Task Force Reports

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Robert S. Garber, M.D.
President, APA, 1970-1971

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AUTOMATION AND DATA PROCESSING IN PSYCHIATRY

A Report of the APA Task Force on Automation and Data Processing

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INTRODUCTION

The psychiatric profession is rapidly becoming cognizant of the major role that computers can, and undoubtedly will, play in all areas of psychiatry. In addition to the literature pertaining to their more established psychophysiological and logistical applications, a literature is now developing around the use of electronic devices in the clinical areas. In recognition of this trend, the American Psychiatric Association appointed a task force to: (a) survey the current efforts at applying computer techniques to the field of psychiatry and to evaluate the degree of success achieved by these efforts, (b) evaluate the gains and losses entailed by data automation in psychiatry (including an evaluative statement on case registries), and (c) recommend future action.

The task force has been aware of the profession's anxiety concerning the possible dehumanizing effects and threat to privacy posed by computers. It has also been aware of the vast horizons brought into view by these machines. As L. C. Payne has noted, the electronic digital computer is "the most versatile piece of apparatus ever invented, and its fundamentally different character in being powerfully relevant to cerebral activities rather than, as with almost all previous machines, augmenting muscular activities, inevitably means that it will have a profound and continuing role to play in many aspects of medical practice." In fact, Rome and others view the automation of significant segments of health services to be the next major step in medical progress. Despite this potential, most psychiatrists view the computer with suspicion and still discuss the possibility of the machines replacing the clinicians.

In the organization of this report, we have, therefore, decided to emphasize the potentialities of the computer and to survey the field by presenting the current status of computer usage under ten major topic areas: Computer Principles, Data Analysis, Data Banks, Automated Clinical Records, Assessment and Treatment Techniques, Simulation Techniques, Psychophysiologic-Laboratory Applications, Logistical Applications, Concept Exchange Systems, and Computer Facilitated Training. In each of these categories we have considered one or more of some fifteen relevant issues that need to be resolved if the benefits of the computer are to be realized: confidentiality, quality control, cost, legality, ethics, inhibition of creativity, acceptability, equipment, system reorientation, compatibility between systems, changes in role definition, impact on training, standardization of terminology, risk of system breakdown, and program or equipment obsolescence. Finally, we have discussed some of the more universal problem areas in computer usage and presented our major recommendations.

COMPUTER PRINCIPLES

Richard Stillman, M.D.

1. *Overview*

What is a computer? Essentially, it is a machine that processes information. In the past, machines have, by and large, been constructed to process energy, and the startling advent of information-processing machines has been seen by many as heralding a computer revolution of no less significance than that of the first widespread use of energy-producing machines (the Industrial Revolution). The computer does for men's minds what energy machines have done for their muscles: It frees them from drudgery while greatly magnifying their power.

Mechanical information processing machines have been used for centuries, from astronomical models used in calculating planetary motions to the abacus and the mechanical "adding machines." However, the explosive growth of modern computers awaited the large-scale use of electronics.

1.1 *Types of Computers — Analog*

Today's computers are of two types, analog and digital. Analog computers are special purpose devices used in the control or study of systems that vary continuously over time, e.g., the cardiovascular system. They represent quantities by voltages (called analogues), which can be transformed, added, integrated, and so on. Their use is limited to applications in which the system can be modeled well by the dynamic properties of electronic circuits. A number of physiologic control systems have been faithfully represented using analog computers, but these computers do not have much flexibility, and (of great importance to psychiatrists) they do not deal with symbols.

1.1.1 *Digital Computer*

The digital computer is badly named. It should be called a symbol computer, for it is equally at home with letters, numbers, and the odd symbols that grace the outer reaches of typewriter keyboards (and are often given special meaning in computer systems). In its heart the computer "knows" only "off" vs. "on," "yes" vs. "no," "one" vs. "zero," "O" vs. "X," and all information it receives must be ultimately converted (encoded) into this binary form. A letter of the alphabet is known to the computer only, for example, as "on-off-off-off-on-on-off-off" and a digit such as 9 as "off-off-off-on-off-off-on."* Looking at the vitals of a computer with a tiny bulb that flashes (X) for "on" and stays unlit (O) for "off," one would have great difficulty knowing whether numbers or letters (or something else) were being processed. A common misconception is that a computer reduces everything to numbers. It does no such thing; it encodes both numbers and other symbols in a more fundamental unit of information (the "bit"), which is sufficiently primitive to be usable as a building block for all written symbols (numeric, alphabetic, and otherwise).

2. *Programs*

The idea of a program is fundamental to an understanding of digital computers. A program is no more than a detailed, explicit sequence of commands which the computer is to execute in the order in which they are given. One of the key aspects of these sequences is that they may include contingencies: "If the sex of the person is female, then go to the menstrual part of the program; otherwise continue with next instruction." "If predicted anxiety score is within 10 percent of actual anxiety score, then print it out; otherwise reset anxiety antecedents and compute new predicted anxiety score." These instructions cause a computer to check, during a program, whether a variable fulfills certain criteria, and to branch to another part of the program accordingly. It is important to note that the actual branch to be chosen in any given run may not be (and usually is not) known in advance; it may depend on intermediate calculations (e.g., of predicted anxiety) made by the computer itself once the run is under way. This contingent branching gives the programmer much flexibility. Although the computer will not handle contingencies not anticipated by the programmer,

* If the reader is struck with the similarity (alliterative and otherwise) with a telegraph code, he has the right idea. The telegraph code is essentially a binary code, with silence and sound corresponding to the offs and ons.

it will vary its activity according to instructions specified in advance.

In what form does the program reside in the machine? In exactly the same sequence of bits (off-on, yes-no, one-zero elements) as the data. Once again, at this atomic level, our contemporary Diogenes with his electrician's light would find only sequences of off-on's in those locations of the computer containing the program. (Nor would the locations themselves be necessarily different from those, where on another occasion, say a thousandth of a second later, the data might be kept.) Just as the computer can distinguish, when told to, between a number and a letter, so it can distinguish instructions from data. To an outsider, to an electrician, it all looks like XOOXOXOO.

2.1 *Programming Languages*

Even very expensive and sophisticated machines are equipped only for a limited variety of elementary program steps. By suitable sequencing of these steps, however, enormous variety in programs can be achieved. A typical machine-level instruction might look like XOOXXOXOOX, and would be interpreted by the computer as "put" (translation of XOOX) the contents of memory location XOX into memory location OOX. Besides transferring information, instructions will erase information, compare information, do arithmetic operations such as add and multiply, and so forth.

2.1.1 *Advanced Languages*

One early improvement was the use of mnemonics to stand for the actual operation. A very great step forward occurred when programmers, tiring of the thousands and thousands of literal instructions that had to be painfully worked out for each problem, devised higher-level languages such as FORTRAN, COBOL, and ALGOL, and provided translation programs by which the computer could decode relatively few high-level statements into the relatively many detailed machine-language statements needed. So a FORTRAN program might contain the statement Y = X**2 + 3*X + 7, which would be equivalent to the ordinary algebraic statement $y = x^2 + 3x + 7$. The computer would be able to replace it with a multiplicity of atomistic statements of the sort, "get x, put it here, multiply it by itself, put the answer there, get x again, multiply it by 3, get what's there, add them together, put them there, add 7 to that, and assign that value to y," and so forth.

Further advantages await the user of a high-level language. Once he has written instructions such as those for calculating the "anger content" of a subject's words, he can embed this procedure in another part of the program (such as finding the frustration level) simply by "calling" his anger procedure, — i.e., he need only write the name of the program again without completely rewriting its instructions. Thus programs often become complicated hierarchies or webs with subtle interactions and complex dependencies among their parts.

2.1.2 *Types of Program Languages*

There are high-level languages tailored for many different types of users, and no one language is universally best for all applications. FORTRAN is algebraic, formula-oriented, and excellent for quantitative research. ALGOL has many stylistic advantages over FORTRAN, but it is not nearly as widely used. COBOL is a business-oriented language with many features related to dollars-and-cents procedures, inventory problems, and so on. PL/1, newly developed by IBM, may combine the better features of all these. SLIP, IPL/V and LISP are list-processing languages; i.e., they process lists of symbols and are extremely general and powerful languages for information-processing (as opposed to simple calculation). Virtually all successful modelling of intellectual activity has been accomplished with list-processing languages.

Programs are known as "software." The physical machines on which they run are collectively called "hardware." User demands for elegant, powerful, idiomatic, and simple programming languages necessitated the development of extremely complex translating programs (called compilers) as part of the development of new machines. For the first time, the cost of software development is actually beginning to exceed that of hardware.

3. *The Physical Computer (Hardware)*

3.1 *Input*

The computer is like a sessile organism, taking in information, processing it, and putting it out. It can receive information from several kinds of sources. Punch-card reader machines sense the positions in which holes are punched in cards (corresponding to letters and digits) and transmit this, card-by-card, to the computer. Like paper tape, the information is easily kept in visible form, but the speed of processing is slow. Information may also be kept on magnetic tape to be "read into" the computer on long reels of wide tape capable of holding as many as 100 million bits. This provides rapid input of data to the computer, although its usefulness is limited by the fact that to get to a given portion of tape may require an inordinately long time — up to four minutes! Finally, new time-sharing systems allow the user to put information into a computer through a typewriter-like terminal many miles distant from the computer. In all these input modes, the computer works vastly more rapidly than the information is put in, and so must be programmed to do its work in the sizable spaces between the arrival of batches of information; thus it may be working on one person's problems while storing the information from someone else's.

3.2 *Information Storage*

Computer memories may be divided roughly into fast and slow, internal and external. Fast internal memories ("core storage") are quite expensive to build, but afford very rapid input and output of information. They usually consist of magnetizable "donuts" strung in square grids, each capable of storing one bit of information. Magnetic disks, often stacked one above another like phonograph records, are considerably less costly per bit of information stored and are capable of holding much more information than core storage holds — but at the expense of slower retrieval. Even slower is magnetic tape, which the computer can use as an extension of its own memory; yet even this "slow" medium is slow only by computer standards. Millions of bits can be entered or read out of tape in a few minutes.

3.3 *Information Processing*

The "thinking" or "executive" part of the computer processes the actual data according to the instructions stored in its memory. Here the computer is extremely rapid, performing basic operations such as transferring data or comparing it or adding it, all in nanoseconds (billionths of a second). This part of the machine consists of a "control unit," which supervises the program sequence, and a "logic unit," which performs the individual calculations. With the capacity to perform a complicated sequence of millions of these atomistic instructions per second, the computer can do vast amounts of numeric or non-numeric calculating in a very short time.

3.4 *Output*

Finally, the computer needs a means of presenting the results of its calculations. In order to keep up with the vast speed of the computer, high-speed printers have been installed in most computer centers. If the output is needed at some future time as input to a subsequent computer calculation, the output may also be stored on magnetic tape or cards punched according to the computer's instructions. In some applications output might be presented on a remote teletypewriter or even on an attached videotube.

4. *Time Shared Machines*

Early computer installations expected users to arrive with programs and data, to submit both, and then wait for them to reach the computer (usually with a sizable queue intervening). The "turnaround time," which is the time between submission of program and data and the appearance of output, might be hours or days, even if only a single question was asked of the data and even if the computer had to spend only seconds on the problem. If an actual program were being written, the smallest error might invalidate the program causing another day's delay; often it would take weeks to correct all the errors in a new program ("debug" it).

This problem has been solved recently. "Time-sharing" computers allow interactive use by many users simultaneously. In reality, the machine is programmed to attend to each user briefly (say 1/20 second), do some work for the user during that period of time, and go on to the next user. This creates the illusion that each user has a whole computer at his command. Because users type in information so incredibly slowly compared with the central processing unit of the computer, complex calculations can be performed in the interstices of user input or output. This type of computer is particularly appropriate for most hospital and clinic uses; these uses require fairly prompt processing of all data sent to the computer and equally prompt replies from the computer (on a teletype or video display) to queries about the status of patients or services.

