. If (Female and Age >45) or (Male and Age > 55) and (Previous Hospitalizations = o) true, diagnosis is involutional reaction, and go to 36; if false, diagnosis is Psychotic depressive reaction, and go to 36.

Decision 14. If (Elation + Grandiosity > 0) and (Agitation-Excitement > 1) and (Auditory Hallucinations + Visual Hallucinations = 0) and (Speech Disorganization > 2) and (Alcohol Abuse < 4) and (Age >25) true, diagnosis is Manic depressive psychosis, manic type, and go to 36; if false, go to 15.

Fleiss et al. compared these three models for computer diagnosis and found that the logical decision-tree model performed as well as the two statistical models (in terms of agreement with clinical diagnosis) on a large cross-validation sample that was similar to the developmental sample. The logical decision-tree method performed better than the two statistical approaches on a sample drawn from a totally new population.

The logical decision-tree approach has been used in three computer programs, DIAGNO I, DIAGNO II, and DIAGNO III. For all three programs the agreement between computer diagnoses and clinical diagnoses made by experts has been as good as that between the diagnoses of the experts. The first two programs have been used in various research projects for describing samples of subjects, selecting subjects for experiments, in epidemiological and cross-cultural studies, and investigating problems in classification.

DIAGNO III is the most complicated of the logical decision-tree programs and uses information on both current and past psychopathology as input data, makes multiple diagnoses, and notes the "most likely" diagnoses as well as diagnoses "also to be considered." The output includes seventy-nine standard diagnoses from the American Psychiatric Association's Diagnostic and Statistical Manual. DIAGNO III is currently operational in the Multi-State Information System.

Either the logical decision-tree or the statistical approaches can be used to develop systems for classifying patients according to any typology for which explicit rules can be made. For example, Benfari and Leighton describe a computer program for use in epidemiological studies, whereby subjects are assigned to the "caseness" categories of the Stirling County psychiatric evaluation procedure. On cross-validation their program had levels of agreement with consensual ratings of two psychiatrists equal to or greater than that of any two psychiatrists on their independent ratings of either detailed symptom patterns or "caseness." Future work on computer diagnosis will probably be in the direction of developing other typologies for specific purposes such as predicting treatment response.

Computerized-Treatment Recommendations

The recognition that actual clinical practice is often at considerable variance with what is considered best by experts and the capacity of computers to rapidly and reliably assess new data based on previous knowledge have led to efforts to use computers to assist clinicians in making treatment decisions.

One of the earliest studies that suggested computer-assisted drug prescription could be more effective than “doctor’s choice” of medication was that of Mirabile, Houck and Glueck at the Institute of Living. They used a computer program based upon a retrospective model of the personality profile of the best responder to combined tranquilizer-anti-depressant therapy. This model was developed on the basis of a stepwise, multiple-discriminant-function analysis of data from a controlled study by Hedberg, Houck, and Glueck. This study compared the MMPI and Minnesota-Hartford Personality Assay admission profiles of patients who responded best to combined drug therapy with those of patients treated by a single phenothiazine. The computer program was used with a large group of new admissions to select sixty whose admission characteristics were similar to the best responders to combined drug therapy in the previous study. The sixty patients were divided into three groups, two of which were treated with different forms of combined drug therapy, with the third being treated by doctor’s choice. Over the twelve-week study period, the patients on doctor’s choice improved the least, suggesting that the computer recommendation would result in greater improvement.

Sletten, Ulett, and their colleagues have studied agreement among clinicians regarding the specificity of psychotropic drugs for treating patients with particular symptoms. Thirty-two senior clinicians were given ten blank mental-status checklists with the name of one of ten drugs on each. For each item they were asked to indicate how useful the drug was for that particular symptom. Part of the sample was used to develop a formula to assign a mental-status profile to a drug. This was cross-validated with the second part of the sample. When agreement was examined for the ten drugs separately, there was only 32 percent agreement on cross-validation. However, when the drugs were grouped into three major categories (major and minor tranquilizers and antidepressants) 84 percent agreement was found in the cross-validation sample, thus indicating good consensus among the experts. These findings have been used to develop a statistical formula for data that are routinely recorded by the clinician and reported to the computer system when a patient is admitted to the hospital. The treatment recommendation is a statement such as, "Given a patient with mental status findings of the type reported on your patient, senior clinicians in the Missouri Division would most likely give of the ten drugs recommended for us."

Overall and his colleagues have conducted a series of studies dealing with the issue of agreement among clinicians on the symptom profiles associated with differential drug assignment. They have developed a statistical formula based upon studies of actual drug use by psychiatric residents and the treatment of hypothetical computer-derived types by experts for recommending a class of drugs for a specific case. The system is operational at the University of Texas Medical Branch in Galveston. Medical students and psychiatric residents fill out the Brief Psychiatric Rating Scales and history forms on the day of admission. By the next morning, a computer print-out summarizes the history and makes drug-treatment recommendations. Overall informs us that the clinicians report that this print-out is useful to them.