5. *Future Developments in Computers*

Advances are continually being introduced that increase the attractiveness and usefulness of computers. The miniaturization and integration of circuits makes the computer faster, more powerful, more complex, and more reliable. The cost of computation has been plummeting exponentially, a hundred-fold in the past decade alone, with no leveling off in sight. In addition to becoming steadily cheaper to use, computers are more and more accessible. Time-sharing brings immediate feedback to many users simultaneously. New programming languages come closer and closer to idiomatic English, reducing the need to state problems in awkward and arbitrary computer languages. The use of video terminals with electronic keyboards facilitates easy, instantaneous input to and display of output from a computer. Many have predicted that the computer will become a utility as ubiquitous as the telephone, and, indeed, more use is already being made of some existing telephone lines by computers than by humans carrying on conversations. The day when computers themselves will be able to speak (synthesizing sounds intelligible to humans) and to hear (recognizing the human voice speaking naturally) is already at hand, although present accomplishments are limited to small vocabularies and are quite expensive. Nevertheless, the trend will persist for computers to free people from all information-handling tasks that we can clearly anticipate, and, probably some that we cannot.

DATA ANALYSIS

Paul T. Wilson, M.D. and Anita K. Bahn, Sc.D.

1. *Definition of Subject Area*

Data Analysis involves all of the operations by which "raw" information about events is converted into new forms that permit better understanding, prediction, and control of those events. These operations may be divided roughly into two groups.

1.1 *Data reduction* involves operations by which information about a set of events or individuals is summarized in order to facilitate drawing conclusions about them. Data reduction — whether applied to events involving a particular individual or to groups of individuals — is extremely important in many facets of psychiatric practice and administration as well as in research. The major components of data reduction include the following:

1.1.1 *Data preparation:* Inspecting, editing, classifying, and arranging information for easy tabulation. If automated analysis techniques are planned, this also involves coding data and converting them to *machine readable form.*

1.1.2 *Tabulation:* Preparing displays or tables showing the number of events or individuals falling within a specified category (e.g., the same age group). *Cross tabulation* shows the distribution of events or individuals according to two (or more) aspects that they have in common (e.g., same age group and sex).

1.1.3 *Description:* Portraying essential information about the distribution of individuals or events in terms of various

statistical measures such as measures of central tendency (e.g., mean, median, mode), and of variability (e.g., standard deviation). These statistical processes may involve such sophisticated operations as multivariate and regression analyses to clarify relationships between different variables.

1.2 *Tests of Significance*

This involves estimating sample reliability (such as standard error) in order to (a) test for a significant (real) difference between two groups or (b) determine, with a certain confidence, the interval within which the true mean or other parameter of the universe is likely to be.

2. *Automation in Data Analysis*

The data analysis operations described above can be performed by various means: (1) manually, e.g., with hand tabulating cards or with cards that are marginally punched (McBee cards for key sorting); (2) semi-automatically, e.g., with cards that contain punched holes (Hollerith cards that can be read, sorted, and tabulated by electrical accounting machines with calculations usually performed on desk calculators); and (3) completely automatically, e.g., with data on Hollerith cards or in other machine readable form and with sorting, filing, tabulation, and computation done entirely by electronic computer.

2.1 *Automation in Data Analysis*

Computers should be used for data analysis only if it is cheaper and more efficient to do so. Availability of computer equipment, programmers, and "canned" (commercially prepared) programs are additional factors to be considered. The following issues are also helpful in determining whether computer operations should be used.

2.1.1 *Volume of data.* In general, the larger the number of events or individuals studied and/or the more information recorded about each one, the more efficient automation becomes. In fact, computers may be the only feasible means of handling large masses of data.

2.1.2 *Number of variables to be considered simultaneously during sample selection or computation.* Automated techniques are particularly useful for selection of cases or for analyses involving many variables.

2.1.3 *Complexity of computations.* Complicated computations having many component or repetitive steps are done far more efficiently with automated techniques. The digital computer is especially designed for such operations.

2.1.4 *Repetitiveness of data and of operations.* Because computer programs, once written, can be used repeatedly — even if minor modifications are necessary — automated techniques are most efficient when they involve repetitive and frequent data analysis operations that are comparatively stereotyped (e.g., preparation of annual reports).

2.2 *Input and Output Operations*

Data analysis is a component step in almost all of the computer applications described in other sections of this report: It is impossible to give examples of input or output *content* to computers without duplicating large parts of those sections. Consequently, we will list a few of the input and output *operations* in which computers can greatly facilitate the initiation and the communication of the data analysis process.

2.2.1 *Input*

2.2.1.1 *Editing.* Computers can be programmed to perform a preliminary analysis of incoming data for obvious errors. (Example: Detecting the inconsistency of the report of the 20 year old patient on a geriatric ward.) (See section on data banks.)

2.2.1.2 *Matching.* Computers can apply various probabilistic rules to ensure that incoming data are merged with comparable data in their files. (Example: Merging data about Thomas Jones of Chicago with data about Tom Jones of Cook County, Illinois when the street addresses are identical.)

2.2.1.3 *Organizing.* Computers can automatically file incoming data in ways that facilitate subsequent analytic procedures. (Example: Preparing a long "longitudinal" or "chronological" file of events about an individual, filing quantitative data in ascending order for subsequent computation of the median of the distribution, etc.)

2.2.2 *Output*

Computers can issue the results of data analysis in three major ways:

2.2.2.1 *Traditional presentation.* Output can be displayed or printed without comments. (Example: Traditional automated records, statistical tables and accounting reports, statistical summary measures, city maps showing psychiatric admission rates for each census tract, etc.)

2.2.2.2 *Alerting.* The products of data analysis can be presented in such a way as to alert someone to a situation requiring his action. (Example: Patient progress report alerting therapist to dramatic change in behavior suggesting impending suicide, property report that underlines stock items in critically low supply, etc.)

2.2.2.3 *Implementation.* The product of data analysis can automatically initiate a response without any human intervention. (Example: Automatic operation of artificial pacemaker following prolonged asystole, automatic preparation of reorder forms for stock items in critically low supply, etc.)

2.3 *State of the Art*

2.3.1 *Current Usage*

2.3.1.1 *Hardware.* Many desirable data analyses are still impossible because of limited core capacity in most computers. This capacity is increasing rapidly as miniaturization techniques and storage materials are improved.

Input operations — traditional bottlenecks in data analysis — are now quickened by such innovations as optical scanning devices and direct, correctable keyboard-to-magnetic-tape typewriters. However, input is still a major problem. Ordinary typed or handwritten material cannot be put directly into the computer without intermediate processing, and even punched card input is painfully slow when compared to other computer operations such as computation and printing.

Filing of incoming data and subsequent file-updating has improved dramatically in the past decade because of random access (non-sequential filing) techniques.

Access to computers and availability of open computer time is improving through the use of multiple access (time sharing) computers and remote terminals for both input and output. These developments are doing much to reduce the machine cost of automated data analysis by making it unnecessary for each research or clinical facility to buy its own computer and do its own programming.

2.3.1.2 *Software.* "Canned" (commercially prepared) programs for many routine computer operations — especially mathematical and statistical processes — are available from many firms. This, together with improved input devices, is doing much to

reduce the personnel costs of automated data analysis. However, data-filing, processing, and some analytic operations, because of the specificity of the data being filed, usually require specially written programs. Lack of standardization of data forms and of hardware increases the cost of software (programming).

2.3.2 *Projected Usage*

2.3.2.1 *Hardware.* Computers with large core capacity will permit larger numbers of variables to be manipulated simultaneously.

Automated input operations will largely supplant paper-using procedures as the costs of remote terminals diminish and the capacity of multiple access computers increases.

Transmission costs (between remote terminals and large multiple access computers) will probably diminish as heavier usage causes all levels of government to view transmission networks increasingly as public utilities and to underwrite the construction of trunk and feeder lines that can be leased at low cost.

2.3.2.2 *Software.* Programming probably will continue to be a major bottleneck in terms of operating costs, personnel shortages, and operating time. However, simpler, more versatile programming languages and standardization of equipment and data forms offer hope for reducing this problem.

3. *Special Issues Relevant to Data Analysis*

3.1 Need for psychiatrists to have at least minimal training in data analysis.

3.2 Need for psychiatrists developing data analysis programs to enlist consultative support from nonpsychiatric experts in such areas as experimental design, statistics, computer programming, and design of input documents.

3.3 Shortage and expense of personnel who can program computers.

3.4 Need to maintain confidentiality of data about individuals.

3.5 Need for accuracy, completeness, and quality control in preparing data for analysis.

3.6 Need for more standardization of record forms and coding systems to maximize compatibility between various data gathering and analysis systems and thereby to reduce costs of cooperative operations greatly.

3.7 Enormous expense of establishing local computer centers.

4. *Recommendations*

4.1 Give psychiatric residents at least minimal exposure to data analysis experiences having some of the following characteristics:

4.1.1 Stress on data analysis as a preliminary to problem solving (both clinical and administrative).

4.1.2 Exposure to rationale and general methodology of psychiatric epidemiology.

4.1.3 Supervised experience in analyzing locally available data for answers to meaningful, previously unanswered questions.

4.1.4 Experience in designing operational documents (e.g., patient records, administrative intake forms, etc.) with a view to subsequent data analysis operations.

4.1.5 Some familiarity with modern data analysis technology, at least enough to permit meaningful conversations with programmers.

4.2 Encourage psychiatrists embarking on projects that involve data analysis operations to identify and establish consultative liaison with local individuals and organizations experienced in such operations as experimental design, statistics, and input-document design.

4.3 Encourage the identification and use of "canned" programs that can be adapted to individual analysis programs with minimal programming time and expense.

4.4 Encourage operators of projects that analyze data about individuals to familiarize themselves with available techniques to maximize confidentiality.

4.5 Encourage psychiatrists developing data analysis systems to train professional and clerical staffs in the importance of complete and accurate recording of data.

4.6 Encourage the greatest possible standardization in psychiatric record keeping and coding.

4.6.1 Encourage local institutions to cross reference their patient code numbers with Social Security numbers.

4.7 Encourage psychiatrists embarking on large data analysis operations to consider alternatives to establishing new computational facilities locally (e.g., by using remote terminals; by renting facilities from local industries, governments, universities, or hospital accounting departments; by mailing data to remote centers for batch processing, etc.).

DATA BANKS

Elmer A. Gardner, M.D. and Anita K. Bahn, Sc.D.

1. *Definition*

"Data bank," in its most broad usage, refers to storage and retrieval of any bits of information about persons, groups, transactions, events or environmental features (usually with the aid of electronic devices). Thus, in a general sense, it can encompass all computer data uses (e.g., automated clinical records, concept exchange systems, logistical support systems). In a more restricted sense, data bank refers to information that is (a) pooled from multiple sources, (b) summarized or coded, and (c) used for statistical purposes primarily. The stored information may be used for (a) service (clinical — administrative) or (b) investigative — heuristic purposes.

1.1 *Single-Source Banks*

Files of nonlinked separate reports about events, persons, groups or environmental phenomena (e.g., storage of vital statistics such as birth or death records, census of population, housing, farms).

1.2 *Multiple-Source Banks*

Cumulative or linked files in which separate reports about a person, group, or event are brought together. "... two or more items of information recorded at different times about a person may, when considered together, be of greater significance than when either is considered in isolation." This section will concern itself largely with multiple source banks such as case registers because, in recent years, considerable controversy has centered on this type of data bank.

1.2.1 *Case Registers*

Linked files of statistical records on individuals who have been identified as cases, i.e., as patients or clients. The cases are selected on the basis of some common diagnostic or operational criteria (e.g., admission to a psychiatric facility after July 1, 1961). Usually residence in a specific county, state, or other defined geographical area is also required (community case register). The register is updated by reports of new events and/or by periodic collection of follow up information.

2. *Input*

2.1 *Content*

Input information consists of one or more of the following:

(a) Date of reporting

(b) Date of event or transaction

(c) Description of the event, transaction, or person. Usually this information is recorded in a standard way and/or coded.

(d) Identifying information about the individual or group to permit linkage with other records (e.g., name of individual, birthdate, Social Security number, address, mother's maiden name).

2.2 *Method*

Input procedures might utilize one or more of the following:

(a) keypunching onto cards or punched tape → Magnetic tape

(b) optical scanning of precoded cards → Magnetic tape

Magnetic tape ⟷ Computer storage

(c) writing on visual displays → Computer storage

(d) typing on remote terminals → Computer storage

(Direct* on-line communication)

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* Data transmittal must be sufficiently rapid to cope with data at the rate at which it is produced (real time).

2.3 *Quality Control*

GIGO, a computer-wide acronym for "garbage in, garbage out," warns that quality of computer output can be no better than quality of computer input, i.e., missing and invalid data stored in the computer are not improved by computer processing. Steps must be taken to insure that new reports are edited before being stored, that reports have been obtained from all reporting sources, that cumulative records are consistent and current, that sufficient identifying information is recorded where linkage is required, etc. In record linkage systems the updating process (adding data to an existing machine record) particularly requires quality control checks and the ability to identify an individual or his group membership, i.e. family.

2.3.1 *Role of computer in editing*

The computer can help control and edit raw input and stored information by rejecting input with:

(a) missing data

(b) inconsistent or contradictory data
- —within the same report (e.g., birthdate and age)
- —between different reports or different parts of a cumulative record (e.g., verifying that dates of two events are in logical sequence)
- —by listing records for persons or events in which more information is required (e.g., listing psychiatric outpatients for whom termination reports may be due)

The computer lists these inconsistencies and questionable items for clerical review and other query. It is then a simple matter to introduce the correct information.

3. *Output*

3.1 *Content*

The computer product ranges from print-outs of the raw (unedited) data to various sorted, summarized, and otherwise modified forms including a narrative print-out of the coded data, arithmetic mean, graphs, etc. Potential output varies with the type of data bank.

3.1.1 *Single or multiple unlinked events*

(a) *Listing of events or narrative.* The items may be printed on the form received, or their usefulness may be enhanced by computer processing (e.g., coding of census tract, calculation of number of days on the hospital rolls).

(b) *Summary of events.* Enumeration and tabulation of all events during a time period (e.g., number of admissions by census tract, average length of hospital stay for discharged patients).

3.1.2 *Multiple linked reports* (e.g., case register)

The linked report system can provide the following types of longitudinal information:

(a) *Listing of events for one individual.* All psychiatric episodes for each individual listed in chronological order.

(b) *Summary of events for one individual.* Tabulation of patient's cumulative number of hospital admissions and bed days. A further level of abstraction is the patient's probability of readmission during the next 12 months based on life table techniques.

(c) *Summaries of individuals* (person-statistics). Linked records yield *unduplicated* lists and counts of individuals admitted to any psychiatric facility during the year. If the register pertains to a defined geographic area, rates of admission are obtained by dividing the unduplicated patient counts by the population count.

(d) *Summaries of groups.* Linked records maintained for groups, such as a family, yield family statistics (e.g., number of three-person families with all members under psychiatric treatment).

3.1.3 *Selection of a sample*

Events or persons may be selected from the data bank for special studies. Thus, hypotheses suggested by the routine data in the bank can be investigated in depth by clinic or field study or further analysis of stored data.

3.2 *Method*

The media of output varies with the computer equipment.

(a) Print-out of lists, tables, or graphs on sheets of paper or cards.

(b) Visual (TV) display

Both may be produced either at a central console or at a remote terminal.

3.3 *Time Factors*

The time elapsed between a request for a report and its production varies with the nature of data bank and files, complexity of computer processing required, and availability of programs. Large volumes of data and cumulative records of variable length (not uniform) tend to delay output. Random access discs and electronic display devices tend to shorten output time.

3.4 *Quality Control*

Computer output, like input, must be carefully monitored for completeness and accuracy. Errors can occur in specifications given to the programmers, in the writing of the programs, or through machine failure. Output totals must be compared with input totals, various cross checks made, and the results inspected for reasonableness.

4. *Confidentiality*

Concern for the protection of personal privacy and the security of the data from misuse are inherent in any bank containing information about identified or potentially identifiable individuals. The Panel on Privacy and Behavioral Research noted that "The right to privacy is the right of the individual to decide for himself how much he will share with others his thoughts, feelings, and facts of his personal life." This panel noted the conflict within our society between the right to personal privacy and the right to know anything that may be known or discovered about any part of the universe.

4.1 *Factors Affecting Confidentiality*

Ethical issues and need for safeguards will vary depending upon the purpose of the register and certain other factors:

4.1.1 *Purpose of the data bank*

(a) *Research.* Here, confidentiality is less of a problem if the objective of research only is adhered to strictly. In such cases, relatively few persons have access to the data, and individual identity is rarely used. Voluntary participation is more often feasible than in data banks used for administrative purposes.

(b) *Clinical-Administrative.* As noted by Dr. Howard Rome, the growth of the corporate structure of medical practice, with the increasing difficulty in integrating the subsystems of this structure, has created scientific, political, and economic pressures that are forcing the medical establishment into electronic data processing. Clinical-administrative needs are producing the most pressing demands for data banks, and it is here that the issues of confidentiality and privacy must be faced. Although summary statistics are often the primary focus, information about specific individuals may be desired for optimum case management and/or administration. Thus, this type of data bank raises more ethical issues and requires greater safeguards.

4.1.2 *Other Factors*

Concern over adequacy of safeguards and resistance to reporting will increase as:

(a) the number of reporting sources, and therefore possible linkages, multiply

(b) the number of potential users increases, and

(c) the "distance" increases between the reporting source and the agent responsible for the data bank.

4.2 *Safeguards for Confidentiality*

4.2.1 *Ethical.* Professional responsibility.

4.2.2 *Technical.* Special keys or access to locked files; separation of statement and identification files using special codes to link them; use of scrambled identification data. Separation of data banks that are potentially linkable may be maintained by special keys, etc., for linkage.

4.2.3 *Legal.* Special statutes to protect the reporting psychiatrist from suit and the records from court subpoena, to specify the use and the users, and to provide penalties for abuse of the system.

4.3 *Summary*

The individual has a right to health and effective medical care, as well as to privacy. Therefore, concern for confidentiality of the data must be balanced with the need by society, often in behalf of the individual, for knowledge that can be obtained in no other way. As noted by some, all change is resisted, particularly when it imposes external demands for the kinds of radical reform that data banks will impose on the delivery and utilization of medical services. In addition, as with every technological advance, there are attendant dangers, e.g., certain data become more accessible and may be used by individuals or government departments for uses not in the patient's interest. Thus, there will be irrational as well as rational resistance to the development of any data bank. We also should recognize that, in many instances, the anonymity that some people struggle to protect is more myth than reality, and that many patients will tend to have less concern about privacy than some professional workers.

5. *Factors Affecting Cost*

The costs of some data banks, especially those with record linkage, may be prohibitive. Factors contributing to high cost and inefficiency are:

5.1 *Inadequate Identifying Information*

A unique person-number is an aid in linking all records for the individual. The Social Security number is widely used for identification, e.g. college students, Medicare recipients, members of the armed forces, veterans, etc., but is not universal

and is not always reported to the data bank. Psychiatric facilities should routinely request this number to improve their record systems.

5.2 *Lack of Standard Systems*

To permit greater sharing of computer programs and to facilitate cooperative studies, more standardization is needed nationwide. This would include (a) uniform categories and codes for a core of demographic, diagnostic, and service items, (b) standard computer file arrangements, and (c) standard computer hardware.

5.3 *Inadequate Number of Users*

A larger number of users will distribute costs and make the total effort worthwhile. Unfamiliarity with the potential uses of the bank and with research methodology contribute to underuse of this rich resource for advancement of psychiatry.

6. *Current Status of Case Registers*

The departments of mental health in many states maintained multiple source data banks for many years, but did not make extensive use of these files as case registers until the advent of electronic data processing techniques. In the state systems, reports usually have been received from all state supported inpatient facilities and, with less completeness, from most or many outpatient facilities. Electronic devices have simplified the pooling of data for each individual patient (case) and the production of summary statistics for groups of patients and/or facilities.

Case registers utilizing electronic data processing devices have existed for more than ten years in the State of Maryland and in Monroe County, New York. Comprehensive reporting systems have been initiated in Missouri and New York to obtain demographic, socioeconomic and clinical data for each case. Similarly, Rockland State Hospital in New York, with NIMH support, has initiated a comprehensive case register as a pilot program for all the state hospitals in several Northeastern states. The limited number of psychiatric case registers extant in this country* and the several abortive attempts at maintaining case registers (e.g., Tri-

* The only psychiatric case registers outside of this country are to be found in the Scandinavian countries, Yugoslavia, England, and Scotland.

county North Carolina register) indicate that the obstacles, cautions, and cost in developing and maintaining such an operation are not to be ignored. At the time of this writing, it may be fair to say that psychiatric case registers still represent more a potential rather than an actual administrative and/or research tool.

7. *Problems and Benefits of Case Registers*

7.1 *Problems*

Since a case register represents one form of a multiple source bank, it is evident that cooperation must be secured from several, and often varied, reporting sources. Private practitioners and the staffs of reporting facilities may object to the time involved in completing reporting forms and may openly verbalize their aversion to the explicit or implicit surveillance of their practice. Reporting personnel may have reasonable concern about the ethical aspects of such a system and the potential threat to patient privacy and safety. Finally, resistance to reporting will occur if there is vagueness and/or confusion in the stated objectives of the case register, in the criteria for distinguishing a case, and in the definitions of items on the reporting form, e.g. what is meant by residency within a specific area, diagnostic terminology, and distinctions between patient status such as "inpatient" vs. "outpatient."

It may be difficult to achieve standardization of terminology between reporting sources for any one case register and between case registers. This obviously limits the usefulness of the register(s). In this country data reported for person identification also may vary considerably from one facility to another and one area to another, increasing the risk of misidentification. The mobility of our population makes it hard to trace patients in their movement between facilities and/or areas and, thus, detracts from the usefulness of the register for longitudinal studies.

The cost of program development, particularly, and to a lesser degree, maintenance operations of a case register are still usually prohibitive for an individual locality. Accessibility to a computer with sufficient core capacity might also limit localized usage. The development of standard data processing programs and the use of remote terminals are gradually reducing these obstacles. Perhaps a greater problem for smaller facilities or localities is the scarcity of personnel with adequate knowledge of psychiatric networks, data processing techniques, and data analysis to minimize the error level in developing and maintaining the system and to utilize the data appropriately.

In those case registers that have been operational it has proven difficult to obtain a sufficient number of knowledgeable users to justify the costs of the system. Commonly, the amount of actual and potential output overwhelms the few people involved in the development and maintenance of the register.

7.2 *Benefits*

The potential benefits of a case register are many and only a few will be noted here. First, it should be noted that some case registers can be simply an elaboration of an already existing reporting system for a governmental agency, i.e. state mental health department. A register provides unduplicated patient counts and thereby provides improved survey and management of a psychiatric network. The movement of patients between facilities and/or services and the course of contact with the network can be easily studied for individual patients or groups of patients. With the movement toward decentralization and increasing variety of services, this kind of data assumes greater significance. In addition, summary statistics can be obtained in which any data in the register can be cross matched against any other data to provide profiles of patient populations or service patterns that would otherwise not be available and that may prove helpful clinically or administratively. A register could be used for better patient management by providing an immediately available clinical record of the person's prior contacts with any of the services in the psychiatric network.