J. Levine and his colleagues at the National Institute of Mental Health have developed a computer program for assisting general practitioners in diagnosing and prescribing treatment for medical patients with psychiatric problems. He gave a group of experts a list of mental-status-type items and asked them to indicate the relevance of each item for identifying five drug treatment-relevant patient types: psychotic (neuroleptic), depressed (tricyclic), manic (lithium), anxious (anxiolytics) and depressed (reactive). There was considerable agreement on twenty-eight items as useful in identifying these types. He next developed a scoring procedure that yields a score for each patient type for each subject. The score is a weighted sum of the items that are judged relevant to identifying that type. The program classifies and reports the patient type with the highest score. In addition, the clinician can get at descriptions of this or all other patient types, as well as information on the psychopharmacology of the drug, specific information for prescribing, and side effects. The program has been written for both cathode-ray tube and ordinary touch-tone phone but is not yet operational in the field.

Klein and his colleagues at Hillside Hospital in New York City have developed a computerized system for classifying patients into nonstandard diagnostic categories that have been shown to predict response to specific drug therapies. The program was developed by analyzing cross-sectional data on a large number of patients. The tails of distributions of symptom ratings were searched for areas of non-overlap in which subjects can, with relatively little false positive error, be assigned to diagnostic categories. The computerized diagnoses were in substantial agreement with carefully made clinical diagnoses and predicted response to drugs as well as did the clinical diagnoses.

Whereas the above methods for automating treatment recommendations were developed by using statistical procedures and a data base, the authors have started work on a system that follows essentially the same approach that we took in developing computer programs for psychiatric diagnosis, i.e., a logical decision-tree approach. Rather than use a data base and a limited number of psychiatric symptoms and categories, as is required by the mathematical models, we are programming the logic of current therapeutic knowledge regarding interaction between patient characteristics and drug response as it is reflected in textbooks, review of relevant research, and the opinions of recognized experts. This program will be part of a larger program called AIDS, Assistance in Diagnosis and Somatotherapy, that will be operational in the Multi-State Information System for Psychiatric Patients.

Since the logical decision-tree approach is not dependent upon a data base, new findings based on strong research evidence can be the basis for modifications of the output. In addition, the logical decision-tree approach lends itself to more informative output than is usually the case with mathematically derived models. Thus, if there is clear-cut evidence for the superiority of one class of drugs, this can be noted with the appropriate dosage range for one drug in that class. For example, for chronic schizophrenia the treatment recommendation might be: "Phenothiazines, e.g., chlorpromazine, 300 to 1500 mg. per day or some other phenothiazine in equivalent doses." However, if there is disagreement regarding various alternative classes of drugs, the output can so indicate. For example, with a severely agitated depression the recommendation might read: "There is a disagreement as to whether patients with agitated depression do better with tricyclics or phenothiazines." When appropriate, recommendations for the course of therapy will be made. For example, when recommending phenothiazines for schizophrenia, the output might be: "Start with at least 300 mg. per day and increase rapidly until symptoms are controlled or patient develops serious side effects." Similarly, untoward side effects can be anticipated. For example, "Since the patient is over sixty, the possibility of orthostatic hypotension and cardiac insufficiency should be anticipated."

The work done to date indicates great promise for the development of numerous systems for computerized-treatment recommendations. This is the one application of computers in psychiatry where the individual clinician is likely to receive the most help in the treatment of his patients. Few clinicians can keep up with recent research findings that compare different treatment modalities, and few clinicians have sufficient experience with a wide range of patients and medications to determine what is best for an individual case. Much of the current work in the field of psychopharmacology is in identifying patient characteristics that differentially interact with drug treatment. The results of these studies will undoubtedly be useful in the further development of computerized treatment recommendations.

Computerized Interpretation of Psychological Tests

The time-consuming nature of the traditional clinical interpretation of psychological tests has naturally led to efforts to computerize scoring and interpretation. Computerization is possible to the extent that the rules for interpreting the results are capable of specification. The availability of normative and validity data facilitates the development of the rules of interpretation. The programs can be written so that given a new case, the data can be analyzed according to specific rules that determine which of a previously stored set of descriptive statements are applicable.

Most of the efforts to computerize psychological test interpretation have focused on self-report measures, particularly the Minnesota Multiphasic Personality Inventory (MMPI), a questionnaire that has had widespread use for several decades. A great deal of normative and validity data are available and long experience of clinicians in its use has led to many "cookbook" rules for interpretation. There are several operational computer systems for interpreting the MMPI, some of which are widely used and are available commercially. According to a recent advertisement by one of the commercially available systems, it was being used by over 800 institutions and one-third of the psychiatrists in the country in private practice.