A case register may be particularly useful as a method for evaluating mental health services, either by utilizing data in the register or by utilizing the register as a source for sample populations to be studied more intensively. The register could serve as the foundation for development of a more comprehensive system of quality control. In addition, output from a register may provide many clinical leads or hypotheses and this, with its use as a source of sample patient populations, can make a case register a valuable clinical and/or experimental tool.

AUTOMATED CLINICAL RECORDS

Ulett, George A., M.D. and Spitzer, Robert L., M.D.
with assistance from
Sletten, Ivan W., M.D.,
and Endicott, Jean, Ph.D.

1. *Definition*

The term "automated clinical records" refers to the recording, storage, and retrieval of information about patients in a form available for processing by electronic or mechanical devices. Today, the term generally implies the use of computer systems. Several systems with multiple facilities linked to a central computer now exist, or are being developed, which involve either single hospitals, individual states or several states. In some systems the traditional clinical record is unchanged, and the information is simply stored or first coded and then stored in the computer. In others there is no paper record or chart, and information is transmitted directly from and to the clinician by his interacting with a terminal device connected to a computer. In these systems, a permanent copy is generated only when needed, as in communicating with another facility.

2. *Input*

2.1 *Type*

The information that enters the system (input) can be introduced in a number of ways. The information can be in narrative form as a direct statement or, more commonly, first converted into precoded categories. The latter can be 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; any concept that can be defined can be translated into a precoded form.

2.2 *Processing*

There are many methods for getting information into the computer, including key punching from a narrative or any type of data form, optical scanning of specially designed precoded forms, typewriter console, and visual display devices (cathode ray tubes) that can receive information through a light pen or by physical contact with the finger of the person supplying the information.

3. *Sources of Information*

Automated clinical record systems facilitate the use of information collected directly from the patient himself, from family members, or from other informants by means of precoded questionnaires. In addition, they lend themselves to the collection of certain kinds of information by trained technicians, thus saving professional staff time.

4. *Storage and Retrieval*

The more commonly used systems permit storage of the data in a central data bank, which can consist of either cards, magnetic tape, or disks that permit rapid access to individual records. In the latter case, it is possible at a terminal to obtain immediate information about a specific aspect of a patient's condition or status.

5. *Output*

5.1 *Type*

For some systems the input document, or a copy, also serves as the definitive medical record. In most systems, however, the computer generates a report that can either serve as a permanent printed record, which becomes the medical record, or the information is shown on a visual display device. The information can be presented in narrative form (even though the input information may have been in coded categories), as a listing of the information. If the input is numerical, it can be presented as scale scores or graphs.

The output information for a given subject can contain more data than was present in the raw input data. For example, output information may contain change scores over time, comparisons with other groups of patients, and suggestions for patient care based upon the comparison of this patient with previous patients given a variety of treatment modalities. (This latter use is discussed under Assessment and Treatment Techniques.)

5.2 *Processing*

The same methods are utilized for output as for input. The output can involve individual patients or groups of patients, as for example, patients from a given ward or from a hospital with certain demographic features, etc.

6. *Use of System*

6.1 *Clinical*

Automated clinical record systems can replace the traditional system of record keeping so completely that there is virtually no information on the record that is not available for electronic processing. At the other extreme, the system can be added to an existing traditional system. For example, the clinician might fill out a mental status automated form in addition to dictating his usual mental status examination. However, this kind of double work is always resented. Most likely, future automated systems will replace portions of the clinical record, while still permitting additional comments and information that is not in a precoded form. For example, the clinician may wish to add additional information to supplement the precoded mental status examination. Some systems permit this information to be entered as narrative (via a typewriter) through the computer terminal. Other systems permit the clinician to write some comments that will be part of the medical record but that are not available for computer processing.

6.2 *Research*

For a variety of reasons, the traditional clinical record is practically useless for research purposes. If the information supplied to an automated clinical record system is of sufficient

reliability and validity, the research potential from these systems is staggering. On the other hand, if the terms are poorly defined, or the informants poorly motivated to give good information, the research value of such systems obviously will be lessened.

7. *Rationale for Automation*

There are several reasons why there is considerable pressure to automate the traditional method of recording psychiatric case records. Automation can reduce the clinician's time in getting information into and out of a record; it also simplifies information retrieval for an individual patient or for summary data about groups of patients. An automated record keeping system can also provide the clinician with data not usually available to him from traditional clinical charts and, thus, help him with decisions about the patient's diagnosis, management, and treatment. Finally, information from an automated record keeping system can be of great value to the administrator or researcher, who usually has great difficulty retrieving information from traditional clinical records.

8. *Issues*

8.1 *Confidentiality*

The issue of confidentiality relating to data banks in general is discussed in another section of this report. Although automated systems create problems in the protection of confidentiality, many have pointed out that current nonautomated clinical record systems are far less than foolproof. It is sometimes possible in hospitals for various persons to have ready access to the confidential clinical information by merely presenting themselves and requesting the patient's chart. With an automated system it is more feasible to put reliable safeguards against such access by unauthorized individuals. This can be done (1) by using assigned code numbers or various physical characteristics detected by sensing devices to identify individuals who are authorized to have access to the system and by permitting only certain types of information to be entered or referred by specifically designated staff members, and (2) by limiting the accessibility of certain kinds of data to certain terminals (e.g., business office terminal can not have access to psychiatric history information).

8.2 *Legality*

Data entered through precoded systems can be considered a legal medical record entry if the identity of the person entering the information is noted and if the person making the entry has been authorized as responsible for the patient's care.

8.3 *Training*

Opinion is divided about the impact that the use of precoded standardized forms will have on the training of clinical personnel. Some feel that training will be improved because of increased attention to definition of terms, comprehensiveness of coverage, and the results of instruction in the use of the specific forms. Others feel that training will be adversely affected because of the inhibition of spontaneity and creativity both in the interaction with the patient in obtaining the information (e.g., trainees will only observe what is on the form) and in becoming too dependent on the form for structuring of thinking. It may well be that in some settings the training will deteriorate, but in most settings it will be improved. The best way to avoid a negative effect on training is to develop and use forms that encourage clinicians to make careful and pertinent observations rather than merely to record preconceived notions into stereotyped categories. In addition, we caution against limiting training programs to teaching student psychiatrists how to complete standardized forms.

8.4 *Standardization of Forms*

Standardization of forms and computerization go well together — the former makes processing easier, the latter acts as a reinforcement for the administrative edict to standardize. There are many advantages to standardization. Findings can be more easily compared between centers, and development of items and forms can be facilitated with a reduction of costly duplication of effort. As a variety of output reports are developed, they can be more widely and generally disseminated. For example, as the data base is analyzed to provide computer aided suggestions regarding patient behavior and outcome, these suggestions can be made generally available.

Complete standardization of all items and forms is probably not possible and may even have some disadvantages. Some items will not be of use as significant predictors of behavior. Also, since patient populations differ from institution to institution, some items may be more useful in one setting than another. Finally, even in the most definitive system, forms must be left open-ended. It will be necessary to search constantly for new items that carry more information and are better predictors.

At this time, however, a set of core items satisfactory to most centers could probably be established. As one example, there appears to be considerable overlap from one center to another regarding the mental status items.

With administratively independent organizations, it will not be easy to standardize. Geographically separate workers do not regularly have the opportunity to exchange views, to discuss common problems meaningfully, or to discover that others are working on these problems. Collaboration on forms will then involve travel for which funds may not be available. Institutions and administrators may have trouble getting their own organization to accept forms from outsiders. Also there is a pride of ownership in building one's own system, a psychological reward not easily put aside.

In order to facilitate collaborative efforts toward standardization, the APA could establish a committee to assist centers toward this goal.

9. *Cost*

At present, automated record keeping systems are expensive. Even the cheapest systems are more expensive than the existing ones that they replace. However, the additional cost can be justified by considering their greater potential for improved records, improved patient care, savings in professional time, and value for research. Also standardization of forms, procedures, programs, and equipment will eventually reduce costs and increase the benefits.

ASSESSMENT AND TREATMENT TECHNIQUES

Robert L. Spitzer, M.D.,
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with the assistance of
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1. *Assessment*

The use of automated procedures has already drastically changed the field of individual patient assessment. The speed and memory capacity of the computer greatly facilitates the processing of many traditional assessment procedures. In addition, newer techniques make use of the unique advantages of computers to investigate areas of functioning that were difficult or impossible to evaluate without automation. There are now numerous automated assessment procedures available to evaluate such diverse aspects of an individual's functioning as current and past manifest psychopathology, personality traits, ego functioning and cognitive abilities.

For several decades clinicians and researchers have made use of standardized procedures as an aid to individual clinical assessment. These procedures have included questionnaires, rating scales, and check lists, which can be completed by the patient himself, a trained professional (e.g., psychiatrist, nurse, attendant) or some other informant (e.g., family member, friend). In the past, because these forms had to be scored manually, their processing was generally time consuming and prone to error. In addition, data analysis was usually limited to simple scale scores. With automation, scoring can be accomplished rapidly and without error. In addition, the same data can provide more detailed reports, taking advantage, for example, of the ease with which the computer can compare an individual's scores with scores of other known groups.

1.1 *Automation of Traditional Techniques*

An example of the impact of automation on a traditional as-

sessment technique is the automation of the Minnesota Multiphasic Personality Inventory (MMPI). This self administered checklist used to require tedious hand scoring. There are now several automated versions of this test currently in use. The psychiatrist can have his patient complete an MMPI on special forms which are sent through the mail to a central computer facility, and within a few days the results are returned to the clinician. The output from these automated procedures contains not only the traditional MMPI scale scores, but also an interpretive description of the patient based upon complex comparisons of the patient's scores with those of known patient groups. This narrative is similar in appearance to that written by a skilled clinician who has considerable experience and knowledge of test results with different kinds of patients. It differs, however, in that the rules of inference are explicit and easily modified with new data, and the report can be based on many more patients than any individual clinician could ever hope to test. The cost of these automated procedures is already low as compared to the cost of an experienced test interpreter. In addition, many psychiatrists can use this procedure in a locality where there are no facilities for having a patient evaluated by a tester. Although opinion is divided as to whether the automated narrative sections of these reports are better or as good as those written by a human interpreter, many psychiatrists are now making use of these automated MMPI interpretation services and are apparently finding them of value.

1.2 *Diagnostic Assessment*

Several automated procedures for classifying patients, either in the standard diagnostic categories, or with other typologies, have been developed. Various models have been employed including various mathematical procedures as well as a logical decision tree similar to the logic of differential diagnosis. Both procedures have yielded computerized diagnoses in substantial agreement with diagnoses made by clinicians on the same cases.

1.3 *Interaction with Computer*

1.3.1 *Interview techniques.* In some of the new assessment techniques still in the developmental phase, the patient interacts directly with the computer (on-line). The patient may provide answers to various questions posed by the computer (through a typewriter or video screen) regarding his psychiatric symptomatology and history. The advantages of this procedure over having the patient answer written questions on a questionnaire is the ease with which a particular response can cue the computer to branch to a line of inquiry relevant to that particular patient. A corollary feature is that areas of inquiry that are irrelevant to the particular patient can be omitted.

1.3.2 *Cognitive assessment.* Other new assessment techniques involve on-line evaluation of cognitive functioning. For example, the traditional mental status test of recent memory, where the clinician recites a list of digits and asks the patient to reproduce them forward and backwards, can be done more accurately, more reproducibly, and therefore, more meaningfully by computer than by individual clinicians. Reaction times can be routinely measured for each response, without the patient even being aware that this dimension is being evaluated.