The first operational system for interpreting the MMPI was developed at the Mayo clinic, where it is used primarily as a screening procedure for medical patients. The output consists of a dozen or so statements derived principally from single-scale elevations, although some scale patterns are included. Glueck and Reznikoff expanded the Mayo statements to produce a longer and more detailed report with emphasis on psychopathology. Finney has developed a system that is capable of producing different kinds of reports, depending upon the kind of patient, the setting, and the needs of the professional requesting the report. One report produces a narrative in the second person, designed to be shared with the patient, by the person ordering the test. Another focuses on prediction of successful parole and the likelihood of an escape attempt, for use in penal settings. Other reports emphasize evaluation of potential for psychotherapy or the more traditional emphasis on psychopathology and diagnosis.

One of the most widely used systems by psychiatrists is that developed by Fowler. His system was designed to simulate the kind of report that is used by psychiatrists and psychologists as a part of their diagnostic evaluation. The first page (Figure 36-5) is a narrative report that describes the patient's personality traits, symptoms, and dynamics. The second page provides the scores on a large number of scales and a print-out of the patient's significant responses to certain critical items that might be of interest to the clinician. The last page is a profile sheet on which the scores are presented in graphic form.

Research done by Fowler, as well as others not associated with the development of his system, has shown that most users are satisfied with the output and find the report useful. A high proportion of users rated the reports as giving a valid overall description of the patient, reflecting the mood and feelings of the patient correctly, and accurately portraying his interpersonal relationships. However, users often reported that psychosomatic complaints and the severity of personality disorders were overemphasized, and that some major symptoms were omitted from the report. A study of the use of the system in Veterans Administration hospitals, where the majority of the therapists were psychologists who had had considerable experience with non-computerized MMPI reports, indicated that 72 percent judged the reports as equal to or better than the usual clinical reports. There were similar findings in a national sample of over six hundred private practitioners.

The computerization of the interpretation of projective tests is more difficult because of the absence of generally agreed-upon rules for interpretations of test responses. However, there have been some efforts to computerize the interpretation of inkblot tests, such as the Rorschach and the Holtzman Inkblot Technique. Zygmunt Piotrowski’s system for interpreting the Rorschach has been computerized whereby several hundred decision rules are applied to the detailed scores derived from the test responses by an experienced Rorschach tester. The program prints out a series of interpretive statements based upon the configuration of scores. A computer system for scoring the responses to the Holtzman inkblots has been developed by Gorham and norms for seventeen different scored variables have been established for normals, state-hospital schizophrenics, depressives, psychoneurotics, alcoholics, and chronic brain-syndrome patients. Veldman and his colleagues have programmed a method for scoring a sentence-completion test where the response is limited to a single word. The output includes an overall rating of mental health.

ROCHE PSYCHIATRIC SERVICE INSTITUTE

MMPI REPORT

CASE NO: 7327 RPSI NO: 17012
AGE 0 MALE MAR. 03,1971

THE TEST RESULTS OF THIS PATIENT APPEAR TO BE VALID. HE SEEMS TO HAVE MADE AN EFFORT TO ANSWER THE ITEMS TRUTHFULLY AND TO FOLLOW THE INSTRUCTIONS ACCURATELY. TO SOME EXTENT THIS MAY BE REGARDED AS A FAVORABLE PROGNOSTIC SIGN SINCE IT INDICATES THAT HE IS CAPABLE OF FOLLOWING INSTRUCTIONS AND ABLE TO RESPOND RELEVANTLY AND TRUTHFULLY TO PERSONAL INQUIRY.

IT APPEARS THAT THE PATIENT, IN HIS RESPONSES TO THE TEST ITEMS, MAY HAVE BEEN OVERLY SELF-CRITICAL. THE VALIDITY OF THE TEST MAY HAVE BEEN SOMEWHAT AFFECTED BY HIS TENDENCY TO ADMIT TO SYMPTOMS EVEN WHEN THEY ARE MINIMAL. THIS MAY SUGGEST THAT CURRENTLY HE FEELS VULNERABLE AND DEFENSE-LESS, AND THAT HE IS MAKING AN EFFORT TO CALL ATTENTION TO HIS DIFFICULTIES IN ORDER TO ASSURE OBTAINING PROFESSIONAL HELP.

THIS PATIENT IS A TENSE, ANXIOUS, DEPRESSED INDIVIDUAL WHO IS OVER-CONTROLLED, HAS DIFFICULTY EXPRESSING HIS FEELINGS, AND IS FILLED WITH SELF-DOUBT. ALTHOUGH HE MAY SEEM INDUSTRIOUS AND CONSCIENTIOUS IN HIS WORK, HE IS TORN BETWEEN A NEED TO BE COMPETITIVE AND A FEAR OF FAILURE. HE MAY SUFFER FROM FATIGUE, WEAKNESS, AND LOW ENERGY LEVEL.

HE IS A RIGID PERSON WHO MAY REACT TO ANXIETY WITH PHOBIAS, COMPULSIONS OR OBSESSIVE RUMINATION. CHRONIC TENSION AND EXCESSIVE WORRY ARE COMMON, AND RESISTANCE TO TREATMENT MAY BE EXTREME, DESPITE OBVIOUS DISTRESS.