2. *Treatment*

A number of facilities are exploring procedures for using automated assessment techniques for the assignment of patients to treatment. For example, on admission to the hospital, a clinician's description of the patient's symptomatology can be used by a computer program to suggest the optimal treatment modality. Subsequent ratings by many different staff members can then be integrated and used to monitor the patient's progress and to suggest modifications in the treatment program. A computerized monitoring system can detect relationships, trends, and patterns that might otherwise remain undetected.

2.1 *Evaluation of Treatment*

The research evaluation of various treatment programs is greatly facilitated by automation. It is possible to process large amounts of data using sophisticated statistical procedures

that would be difficult or impossible without computers. Examples include such techniques as analysis of covariance (which takes into account initial level and relationship between pre-treatment and post-treatment scores), and factor analysis (which reduces a large universe of items into a smaller and, thus, more manageable number of dimensions). In addition, the automation of clinical records is providing researchers with a data base that they never had available to them in the past.

2.2 *Computer as Therapy Assistant*

In addition to supplying information relevant to treatment assignment or evaluation, computers can be used as active participants in therapy. Computers have been used in the treatment of autistic children. For example, a computer can respond to the child's increasing vocalizations with interesting displays of visual and auditory material. Computers have also been used in the administration of behavior therapy to patients with phobic disorders by a programmed presentation of fear items.

Recent work in computer use of natural language, in which the computer generates its own sentences, has been used in experimental interviews and suggests the possibility of computerized therapy modeled after the more traditional verbal type of psychotherapy.

SIMULATION TECHNIQUES

Joseph R. Marches, Ph.D., and
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1. *Definition and Example*

A simulation is a "working model" of a complex process. It is constructed to increase our understanding of the process being simulated. Often, in addition, it is used to predict, and sometimes to actually replace the more complex process in certain situations. The first simulations used mechanical models, such as plaster models of river beds to simulate floods, in order to predict and understand their occurrence. Nowadays very sophisticated and complex modelling can be done with computer programs in which the outside world is represented event-by-event by far more rapid changes inside the computer. This affords much greater speed and flexibility; many more assumptions and combinations of circumstances can be entered in the computer and their consequences quickly ascertained. A reasonably sophisticated simulation of a therapeutic dialogue or of a human personality, for example, might require the processing of millions of logical operations, even though the number of initial assumptions would be far smaller. The computer is thus a tool akin to a scratchpad, on which simulation depends for purely practical reasons.

An example, taken from the psychiatric literature, suggests other features of simulations. There are many different methods now being tried for patient diagnosis on the basis of input information supplied to the computer by informants (clinicians, the patients themselves, or both). Some of these computer programs apply elegant mathematical techniques, requiring astronomical numbers of arithmetic calculations to arrive at a diagnosis. Others, however, use a complex decision-tree similar to that used by a clinician ("The patient has loss of memory *and* recent personality change *but* no hallucinations *and* no delusions, therefore, . . ."). These latter programs *simulate* clinicians even though the former programs may produce an equally reliable diagnosis. There are more correspondences between the decision processes in the latter

programs and those of clinicians. This type of program can be used to generate diagnoses (a worthy end in itself) and also to study the complicated behavior engaged in by clinicians themselves when they attempt to diagnose patients.

2. *Examples of Computer Simulation Models*

2.1 *Abnormal Personality*

Several computer models of abnormal personality have been developed. These differ widely in their fundamental assumptions about personality but share a degree of internal complexity that make them potentially quite faithful to the interdependence of human personality elements. These models are able to react with "satisfaction," "anxiety," and "frustration" to different events with not much less (or more) appropriateness than human beings. The reactions would not be practically predictable from the assumptions alone (without using a computer) because, simple as the assumptions may be, the working out of the detailed sequences of their interactions would be impossible for an unaided person.

2.2 *Belief Systems*

Closely related to models of personality are simulations of individual belief systems. These can be used to study and predict which beliefs will be held in the face of various sets of other beliefs or evidence. A simulation of the beliefs of a prominent political figure has been conducted and, indeed, computer simulations of the beliefs of the voting populace have been increasingly used in major political campaigns.

2.3 *Service Patterns*

More institutionally oriented models simulate planned or existing services to determine how well they will satisfy in detail the needs of the population (also simulated). The waiting rooms of clinics have been the basis of several smaller models studying the effects of changing appointment procedures on the average length of time wasted by the patient (and by the doctors). More complex simulations encompass a larger part of the organization. Models of communities may give the investigator the chance to vary elements (such as availability of outpatient care, rates of population change, etc.) over which he could have no control in the outside world.

2.4 *Diagnostic and Therapeutic Patterns*

Many of these simulations are of great potential value. The simulation of diagnosis can provide insight into the process of clinical judgments. It can also serve a teaching function, demonstrating useful sequences of deduction in arriving at a diagnosis. Simulated patients can provide beginners in psychotherapy with practice in interviewing instead of "cutting their teeth" on real patients from the start. In fact, a really good patient model would enable one to experiment with different styles of psychotherapy in a "dry run" before attempting these styles with humans, making simulation the counterpart of a laboratory guinea pig. (No simulation to date has achieved this goal, however.)

A more complete listing of the areas around which simulation has been developed with relevance to clinical practice, training, and research includes the following topics and appears among the references cited for this section at the end of the report.

1) cognitive — perceptual conditions
2) belief systems
3) human interaction
4) psychopathologic processes
5) interview interaction
6) community populations (reference provides a basis)
7) diagnostic category and process of assessment
8) simulation of instruction systems

3. *Principles of Simulation*

Whether it is the emotional state of a human or the utilization pattern of a mental health center that is being simulated, certain principles are necessary in developing the model.

The model must be stated clearly, with its assumptions explicit and amenable to logical (or mathematical) manipulation. This requirement is actually one of the great advantages of simulation — there is no "hand-waving," vagueness, or room for implicit

assumptions or appeals. The axioms and givens of the simulation are completely public and readily communicated, a requisite for all scientific models. In some simulations input variables are manipulated by the investigator and compared with output variables. Examples of this kind of process are models of drug action, interpretations by the therapist, or parental behavior. Output variables, such as sleeping, depression level, and amount of antisocial behavior are dependent on the input variables and on the system's operating characteristics. The overall goal in simulating such a system is to achieve a functional interaction between input and output variables of the system so as to describe it accurately over a wide range of input values.

Throughout the development of simulation it is necessary to compare the model with the simuland (that which is being simulated) and make adjustments in the simulation. The adjustment may involve only resetting some numerical values of variables in the simulation, or it may involve a restructuring of the basic logic itself. As this "tailoring" proceeds, effort is needed to avoid "patching up" an inherently inappropriate model by adding additional assumptions to the simulation to explain the embarrassing divergences from reality. This certainly has its counterpart in scientific theorizing, where efforts are directed toward the most economical theories, while those that explain the world in comparatively labored and tortuous ways do not survive. A simulation may resemble its object quite closely, but if it is a quiltwork of *ad hoc* procedures, it only imitates and does not illuminate.

4. *Evaluation of a Simulation Model*

The success of the simulation is likely to be measured against many more criteria than is the success of a simple hypothesis. Not only must result match reality, but process must match it as well. In simulating human problem solving, for example, the idea is not only to get as many problems right as a human, but to solve them in the same way and to make similar kinds of mistakes along the way. There are no universally accepted criteria for judging simulations. Suppose Simulation A matches its simuland half the time and Simulation B three-quarters of the time, but B, when it makes an error, is much farther off than A. One simulation of a psychotherapist relies heavily on a vast memory of things which-might-be-said, and, in fact, convinces many of those "talking" to it that it is a real therapist. But its fluency conceals the fact that nowhere in its program is there any mechanism for directing the interview toward a therapeutic goal. A different simulation, conducted perhaps on the same computer, generates less feeling that there is a psychiatrist present, but responds to the subject's statements with an internal model of appropriate goals. Which is better, and is either good enough?

5. *Future Developments*

In all likelihood, simulation techniques will continue to have greater theoretical than practical use, although mental health assessment procedures applied to both individual and community populations will greatly benefit by the increased usefulness and clarity of simulation techniques and models. (Simulation techniques are of growing interest and use to epidemiologists and city planners.) Certainly there is no possibility of replacing the mental health worker by a computer. Simulation models require a high degree of professional (e.g., psychiatric) consultation if they are to function successfully. They serve as supplemental aids to the practicing mental health professional and extend his insight into problems, rather than duplicating or replacing his direct services.

PSYCHOPHYSIOLOGIC LABORATORY APPLICATIONS

George A. Ulett, M.D., and
Elmer A. Gardner, M.D.

1. *Automated Clinical Pathology*

1.1 *Instrumentation Monitoring*

The purpose of on-line* monitoring of the instrumentation of laboratory functions is to relieve technicians of the routine and onerous time consuming checking of laboratory routines and to insure accuracy, precision, and reliability. The instruments are tied into analog-digital converter devices which change biological measurements to discrete numbers. These computers are programmed to correct for baseline drift and warn the technician when something is going wrong.

The instruments used to perform laboratory tests are many and varied. Manual equipment usually gives one data point per minute. Automated equipment ranges from one cycle per minute to 1000 cycles per minute, and runs the gamut from machines that emit high frequency-short duration analog signals to low frequency—long duration signals. Data from these instruments may be handled off-line with manual entry into the computer, or on-line, using analog tape and both high speed and low speed data input channels to the central processing unit.

1.2 *Record Keeping*

Hospitals usually require a flexible input capacity for both fixed and variable format data, as well as a wide variety of output formats. Rapid data retrieval is also necessary.

Acquisition and reporting systems are designed to get information to-through-and-out of the lab more rapidly. This is

* On-line indicates direct communication with the computer; information is continuously transmitted to the computer via teletypewriter or comparable equipment rather than being transmitted periodically, in batches on cards or magnetic tape.

usually accomplished by using cards or optical scan sheets for test requisitions. These are fed into the computer, which can be programmed to produce not only a list of patients needing specific lab tests but master lists, work sheets, specimen collection schedules, labels, and all the other myriad lists necessary for the day-to-day operation of a laboratory. Test results can be sent directly to remote printers on the wards.

1.3 *Rationale for Automation*

Clinical pathology laboratories lend themselves quite well to computer assistance. Approximately 30% of the workload in a clinical laboratory is clerical. With the advent of automated equipment, this figure may well increase rapidly. Skilled technicians are becoming a scarcity, the machinery is becoming more complex, and the paper work is increasing daily.

In general, a computer based laboratory data processing system must provide for better utilization of trained technicians, a reduction of paper work and documented quality control. The system must be economically justifiable and allow for both the laboratory instrumentation and hospital requirements.

By combining on-line monitoring and data acquisition and reporting systems, the clinical pathology laboratory can handle a greatly increased workload. Technicians would not have to do manual calculations or frequent machine checks, and clerks would not have to make innumerable lists and post results. Automated methods and computer calculations greatly reduce the chance of errors and increase both accuracy and precision. Reliable test results are rapidly available to the physician, and patient care is improved.

On the negative side most of these systems are expensive, the computer and the laboratory instruments are machines subject to breakdown, and it is difficult to clear invalid data from the computer. Other pitfalls include the problem of using technicians as computer operators; the widespread belief in the myth that computers are infallible; and the failure to design a *total* system to handle all data and all forms by computer.