THERE ARE UNUSUAL QUALITIES IN THIS PATIENT'S THINKING WHICH MAY REPRESENT AN ORIGINAL OR ECCENTRIC ORIENTATION OR PERHAPS SOME SCHIZOID TENDENCIES. FURTHER INFORMATION IS REQUIRED TO MAKE THIS DETERMINATION.

HE SHOWS SOME CONCERN ABOUT HIS PHYSICAL HEALTH. HE MAY OVER-REACT TO MINOR ILLNESSES, PERHAPS USING THEM AS A MEANS OF AVOIDING DIFFICULT SITUATIONS. HE IS LIKELY TO BE A RIGID, SOMEWHAT SELF-CENTERED PERSON.

HE APPEARS TO BE AN IDEALISTIC, INNER-DIRECTED PERSON WHO MAY BE SEEN AS QUITE SOCIALLY PERCEPTIVE AND SENSITIVE TO INTERPERSONAL INTERACTIONS. HIS INTEREST PATTERNS ARE QUITE DIFFERENT FROM THOSE OF THE AVERAGE MALE. IN A PERSON WITH A BROAD EDUCATIONAL AND CULTURAL BACKGROUND THIS IS TO BE EXPECTED, AND MAY REFLECT SUCH CHARACTERISTICS AS SELF-AWARENESS, CONCERN WITH SOCIAL ISSUES, AND AN ABILITY TO COMMUNICATE IDEAS CLEARLY AND EFFECTIVELY. IN SOME MEN, HOWEVER, THE SAME INTEREST PATTERN MAY REFLECT A REJECTION OF MASCULINITY ACCOMPANIED BY A RELATIVELY PASSIVE, EFFEMINATE NON-COMPETITIVE PERSONALITY.

NOTE: ALTHOUGH NOT A SUBSTITUTE FOR THE CLINICIAN'S PROFESSIONAL JUDGMENT AND SKILL, THE MMPI CAN BE A USEFUL ADJUNCT IN THE EVALUATION AND MANAGEMENT OF EMOTIONAL DISORDERS. THE REPORT IS FOR PROFESSIONAL USE ONLY AND SHOULD NOT BE SHOWN OR RELEASED TO THE PATIENT.

Figure 36-5.
A portion of an automated MMPI report.

Further developments in this area will undoubtedly involve new tests that are developed specifically for computerized analysis and interpretation.

Interviewing by Computer

Questionnaires regarding psychiatric symptomatology, history, and demographic data are frequently used with psychiatric patients. They avoid the need for specially trained interviewers to collect this information and have the advantage over the usual clinical interview in that the data is collected in a standardized fashion using precoded categories suitable for later data analysis. The capacity of computers to branch, that is to modify the operations of the program based on the analysis of the incoming data, suggests that computers could simulate the human interview process in which answers to questions determine the content of future questions. If this were possible, interviewing by computer would have the standardization advantages inherent in questionnaires, and the flexibility inherent in the clinical interview.

A number of investigators have developed systems whereby patients can be interviewed by directly interacting with a computer. An example of such a system is that developed by Maultsby and Slack for obtaining psychiatric-history data. The patient sits facing a cathode-ray screen on a computer console. The questions are displayed on the screen and responses are made on the computer keyboard. The presentation of a question is a function of the patient’s responses to previous questions.

The usual set of responses available to the patient is “Yes,” “No,” “Don’t know” and “Don’t Understand.” With some questions, different sets of multiple-choice answers are presented. The patient answers the questions by pressing one of four numbered keys corresponding to the four responses. The number chosen by the patient replaces a question mark on the screen and if he has made an error or changed his mind, he can delete his response with the change button or back up to the preceding question. When he is satisfied with his response, the patient presses the “go” bar and the computer advances to the next question. If a key representing an illegitimate response is pressed, the computer will not acknowledge this. A question remains fixed on the screen until an appropriate response has been made. Open-ended questions are used in the computer-based history for obtaining numerical information such as age, dates, and time relationships as well as such alphabetic information as name, chief medical problem, and occupation. The response field for these questions is indicated by question marks on the screen that are replaced as the history data are typed by the patient on the keyboard. This enables the patient to check the accuracy of his response. The computer was programmed to simulate a rather euphoric and emotionally responsive interviewer. When the patient responded “No” to a question that had significant negative connotations, the computer responded with such statements as: “Great! I am glad that we don’t have to consider that,” or “Gee, I am glad to hear that.”

The content of their history involves general questions concerning personal, family, social, educational, marital, and financial conditions. Responses indicating unusual situations are followed by questions eliciting specific details. At the completion of each interview the computer questions the patient about his reaction to the interview. Finally, a printed summary is generated for the physician. An excerpt from a computer summary reads:

> Suicide gestures, 3 times; history of self-inflicted injury; patient has explanation for self-infliction of injury; attending physician should inquire; reasons for self-inflicted injury—feeling sorry for myself and guilty; feels has weight problem but cannot say what it is; feels can help self; feels deserves help; is willing to work to help self.

In a study with both psychiatric patients and medical or surgical patients for whom a psychiatric consultation had been requested, patient reaction was generally favorable to the procedure. Psychotherapists of these patients generally found the summaries helpful in making patient evaluations and in alerting them to inquire into certain key areas.

A number of investigators have also developed programs for the computer to interview a clinician about a patient. Shapiro, Feldstein, and Fink took the DIAGNO II program for computer diagnosis and modified it. In the regular DIAGNO II program, the computer processes ratings supplied by a clinician on all of the relevant psychopathology variables. In contrast, their programmed version of DIAGNO II interacts with the clinician, asking him only those questions needed to arrive at a particular diagnosis. For example, the program starts by asking questions relevant to a diagnosis of organic brain syndrome. If the responses justify such a diagnosis, no more questions are asked. If such a diagnosis is not warranted, the program then asks questions relevant to the diagnosis of a functional psychosis. If no psychiatric disorder is diagnosable, the program will have asked about the entire set of psychopathology variables.

Their program uses an interactive oscilloscope device whereby the questions are presented to the clinician and he responds by touching the screen in any one of twenty sensitized bands under which a choice has been displayed. Using their interactive system, the amount of time taken to arrive at a diagnosis is from five to fifteen minutes, whereas it ordinarily will take a clinician from fifteen to thirty minutes to complete ratings on all of the psychopathology scales used in the DIAGNO II program.

Levine's program for assisting general practitioners in diagnosing and prescribing treatment, which was described earlier (see page 825) also operates in an interactive mode. The program asks questions of the practitioner about his patient's symptomatology. In addition, the practitioner is asked if he wishes information on the psychopharmacology of the recommended drug or a description of other typical patients who respond well to a particular drug.

Computerized interviewing can easily include tests of cognitive functioning, such as memory, arithmetic ability, or fund of information. The branching capacity of the computer can be used to present tests of increasing difficulty, until the subject shows signs that he is unable to perform at a higher level, at which point the computer could branch to another task. Just as in Maultsby's computerized psychiatric history (see page 828) the computer could reinforce the correct responses and reassure the patient when he made mistakes.

A much more ambitious approach has been taken by other investigators, such as Colby and his associates at the Computer Science Department at Stanford University. Here the attempt is to program the computer so that it can accept natural language responses from the patient as input rather than being limited to a small number of fixed responses, as in the systems described above. The initial work consisted of studying interviews of patients by actual psychiatrists when both the patient and the psychiatrist were forced to use remote teletypes as the communication mediator. In this way, all paralinguistic interaction, such as voice tone and speed of response, are eliminated. Study of this type of transcript material led to the development of a program for interviewing a hospitalized psychiatric patient. Although ultimately designed to operate without human assistance, the program now requires a human to translate the English statements of the patient into a form that is processable by the program. Depending upon the coded input, the program makes decisions regarding which topics should be explored by output questions. A series of variables are consulted to determine whether the current topic should be continued or another topic with a higher priority should be considered. Within a topic, there are a series of questions that can be asked by the computer. Before a question is asked, the computer searches its memory to determine if information has already been received making the question unnecessary.

Computerized Therapy

Attempts to develop systems whereby a patient interacts with a computer, with the computer serving as the therapist, have developed along three main lines: to apply systematic desensitization, to administer positive or negative reinforcements, and to conduct a psychotherapeutic dialogue in natural language.

Lang has developed a computer system called DAD (Device for Automated Desensitization) for applying desensitization therapy to the treatment of focused-phobic behavior. The program administers audio-tape instructions for muscle relaxation and prepares the patient to visualize fear stimuli arranged in hierarchical order. Each item of the hierarchy is automatically presented a preprogrammed number of times before going on to the next one. If the patient feels anxious or has difficulty visualizing the stimuli, he presses a switch and additional instructions are given for relaxation. The program then returns to an earlier item on the hierarchy and begins the sequence again. Comparisons between systematic desensitization administered by DAD with that administered by live behavior therapists suggest that they are equally effective. Furthermore, the automated procedure allows for extensive monitoring of physiological data concomitantly with the administration of the therapy.

Colby's group developed a system for aiding language development in nonspeaking children. Since such children are often fascinated with machines and have difficulty interacting with humans, a computer system might have particular advantages over conventional therapy. In their system, the child interacts with a display device that consists of an 8 X 10-inch screen and a keyboard whose keys, when struck, produce English letters, numbers, logical and mathematical symbols, words, phrases, and pictures of objects on the screen. In addition, sounds, syllables, words, or phrases are presented through a speaker.

The program is divided into eleven games of varying complexity. In the simplest game, the child types a symbol and the program displays the symbol and a voice pronounces the appropriate sound. In the most complex game, a phrase or sentence is associated with each key. When the key is struck, the voice utters the associated phrase or sentence. Once a child has become accustomed to some of the expressions, words are omitted from them and the child is expected to fill in the missing words.