2. *Automated Electroencephalography*

2.1 *Clinical Uses*

Traditionally the electroencephalogram has been interpreted

by "eyeballing"; it would appear that for clinical applications in the near future this is unlikely to change. It is not that computers cannot be programmed to quantify and interpret EEG data but rather that the necessity of scanning the record visually for artifacts, the problems of changes in the state of vigilance during recording and the traditions of the "art," have, to this date, served to deter the application of computers to the problems of clinical electroencephalography. A number of systems have been developed, primarily for research application, to list the characteristics usually noted in the EEG in such fashion that these data can be handled by the computer for statistical analysis. This is done usually with grouped patient data.

2.2 *Investigative Uses*

Electroencephalographers were among the first to explore the use of analog-digital conversion of physical data for statistical research. The first Gray-Walter Analyser (1944) was a mechanical tuned-reed device for Fourier type transformations. Since then similar tuned resonator equipment has become wholly electronic. Depending upon the needs of the problem, analog-digital conversion is done either with small, special purpose computers or by using programs developed for larger general purpose computers. Such utilization has included power spectrum analysis, period analysis (zero-cross, base-line cross), autocorrelation, cross-correlation, wave form analysis and amplitude integration methods. In evoked potential laboratories the Computer of Average Transients (C.A.T.) 400 has been used to average the responses from sensory, visual or auditory stimuli. Similar techniques, particularly amplitude and wave form integration, have been applied to other psychophysiologic data including electromyogram, galvanic skin response, and respiratory records.

2.3 *Rationale for Automation*

Among the advantages of such methods for handling psychophysiologic data are: objectivity; the possibility of handling large grouped masses of data; the ability to detect small differences in batched records that are difficult to discern by individual visual inspection; and savings in clerical time in measuring and counting records. The major difficulty encountered is the need for additional complex and expensive equipment.

3. *Automated EKG*

Computer interpretation of electrocardiographic signals has evolved slowly over the course of the last decade.

3.1 *Equipment and Operation*

The standard EKG machines were used to acquire data in early research work. Data from strip charts were put onto checklists, which were then keypunched and processed by the computer. The interpretations were subjective, the process time-consuming, and the system suitable only for research on a small part of a large number of EKG's.

Eventually, special EKG machines were built for data acquisition. Some produce vectorcardiograms, using orthogonal leads. Others use the standard twelve limb leads. The acquisition process is basically the same in both types of machines. The standard strip chart is produced. At the same time, an FM modulator picks up the EKG signals and records them on magnetic tape.

Teleprocessing systems now allow a physician in a remote location to use the special EKG machine, then transmit the tape recording via data phone to a computer center many miles away. The incoming EKG signals are put on magnetic tape, the signals on the tape are fed through an analog-digital converter into a central processing unit, the digitalized EKG signals are analysed by the EKG program, and the results are transmitted back to the physician via teletype.

3.2 *Output*

The logic in the computer program is similar to that used by the clinician in interpreting EKG's. The amplitude, slope, duration, and frequency of the peaks are noted and pattern recognition and measurements are programmed. All waves are identified and all amplitudes and durations are calculated for each lead.

The digitalized data is further evaluated for a diagnostic impression. There are several approaches to this. Group measurements can be evaluated from lead to lead, according to criteria that identify specific constellations. Abnormal amplitudes and durations can be identified and related to known disease states, or statistical groupings of measurements of wave forms and intervals can be obtained.

The output can consist of the identification of all waves, with their amplitudes and durations printed for each lead. The rate, P-R, QRS, and ST interval can be calculated. Objective statements can be made, and the diagnostic impression is actually the interpretation of these statements.

3.3 *Rationale for Automation*

Such systems allow for a rapid analysis of the EKG and eliminate the need for a highly trained cardiologist to read routine, normal EKG's. These systems are economically justifiable in areas where very large numbers of EKG's are done.

LOGISTICAL SUPPORT OF COMPUTERS IN HOSPITAL PROGRAMS

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The health industry is the third largest in the United States. Only the food industry and national defense rank higher in total spending. However, from a data processing point of view, the health industry is still in its beginning stages. Of the approximately 7,000 hospitals* in the United States, less than 10 percent have gone beyond the punched card stage. The majority of hospitals in this 10 percent group use their data processing systems primarily for basic accounting and logistic operations. The biggest gains made through the installation of EDP (electronic data processing) systems have been in reducing administrative effort and providing significant data to administrators for the decision-making process. However, even these limited gains have not been accomplished without proper and carefully thought out plans.

1. *Development of an Automated System*

1.1 *Planning*

The most important steps in the development and installation of a computer system are planning and systems design. Adequate planning is essential in order to accomplish three basic objectives: to identify fully the desired end results, to insure that measures taken to accomplish these results are adequate and to minimize the overall costs for achieving both short and long range automation objectives. The automation objectives desired can vary considerably in different hospitals. An effective plan ensures that measures to meet a hospital's short

* There are approximately 312 state and county mental hospitals and about 180 private mental hospitals in the U.S. General hospitals in the U.S. that accommodate psychiatric patients number 1,316 and Veterans Administration hospitals in the U.S. about 40.

range needs are compatible with the efforts to obtain its long range computer objectives. Each noncompatible measure is appropriately considered in light of its cost and value. Characteristics of today's computer programs, summarized below, support the importance that is placed upon proper planning.

1.1.1 *Applied development*

Extensive applied development efforts, including systems analysis design and programming, must be taken on an orderly basis when planning a computer system. Software development in the computer field may reduce this effort when undertaking future computer conversion programs; with few exceptions, such capabilities have already been over-emphasized.

1.1.2 *Cost Studies*

Substantial costs are involved in undertaking a computer system. Hospital administrators undertaking major computer systems often do not recognize that equipment costs frequently represent only 40 percent of the total cost of a computer operation.

1.1.3 *Reorganization*

Computer efforts frequently require a shift in organizational responsibilties and duties to make the proper talents available. Such shifting normally requires proper planning and adequate time for completion.

1.1.4 *Personnel Training*

The critical shortage of trained application-development personnel and other computer specialists makes it necessary for many organizations to train their own computer staff before they can proceed with the development and implementation of computer systems. Such training efforts can require many months to complete.

1.1.5 *Attitudinal Development*

The proper psychological environment must be developed within the hospital. A well planned orientation effort is required to develop the right acceptance of the computer by all members of the hospital staff, and the representatives of all staff divisions should also be involved in planning the computer system.

1.1.6 *Equipment*

Equipment manufacturers often require up to two years to deliver computers. Planning is essential to make the right equipment available at the right time.

1.1.7 *Physical Facilities*

It is necessary to provide adequate physical facilities for housing a computer operation. Site preparation requires careful planning to ensure that the right space, access, air conditioning, power, floor load capacity, and other environmental factors are given proper attention.

1.2 *Systems Alternatives*

Hospitals have three primary approaches to data processing today:

1.2.1 *Hospital Information System Approach*

This term has become widely accepted and implies a total system approach involving both accounting and patient oriented applications. It is primarily patient oriented but handles business functions and creates data for research purposes as by-products of normal routine processing. In this system, nursing stations and ancillary departments communicate directly with a computer by means of remote terminals.

1.2.1.1 *Logistic Support Sub-systems*

Logistic support sub-systems of a total hospital information system can be divided into two categories: a business oriented sub-system and an operations control sub-system. Included in the business oriented sub-system are patient billing, accounts receivable, dietary planning, food inventory, purchasing, personnel records, fund control-cost accounting, and payroll-labor distribution. The operations control sub-system area would include such applications as personnel assignments and scheduling, systems for nursing service, central service and housekeeping, plant operations scheduling for maintenance and construction, and overall computer project planning and control procedures.

1.2.2 *Business Oriented Shared System Approach*

This approach has proven quite popular from an economic point of view. The sharing by a number of hospitals of the normal high development costs and professional personnel talent has many advantages. Under this approach, a number of small hospitals are connected to a central computer via communication terminals. Most hospital groups in operation today or under development concentrate on business applications.

1.2.3 *Install Computer and Develop System*

Those hospitals that elect this approach simply install a computer and start to develop applications. Most of the hospitals, except those that are research-oriented, started with business oriented applications. This approach is suitable only when experienced management and data processing professionals are available.

2. *Strengths and Weaknesses of Systems*

The largest contribution the computer has made to date in the hospital field has been in the business oriented applications and in alleviating administrative burdens. Summarized below are some of the strengths and weaknesses of major logistic applications in operation today:

2.1 *Patient Billing and Accounts Receivable (A/R)*

These applications offer the greatest tangible benefits and are often selected for initial development. Control over late and missing patient charges, increased revenue and a reduction of A/R, and improved collection practices are selling factors. Use of remote terminals in business offices to prepare a patient bill on demand is characteristic of general-private hospitals.

2.2 *Dietary-Food Inventory*

Because 15-20 percent of the hospital's operating expense is used to support the dietary functions, this sub-system has a high priority. Use of the computer has provided reductions in raw food costs, reductions in inventory levels using reader points and economic order quantities and substantial savings in shipping costs, warehouse space, and purchase prices.

2.3 *Purchasing*

Effective use of the computer in purchasing ties in very closely with the inventory control functions. Group purchasing has demonstrated savings as high as 15-20 percent of purchasing costs because clerical effort constitutes such a high proportion of purchasing expenses under manual systems. Popular reports provided by a computerized system include vendor history performance and supplier availability status.

2.4 *Personnel Records*

Mechanization of personnel records can provide skills inventory and promotion dates to improve morale, answer credit inquiries, and answer various inquiries from government agencies. Reduction of clerical effort needed to support a manual system is substantial.

2.5 *Property Records*

Based upon the size of the hospital the reduction of clerical effort could be substantial. Computer storage and processing can provide automatic reporting of property acquisition costs, depreciation, and book value figures of all hospital capital assets. These types of data are essential in order to support government reporting requirements and to tie into the cost accounting system.

2.6 *Fund Control-Cost Accounting*

This is defined as the determination of costs actually incurred in performing all principal functions within the hospital. These data are necessary to determine patient charge requirements. Standard per diem rates from third party insurance agencies are based upon a generalized cost accounting system. Accumulation of cost data must be weighed against the acquisition costs, yet few hospitals have an adequate cost accounting system in operation. A very complex system will affect every department function in the hospital. It is essential to good management practices that detailed cost data be accumulated in every area of responsibility and used in comparative analysis purposes.

2.6.1 *Patient Fund Control*

This sub-system is unique to psychiatric long term hospitals. Through the use of the computer, automatic fund control balance amounts can be maintained. A decision to automate this application must be based upon the number of patients involved and the associated number of transactions.

2.7 *Payroll-Labor Distribution*

This sub-system is one of the first applications to be automated in any hospital computer program. Many problems exist in the payroll processing and maintenance under a manual system that can be reduced through automation. A strong selling point is the fact that 65-70 percent of a hospital's total operating expenses is used for salary.

CONCEPT EXCHANGE SYSTEMS

Paul T. Wilson, M.D.

1. *Definition of Subject Area*

Broadly defined, a concept exchange system is any facility that communicates conceptual information from people who generate it to people who use it. This definition includes such facilities as meetings, books, journals, and informal networks or "invisible colleges" of workers in the same field. This report limits its scope to concept exchange systems that employ modern data processing techniques.

1.1 *Difference between "conceptual information" and "data"*

Data describe the events that occurred in a particular situation. Conceptual information describes characteristic relationships between classes of events that are assumed to occur in all similar situations. In psychiatry, for example, the events reported in one patient's clinic record are *data*, while the general principles derived from examining thousands of patients' records are *conceptual information*. Data are converted to conceptual information by the process of "data analysis" described in another report.

2. *Automation of Concept Exchange Systems*

2.1 *Varieties of concept exchange systems that may be automated*

2.1.1 *Clearinghouses:* Systems that supply documents or references to documents originating from several organizations or sources. Some clearinghouses provide information that answers specific questions. (Example: National Clearinghouse for Mental Health Information, National Institute of Mental Health, Chevy Chase, Maryland 20015.)