Colby’s group has used this system with disturbed children and reports that there was significant improvement in language function in fifteen of twenty-one children treated. Although there was no control group and many of the children were receiving other kinds of therapy, there is evidence that the system was instrumental in the improved language function.

A quite different approach has been the development of systems whereby the computer converses with a patient in natural language. Weizenbaum, who developed the first program for on-line communication between man and computer using natural language, ELIZA, programmed Rogerian type psychotherapy responses because of their relatively restricted nature. However, his program was primarily for the purpose of studying computer-language issues rather than providing a communicative experience between man and computer that would be psychotherapeutic. Colby and his group developed a system whose primary aim was psychotherapeutic. A patient converses with a computer through a teletype, typing in anything he wishes to say, using his own spelling and punctuation. When he desires a response from the program, he signals the end of his transmission and then receives a typewritten reply on the teletype. The dialogue has many properties of spoken conversation. The program scans input sentences for the presence of key characters, words, or combinations of words that are preprogrammed and responds to them with statements that question, focus, rephrase, communicate an intent to help and occasionally interpret. For example, an actual interchange between a person expressing negative feelings toward the computer-therapist was as follows:

PERSON: I DON'T UNDERSTAND.

PROGRAM: DO YOU WANT TO UNDERSTAND.

PERSON: I HATE YOU, YOU STUPID MACHINE.

PROGRAM: WHAT DON'T YOU LIKE ABOUT ME.

PERSON: YOU HAVE NO FEELINGS.

PROGRAM: HOW DO YOU MEAN.

PERSON: I MEAN YOU CANNOT EXPERIENCE WHAT I EXPERIENCE BECAUSE YOU ARE JUST A MACHINE.

PROGRAM: TELL ME MORE ABOUT SUCH FEELINGS.

PERSON: WE ARE NOT COMMUNICATING.

PROGRAM: I AM TRYING MY BEST TO COMMUNICATE WITH YOU.

PERSON: ARE YOU REALLY.

PROGRAM: HOW DO YOU SEE IT.

PERSON: WHAT DO YOU MEAN.

PROGRAM: JUST TRY TO SAY WHAT IT MEANS TO YOU.

PERSON: I THINK YOU ARE ALL GOOFED UP.

In contrast to the systems for computerized therapy involving desensitization or the selective use of positive or negative reinforcement, systems for computerized psychotherapeutic dialogue are a long way from practical application.

Computer-Facilitated Training

Many of the applications already described have great potential for facilitating training in psychiatry. The use of a common set of definitions in automated-record-keeping systems has already proven of value in training mental-health personnel. The computerized output in many of these systems is designed to serve a teaching function. Levine’s program for assisting general practitioners in treating psychiatric symptomatology is also designed to teach psychopharmacology. In contrast, other systems have been designed with teaching as their primary function.

Hillman developed a program, THERAPY, (Theoretically Human Electronic Response with a Practical Yield) whose purpose is to teach interviewing techniques in psychotherapy. The program has been written to simulate a patient who is passive, uses denial to an extreme, and tends to ask for direct advice without taking any action. The object of the teaching device is to get the patient to respond in a manner more amenable to therapeutic intervention within the allotted number of patient-therapist interactions. The therapist codes his responses according to six types of content (e.g.., interpretation, requests for history information, rewarding statement) and his affect as either angry, annoyed, neutral, pleased, or satisfied. Rather than branching to two or more different patient responses based on a given therapist response, the program assigns probabilities to the various patient responses depending upon the content of the therapist's statement and his affect, and the number of therapist-patient interactions that have already taken place. The program is written so that the "patient" responds poorly or well depending upon certain rules of interaction that have been explicitly programmed. For example, interpretations given early in the interview or taking a supportive or sympathetic approach will produce responses characterized by denial, projection, and helplessness. The computer prints out the entire series of interactions.

Such a program might be of practical value if a library of clinical problems could be developed. Students would have the opportunity to practice their interviewing skills under similar and reproducible circumstances. In addition, programs could be altered so that the responses coincided with different theoretical views of optimal therapist-patient interaction. The use of such programs might help a therapist analyze his therapeutic approach in a situation that is less threatening than with a real patient.

Kahn and Tait have developed a system, CLAVICHORD (Closed Loop Audio-Visual Instructional Computer System to Help in the Observation and Recognition of Disease) that utilizes computer and audio-visual software to assist mental-health personnel in learning the basic clinical skills for recognizing the symptoms of emotional disorder. The trainee watches a live or video-taped patient interview, records his observations of psychopathology on a standardized rating scale, the Current and Past Psychopathology Scales. The data is immediately teletyped by the trainee or a clerk into a modem connected via telephone lines to a central computer. Within a minute, the trainee receives a comparison of his ratings with those of either the instructor, or a group of senior psychiatrists, and two types of diagnostic output, DIAGNO II output described previously, and output from a stepwise, multiple-discriminant-function analysis that gives several diagnostic alternatives and a probability statement for each. The student then sees a video-tape rerun of the original interview and evaluates how and why his scores differ from the standard. The system has the obvious advantages of immediate feedback, which allows the trainee to compare his judgments with those of an expert and to review the original stimulus on which he based his judgments.