2.1.2 *Libraries:* Systems that provide documents containing information about specific topics. (Example: National Library of Medicine, Bethesda, Maryland 20014.)

2.1.3 *Referral Centers:* Systems that provide the names of organizations that can supply a particular kind of information. (Example: National Referral Center for Science and Technology, Library of Congress, Washington, D.C. 20540.)

2.1.4 *Selective dissemination of information (SDI) systems:* Systems that automatically send information users references to new documents whose contents match the users' personal *information profiles*. The user can then request copies of documents of particular interest. (Example: Institute of Scientific Information, 325 Chestnut Street, Philadelphia, Pennsylvania 19106.)

2.2 *Rationale for Automation in Concept Exchange Systems*

Computers are valuable in concept exchange systems because of their speed and accuracy in filing and retrieving documents and references to documents. Documents (and their references) transcribed onto computer tapes may also be stored efficiently and machine-examined rapidly.

Criteria for automating concept exchange systems include the following:

2.2.1 *Number of documents processed.* In general, the larger the number of documents (or their references) stored in a system, the more appropriate it is to automate its operations.

2.2.2 *Number of index terms or descriptors assigned to each document.* Generally, automated techniques are best used for systems that index each document (or reference) in considerable depth.

2.2.3 *Number of index terms or descriptors used simultaneously to retrieve documents.* Systems using lengthy retrieval formulae or criteria should usually be automated.

2.3 *Illustrations of Input and Output*

2.3.1 Input to a concept exchange system may be of almost any kind, including books, research articles, review articles, abstracts of articles, project descriptions, bibliographies, and photographs.

2.3.2 Output from a concept exchange system may also take a wide variety of forms. Some of the more common outputs are listed and briefly described below.

2.3.2.1 *Abstracts:* Brief summaries of whole documents. (Example: Abstracts of papers presented at the annual meetings of the American Psychiatric Association are published in the annual Scientific Proceedings.)

2.3.2.2 *Bibliographies:* Lists of references to documents from a particular source or about a particular topic. Each reference usually indicates the document's title, author, date of publication, and source (journal, book, etc.).

2.3.2.3 *Indexes:* Alphabetical lists of terms (sometimes consisting of several words) that describe or characterize various aspects of documents, including their subjects, authors, or sources. Each term is usually accompanied by a list of documents to which the term applies. (Example: *Index Medicus*, produced by the National Library of Medicine.)

2.3.2.4 *Primary documents:* Copies of the same documents that entered the systems as input. (The major output of traditional libraries is primary documents.)

2.3.2.5 *Secondary documents:* Documents produced by the system and that announce or report on the primary documents it contains. These may include the following:

Abstract journals: Journals containing abstracts of articles (and, occasionally, of other kinds of documents) about a particular topic. (Example: Digest of Neurology and Psychiatry published by the Institute of Living, Hartford, Connecticut 06102.)

Annotated bibliographies: Bibliographies that list, in addition to basic bibliographic data, a brief description or explanation of the document's contents. (Example: *Medical Reference Works, 1679-1966: A Selected Bibliography* by John Blake and Charles Roos.)

Contents journals: Journals consisting of the reproduced tables of contents from other journals. (Example: *Current Contents: Behavioral, Social and Management - Sciences*, produced by the Institute for Scientific Information.)

Information directories: Documents listing institutions and/or people that can supply information about particular topics. (Example: *A Directory of Information Resources in the United States*, published by the National Referral Center for Science and Technology.)

2.3.2.6 *Answers to specific questions:* Users are given information in the form of verbal answers to their questions.

2.4 *State of the Art*

2.4.1 *Current usage*

2.4.1.1 *Hardware.* Because of computers' limited "core capacity," (i.e., active memory) the file of documents in automated concept exchange systems must still be reviewed serially (i.e., by having the computer "read" rolls of computer tapes into which document information has been transcribed) for retrieval purposes. For the same reason, it is still prohibitively expensive to store and retrieve information from the whole texts of documents.

2.4.1.2 *Input procedures.* Incoming documents must be analyzed, indexed, and abstracted manually, and references to documents must be hand-transcribed to machine-readable form. Because of personnel costs, it is prohibitively expensive to transcribe whole texts of documents into machine-readable form.

2.4.1.3 *Output procedures.* Most automated concept exchange systems still require considerable telephoning, correspondence, and hand-programming before users can obtain the documents or document-references they want. Users must then "digest" these documents to find the answers to their specific questions.

2.4.2 *Projected usage (immediate and long range)*

2.4.2.1 *Hardware.* The computer industry is making concerted efforts to increase the core capacity of their large computers. Within the next two decades, miniaturization of coding techniques (ability to use less space on tapes, etc. for coding information, similar to but not to be confused with miniaturization of electronic components) may let the equivalent of whole libraries be available for review and retrieval.

2.4.2.2 *Input procedures.* Techniques for automatically transcribing whole texts of documents to machine-readable form — as well as analyzing, indexing, and abstracting them — will probably develop during the next decade.

2.4.2.3 *Output procedures.* The storage of whole texts of documents and the development of more efficient, less expensive remote computer terminals, larger multiple-access computers, and better "natural language" computer programs will eventually let users of concept exchange systems "converse" with computers to obtain answers to specific questions. Already possible in pilot systems, practical interactive systems will probably not be available for the next twenty years.

3. *Special Issues Relevant to Concept Exchange Systems*

3.1 *Legal*

Current copyright laws prevent the free reproduction and distribution of privately published documents (including professional journals).

3.2 *Operational*

3.2.1 Most existing concept exchange systems make little or no effort to screen incoming documents for quality.

3.2.2 The quality of the output from concept exchange systems (also) depends largely on the subject-area competence of the personnel who perform its indexing, abstracting, and retrieval operations.

3.2.3 Many existing concept exchange systems provide a comparatively "routine" service that varies little with users' individual needs and preferences.

3.3 *Professional*

Most psychiatrists receive little, if any, training in the availability and use of concept exchange systems relevant to their work.

4. *Recommendations*

4.1 *Legal*

Copyright laws must be modified so that copies of documents may be made more freely without threatening the commercial publication system.

4.2 *Operational*

4.2.1 Some screening efforts should be made to prevent information of poor quality from entering psychiatric concept exchange systems.

4.2.2 Psychiatric document evaluation, abstracting, indexing, and retrieval should be done by people who are reasonably familiar with psychiatric concepts.

4.2.3 Psychiatric concept exchange systems should provide information only after the user's specific information needs, purposes, and professional sophistication have been determined.

4.2.4 Psychiatric concept exchange systems should monitor their operations repeatedly to evaluate the satisfaction (and dissatisfaction) of information users.

4.3 *Professional*

Instruction and experience in the use of concept exchange systems should be made part of psychiatric residency training.

COMPUTER FACILITATED TRAINING

Jon K. Meyer, M.D.

1. *Introduction*

Well demonstrated storage, processing, and retrieval capabilities suggest a possible role for the computer as an information-rich tutor in transactions with medical students, interns, psychiatric residents, and psychiatrists. The purpose of this section is to outline possible instructional applications of computers.

2. *Definition and Scope*

Computer facilitated training refers to the use of the computer in interaction with a student or trainee to display information, to accept and process the student's response, and to present further information contingent upon that response. By emphasizing the interactive feature, this definition eliminates such functions as the batch processing of information requests by concept exchange centers.

3. *Training Modalities*

There are three basic computerized teaching modes: (1) "drill" and "tutorial," programs; (2) simulation and gaming; and (3) information file maintenance and manipulation. The drill and tutorial programs are those most often given the label "computer assisted instruction" or "CAI."

3.1 *Drill and Tutorial Programs*

3.1.1 *Drill.* In drill programs the student is asked to respond to a series of questions or problems presented in a predetermined order. Drill exercises are prevalent because it is relatively easy to assemble material, assign it, and to serve many users simultaneously with limited equipment. The best known drill programs are those used at the elementary school level.

3.1.2 *Tutorial.* Tutorial programs consist largely of adaptations of lecture or textbook material. The more sophisticated programs make the computer's response at significant points dependent upon student input. In most cases, tutorial programs function like computerized programmed instruction texts.

3.2 *Simulation and Gaming*

The simulation and gaming applications go beyond the usual techniques associated with drill and tutorial programs. The simulation or game program constitutes a model of a real or imaginary system or set of interactions. The program is designed to provide an appropriate reply over a wide range of student input. Such programs can serve to examine the decision-making skills of a student during training or to provide practice in problem situations which may not be encountered often enough to maintain essential skills.

3.3 *Information File Manipulation*

Information file maintenance and manipulation requires on-line tools for the organization and retrieval of information. The student is allowed to reorganize and augment, for purposes of self-education, his personal version of a basic information file.

4. *The Advantages of Computer Use in Training*

Benefits unique to computer presentation and control of educational material are: greater control over stimulus - response - reinforcement contingencies, reduction of man hours spent in teaching routine material and/or in routine testing, the provision of more individualized instruction with large classes than may be possible otherwise, the provision of remedial or background material without consuming man hours, and increased freedom for students to pursue ideas at their own pace.

5. *Input and Output*

5.1 *Input*

Input in all areas of computer utilization requires a highly structured approach. Training is no exception. Courses are usually produced by teams consisting of content experts who specify instructional objectives, programmers who convert the content material into appropriate instructional interaction, and program editors who revise and refine instructional sequences in the light of performance data. Reports of time expenditures in tutorial program design indicate between 100 and 400 hours of planning, writing, programming, and debugging to produce one student hour of instruction.

5.2 *Program Languages*

The computer programming languages available for instructional purposes are constraining limits on possible input and output. These languages fall into four general classifications: (1) conventional compiler* languages, (2) adapted conventional compiler languages, (3) interactive computing and display languages, and (4) author languages. The compiler languages (ALGOL, COBOL, FORTRAN) require an experienced programmer for instructional applications and are inefficient for many simple instructional tasks. The adapted compiler languages (MENTOR, ELIZA, CATO) represent an attempt to correct the inefficiencies in the first group by adding such features as student sign-on and sign-off, answer matching, and record handling. Programming experience, however, is required for their application. The interactive computing and display languages (ADEPT, BASIC, QUIKTRAN) are usually considered "student" languages and provide computing power and graphic display capabilities that are highly interactive and easy to learn. The author languages (COMPUTEST, COURSEWRITER, PLANIT) have built-in capabilities for constructing and administering instructional sequences, answer matching, monitoring student activities, and collecting performance records. Input and output features of various types of instructional programs from the student's point of view are summarized in Table I:**

* Compiler languages build upon simpler codes so that one program instruction, utilizing very few words, may signify a long sequence of operations to the computer.

** Reprinted by courtesy of F. D. Thompson Publications Inc., Greenwich, Connecticut, from "Current Problems in Computer-Aided Instruction" by J. L. Rogers, *Datamation*, September, 1968, pp. 28-33.