Special Research Uses

Several new areas of psychiatric inquiry have been made possible by the availability of computer technology. We are not referring to routine or complicated analysis of research data, which has been made more feasible through the use of computers, but rather to areas of inquiry in which the computer’s capacity for analysis is central to the research problems being studied.

Just as computers have been used with great success to simulate complex physical processes in engineering and other physical sciences, so computers have been used to test working models of complex psychological processes, such as intelligence, personality, belief systems, psychotherapy, the differential-diagnostic process of clinicians, and interviewing strategies. The latter two have been discussed previously. A computerized-simulation procedure that accurately models events in the real world can be used to generate and test theories about complex phenomena. In the field of psychiatry there is no difficulty in generating new theories. Simulation, however, requires that theories be stated in a form that can be tested. If the input-output variables for the real world and the simulated model do not correspond, it suggests that the theory underlying the simulation model cannot be used to explain the real world phenomena.

Colby and his colleagues have worked extensively in this area. One example of their work is the simulation of paranoid information processing.

The program is designed to simulate a particular patient, a twenty-eight-year-old single man who works as a postal clerk. He has particular concerns and a specific delusional-belief system. He is eager to tell his story to interested and nonthreatening listeners. The program interacts with a human interviewer through teletyped natural language messages. The program interprets the input expression of the interviewer and produces internal (affective) and external (linguistic) responses that characterize the paranoid mode according to the programmed theory. With each communication, a series of variables such as fear, anger, and mistrust interact to determine the response to the next communication. Two versions of the model were developed, one more paranoid than the other.

The validity of the simulation model was tested by having a group of psychiatrists interview both versions of the "patient" and judge the output in terms of degree of paranoid behavior. In addition, a group of judges were asked to rate the level of paranoid behavior in the output of the computer and of a real paranoid patient. The results of these studies suggest that the simulation of paranoid processes was relatively successful.

Since psychiatric disorder almost invariably is reflected in some disturbance in communication, the study of various properties of language has been an area of inquiry long before the advent of computers. However, with computers, not only can many of the traditional procedures be automated, such as content analysis and measures of patterns of sound-silence in dialogue, but more sophisticated analyses are possible, such as the testing of mathematical models of conversational rhythm. The work of Jaffe and his colleagues demonstrates the potential of work in computational linguistics. Then work has developed along two lines. They have developed a system of "automated interaction chronography" whereby an on-line computer listens to social or psychotherapy dialogues and/or monologues and extracts various rhythmic parameters. These parameters have been found to be reliable, characteristic of a particular speaker, and yet systematically modifiable by emotional stress, delayed auditory feedback stress, psychoactive drugs such as LSD, amphetamines or marijuana, and by functional speech disorders such as stuttering.

They have also developed systems for automated content analysis of psychiatric interviews. The transcripts of the interviews are key punched. Then the computer categorizes and counts units of verbal behavior that are specified in advance. Based on these counts, indices are derived and are used to make low-level inferences about the patient's mental state. For example, the ratio of self-referring pronouns to total pronouns is an index of "interpersonal orientation." It has been found to decrease as patients improve and become less self-preoccupied and more socially related. The ratio of the definite article (the) to the indefinite article (a or an) is used as a measure of "specificity of reference." A high ratio indicated concreteness, and a low ratio vagueness.

One of the first uses of analogue-digital conversion of physiological data for psychiatric research was the analysis of electroencephalographic data. The advantages of automation include the possibility of handling large amounts of data for groups of subjects, the possibility of detecting small differences in records that are difficult or impossible to discern by visual inspection, and the savings of clerical time in measuring and counting records. Computerized EEG analysis has not, as yet, been of use for clinical diagnostic purposes.

An example of the research use of automated EEG analysis is a study by Hanley and his associates. Seventy-two-hour continuous EEG tracings were collected from a forty-eight-year-old chronic schizophrenic by using implanted electrodes. The patient had never been observed to have a temporal lobe seizure and frequent waking and sleeping scalp EEGs had always been normal. During the monitoring period the subject behaved in a number of bizarre ways, as he characteristically did when not being monitored. On the basis of detailed behavioral descriptions, samples of his behavior were classified into ten groups, eight of which were pathological and two of which were normal. Samples of the EEG readings taken during the different behavioral states were recorded on magnetic tape and subjected to comprehensive computer analysis in an attempt to define the EEG correlates.

Visual analysis showed no differences. However, using computerized spectral and discriminant analysis, it was possible to discriminate among the ten groups of behavior with 93 percent correct classification. In no instance was a bizarre behavior state misclassified as normal or vice versa. If such remarkable findings hold up under cross-validation, clearly the computerized analysis of EEG data will be one of the most powerful investigative tools in psychiatric research.

The field of human-evoked potential research only became possible with the introduction of small computers into the experimental laboratory. They were necessary to extract the small, evoked potential signal from the "noise" of the EEG by averaging at each point in time following many presentations of a stimulus. However, this early limitation of making only averaging available has long since been by-passed in many laboratories that have become concerned with trial-to-trial variability, as well as such subtle problems as the fact that similar components in different trials may not occur at the identical point in time following the stimulus. The problem of latency "jitter" has required cross-correlation techniques or cluster analysis, both of which utilize the wave form obtained in each trial in the processing. Such analyses have required much larger computers than the early averaging devices and the increased utilization of ever-larger computers is a major aspect of the direction of human-evoked potential research. In addition, investigators of evoked potential increasingly use the computer to run experiments, particularly in situations where the determination of the sequence of experimental events depends on the analysis of the data obtained from the subject during the experiment.

An example where more sophisticated computer analysis of evoked potential data contributed to the clarification of a research finding may be seen in the work of Callaway. He presented a series of two clearly discriminable auditory tones to normal subjects and schizophrenic patients. All subjects were told to ignore the differences between the two tones. The correlation between the two average-evoked potentials to the tones were found to be significantly lower in the schizophrenic than in the normal subjects. Presumably, this indicated that schizophrenics were less able than normal people to follow an instructional set to ignore the differences between the two tones. However, in a subsequent complicated computerized reanalysis, utilizing a stepwise discriminant analysis, it was shown that for the schizophrenics the differences among single trial evoked potentials were no greater when they were responses to the different tones than when two sets of trials were selected at random from responses to the same tone. Therefore, the earlier finding of lower two-tone correlations for the schizophrenic patients simply reflected the greater intra-individual variability in schizophrenic response.

Comment

Specific computer applications in psychiatry are increasing and there is every reason to believe that this trend will continue. The American Psychiatric Association recognized the importance of the major role that computers can play in all areas of psychiatry and appointed a task force to survey computer techniques in psychiatry, to evaluate the gains and losses entailed by automation of psychiatric data, and to make recommendations to the association. This task-force report discusses in greater detail many of the issues, such as confidentiality and computer-facilitated training, that are merely mentioned here.

Despite the progress made in computer applications in psychiatry, it is clear that computers have had a far more direct impact on patient care in other fields of medicine. An examination of the computer applications in these fields reveals some of the possible reasons for this discrepancy. Whereas there are numerous laboratory tests in clinical pathology that lend themselves to computerization, with the exception of the electroencephalograph there are few laboratory tests that are clearly relevant to differential diagnosis or treatment in psychiatry. Although the computer analysis of psychological tests has gained some acceptance, psychological tests, with or without computerization, do not play as important a role in psychiatry as do physiological tests in the rest of medicine. In a similar manner, computers have vastly improved the ability to monitor physiological functions of patients during and after surgery, in coronary-care units, and in other situations where close attention to numerous physiological variables can be lifesaving. While some aspects of psychiatric status lend themselves to analogous monitoring, there is obviously less to be gained from computerization because the consequences of changes in psychiatric status rarely involve a threat to life itself, and the variables that can be monitored are not as clearly related to needed intervention or to outcome as are the physiological variables in physical illness.

Computers are being widely used to assist clinicians in differential diagnosis and treatment in fields of medicine, such as neurology, hematology, cardiology, and radiology. These fields often deal with well-defined disorders that can be described with a relatively small number of variables, for which empirical data is available, indicating their relationship to diagnosis and treatment response. In contrast, in psychiatry we deal with disorders that are often poorly defined, and with numerous variables that lack consensual and operational definition. Furthermore, there is insufficient empirical data available indicating the relationship of these variables to diagnosis or treatment. Although, as noted previously, considerable work has been done on computerizing psychiatric diagnosis and treatment recommendations, it lags far behind the clinical use of analogous techniques in other areas of medicine.

One could argue that the very nature of psychiatric data precludes computer use because the variables in psychiatry are too complex and subtle. This is the view of many clinicians who believe that the crucial aspects of psychiatric disorder cannot be expressed in a form suitable for computer analysis. This view is based on the misconception that only "hard" data, such as age, symptomatology, and number of previous hospitalizations, can be coded for computer analysis. On the contrary, any concept that can be operationally defined, such as ego strength, positive self-regard, or empathic response of therapist, can be coded for computer analysis. We believe that the chief obstacle to computerization in psychiatry is not the nature of psychiatric data, but, rather, the relative lack of knowledge at this time regarding the relationship between psychiatric symptomatology, diagnosis, treatment, and course of illness. This lack of knowledge contributes to controversy as to what variables to computerize and as to the value of the computerized output itself. As psychiatry becomes increasingly based on actual knowledge, rather than on theoretical speculation, so will the value of computers to psychiatry increase.

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