TABLE I

Application Category	Inputs to the System	System Functions	System Output
COMPUTATIONAL AID	Values of variables. Data from observations.	Solves the formula. Carries out the analysis.	Solutions to the problem (results of the calculation, statistical analysis, etc.).
SIMULATION	Responses to instruction or data in the learning environment (decisions in games, procedures for operating on-line terminals, test cases in laboratories, maneuvers in aircraft, spacecraft, or naval vessel crew training etc.).	Uses learner inputs to solve a mathematical model of the process (physical, social, organizational, economic, etc.) being simulated.	Outcomes of the learner's decisions sometimes expressed as changes in the computer controlled parts of the learner's environment.
LESSON MATERIAL STORAGE AND RETRIEVAL	Information that identifies the learner's area of interest (subject, period, area, etc.) or the learner's progress in a particular course of instruction.	Matches identifiers with those of stored lesson or supplementary material.	Lesson (or supplementary) material requested by the learner (language exercises, classroom or homework assignments, etc.).
LESSON PRESCRIPTION	Learner's performance on test administered following last assignment (may be entered by teacher, teacher's aide, etc.).	Matches learner's performance on last test with characteristics of alternative instructional units for next topic.	Assignment of next instructional unit for use in classroom or laboratory, or for homework, outside reading, etc.
TESTING	Answers to drill and review problems.	Grades learner's answers (right or wrong); adjusts difficulty level of next problem set; collects data on all students by problem set.	To learner — right or wrong on each problem; % for set. To teacher — summaries of learner performance.
INTERACTIVE INSTRUCTION	Responses to questions asked by the system.	Analyzes learner's response, and selects next item to be presented to learner.	To learner — for correct answers, indication of correctness, plus next item; for incorrect answers, some dialogue exploring the correct answer. To course designers, error data by item.

TABLE I — *Continued*

6. *Current and Projected State of the Art*

6.1 *Current State*

Computer applications in education and instruction are in the research and development phase and seem likely to remain at that stage during the next five years. Currently, gains from computer application over reasonably well designed lecture or textual materials have not been demonstrated with capable adult learners. With elementary students, on the other hand, some gains in effectiveness have been demonstrated.

6.2 *Costs*

The cost of curriculum development is high. Estimated costs range from $200,000 to $2,000,000 for a hundred hours of terminal time constituting a one year course. Communications networks may play an important role in bringing computer-based instruction within economic constraints by allowing the expensive instructional software to be used with large numbers of students. Such developments may make computer-based instruction justifiable on a cost-benefit basis in the early 1970's.

6.3 *Future*

The trend in instructional use of computers for students at higher education levels is likely to be away from the drill and tutorial models. In future systems, the primary sources of knowledge are likely to be made available to students through organized files. The computer will provide the necessary tools for managing and manipulating this information.

7. *Special Problems Related to the Use of Computers in Training*

The characteristics of any current instructional computer system impose limitations on the material that can be presented to the learner and on the responses the learner may make. He is either forced to respond within the constraints of an artificial language, thus presenting no ambiguity to the computer, or within natural language restricted to rule out the most common sources of ambiguity. Characteristics of the response other than meaning (the presence of specified key words, the order in which they appear, etc.) determine its subsequent processing.

As in other areas of computer application, the problem of standardization is pressing. There are no observed standards for instructional hardware or software.

The shortage of qualified people to produce innovative educational materials constitutes a major obstacle to successful instructional applications.

8. *Recommendations*

Authors of psychiatric texts should be encouraged to develop computer-based materials, particularly simulations of physiological processes or clinical situations, to supplement the text. Actual computerization of the text would probably offer no advantages over the printed page.

On-line, time sharing communications networks with provision for individual files should be encouraged. The availability of concepts and data from broad sources, together with the capacity to store and manipulate the information according to personal needs, would make an important contribution to psychiatric education.

OVERVIEW AND RECOMMENDATIONS

1. *Overview*

1.1 *General Themes*

The varied uses of the computer in psychiatry, as in all of medicine, make it difficult to present any overall evaluative statement without obscuring the considerable unevenness of its use throughout the field. Thus, one can note certain themes that are repeated in all sections of this report: (a) The computer currently is being used mainly for administrative and research purposes, and, to date, has had only limited use in the clinical and teaching areas. (b) The potential usefulness of the computer has been demonstrated or suggested for all aspects of psychiatric practice and education, but its utilization has been curtailed by a number of factors: prohibitive costs; a limited range and flexibility of programs and programming languages; lack of standardization of data, forms, computer files and hardware; the relative slowness of input and output equipment; inadequate storage capacities of most available equipment for many data processing needs; the inaccessibility of major computer facilities to many potential users; an ignorance of most potential users about electronic data processing, breeding fear and inhibiting inquiry at appropriate times; and a lack of knowledgeable personnel to develop computerized systems.

Many of these obstacles to widespread computer usage are already being alleviated and may be minimized within the next decade. Psychiatry is probably on the threshold of entering its computer age, and the profession should address itself to some of the crucial issues this raises because no corner of the field will escape totally the influence of automation. (This statement, as with most of this report, is equally applicable to other branches of medicine.)

1.2 *Current Problems*

There are five major problems that are mentioned repeatedly in this report and that will be discussed before reviewing the benefits and future trends of automation in psychiatry. None of these problems is unique to automation, but their resolution becomes more urgent with the introduction of electronic devices which increase significantly the possibility of compounding error, confusion, or trauma. (The absence of key personnel could impair the use of a record room for a short period of time, but equipment breakdown, poor programming, changing to another program language or computer system could preempt the equivalent of several record rooms for a period of days to years.)

1.2.1 *Confidentiality*

The potential abuse of records and the intrusion upon individuals' private domains have been discussed in the section on data banks. Automated record systems are safer than manual systems from inadvertent or malicious unauthorized use, but the pooling of data from a number of sources into more centralized files does present a threat to privacy and raises a number of questions that must be considered by a profession dealing with sensitive, personal information. The APA Task Force on the Confidentiality of Medical Research Records has grappled with such questions and proposed a statement relevant to the research area. But these questions must now be the concern of the entire profession before automation becomes a pervasive reality rather than a potential. Which information falls within the private domain and which is public? What role should the patient play in making this distinction? How can confidential material be guarded from abuse, and who should assume responsibility for this protection and the communication of knowledge about such protection? With the increasing subsidization of health care by government and the many demands made upon any source of personal information, the answers to such questions cannot be ambiguous.

To deny access to all records or refuse to answer all inquiries is no longer a sufficient response: This only denies the many advantages of automation and invites decision making by others responsible for health care but without the benefit of factual information. Similarly,

if record linkage is prohibited in an attempt to protect confidentiality, the gain from automation will be considerably minimized. This is exemplified by Connecticut legislation that prohibits any identifying information from being transmitted by a mental health facility to a pooled data bank.

Should professional surveillance of automated record systems be the responsibility of one or more groups representative of organizations at a national level, such as the APA or NIMH, or of organizations at a more local level? Such groups could detect possible threats to privacy and could establish ethical standards for developing and maintaining computerized record systems. At the moment, there is no one organization toward which any potential user can turn to learn about the most recent technological advances (hardware or software) for safeguarding the privacy of computerized records against improper use (e.g., special codes for access to the file, identification of fingerprints or "voice prints" by the computer before "permitting a record search").

A variety of legal questions already has arisen or may arise and requires input from the psychiatric profession for resolution. What constitutes an invasion of privacy or a break in confidentiality within an automated system? Should exceptions be made for machine and/or program failure? The Task Force on the Confidentiality of Medical Research Records calls attention to the Maryland statute that protects those responsible for research record systems and the patients reported to these systems from external abuse by specifying who may or may not have access to the file, when and how such access can be obtained, and the penalty for violations. Under this statute the research records are not admissible as evidence in any court. The penalty for violation of confidentiality in the Maryland statute is minimal, however, and may not constitute much of a deterrent. The threat to privacy with the pooling of data in automated record systems similarly may be reduced by legal safeguards against non-medical use. Some consideration should also be given to penalties for improper use by persons responsible for automated systems (psychiatrists, etc.) if a patient is to have any security about the privacy of the information he provides. These penalties could be in the form of professional censure, suspension or revocation of license, or through adjudicative procedure.

1.2.2 *Educational Implications*

As noted in all sections of this report, there is a wide and increasing discrepancy between the actual or potential use of automation in psychiatry and psychiatrists' knowledge about electronic data processing. Further, because of the limited use of computers in patient management and teaching, few medical schools have machines to use in teaching automation. If, as we envision, psychiatry is entering its computer age, then this knowledge gap can significantly impede progress and diminish the contribution of psychiatrists to the mental health field. Not even the most cursory knowledge of computers, programming languages, and such related areas as data processing, research design, and record or form development is provided routinely in medical school curricula. There are few graduate courses or seminars provided for psychiatrists (or any health professionals) comparable to those given by some computer companies for business executives. Just as those without the ability to evaluate the investigative literature are compelled to depend upon pharmaceutical companies and drug salesmen for knowledge about proper medication, without some acquaintance with the usefulness of the computer, the indications for utilizing data processing techniques and available resources, the average psychiatrist may dismiss automated techniques, utilize automation indiscriminately, or have a generalized fear of computers and automated systems. Thus, he may not be cognizant of the almost universal applicability of computers in psychiatry and may neglect or avoid any participation in the essential efforts at standardizing terminology, designing forms, developing coding systems, and developing data processing systems. At the same time he should be cognizant of the limitations of computers.

Although the task force is unanimous in its agreement that some teaching about computer technology should be included in medical school and graduate medical programs, the members of the task force are not able to reach agreement about the amount of education re-

quired. Some of the task force believe that a two to three hour session could provide adequate knowledge about the computer sciences for the average medical student or psychiatric resident. Others on the task force would propose a course of ten to fifteen hours for every student or resident.

1.2.3 *Quality Control*

With the increasing use of machine-stored data, the increasing number of potential users, and the possibility of sharing massive amounts of information (ultimately, whole libraries), the quality of the input becomes even more vital. As noted previously in this report, improved coding techniques and more natural programming languages in the next decade will simplify input procedures and may thereby help improve the quality of information being stored. Nevertheless, little attention has been given to what constitutes adequate editing of input and output data and to how much error can be tolerated within a system. Although these are obvious questions for all automated systems, they assume even greater significance in a field that deals with such sensitive, personal data. This involves the issues of standardization of forms and terminology, the education of psychiatrists to familiarize them with data processing techniques, and the possible development of criteria for adequate quality control.

1.2.4 *Role and Systems Reorganization*

As the utilization of the computer becomes more ubiquitous in psychiatry, it is increasingly probable that its employment in one sector of the field will have a significant impact on another sector. Unless some group(s) with a general perspective of the field have responsibility for prognosticating such trends, significant role changes or system reorganization may occur with no warning or preparation. There may be no opportunity for re-education of personnel, attitudinal adjustment, or change in organizational structure. Again, this would not be unique to a "computer age," but the frequency and extent of such change may be considerably greater.

Several examples could be given of this type of secondary effect, but three will suffice: (a) There is currently a growing movement to train "paraprofessionals" to replace, complement, or supplement a variety of professional roles. Several community colleges have initiated degree programs for these new roles. In most programs these new workers are being utilized to conduct structured initial interviews, administer some assessment tests, perform certain clerical functions, and to act as "expediters." Yet it is quite likely that some of these functions will be automated within the next five to ten years, and an extensive shift in role functions would be required. Thus, their functions should be reviewed, and those that may be automated need to be de-emphasized and other functions emphasized in educational programs. (b) The rapid expansion of automated self-assessment techniques (e.g., MMPI) soon may replace certain aspects of some professional roles. Here, too, the current educational programs should be re-assessed and restructured. (c) As automated records and remote terminals with various alerting and feedback functions become more feasible, the coordination of medical care sub-systems (e.g., mental health center components) will be more easily realized. It would seem that this coordination might improve continuity of care, but unless proper administrative structures are created and necessary attitudinal changes occur among mental health workers, the automation may create turmoil rather than efficiency.

Persons who are keeping abreast of developments in automation, in liaison with representatives from various councils of the APA and different divisions of NIMH, might monitor the potential impact of automation and communicate their concern widely via newsletters, NIMH bulletins, etc.

1.2.5 *Equipment, Program, and Personnel Accessibility*

It has become commonplace to hear comments about the size of the health industry in the U.S. and the need for improvement of the health care delivery system. Consideration also must be given to the increasing dependence that psychiatry (and all of medicine) will have upon the suppliers of computer equipment, programs, and personnel and upon the implications of this dependence

for health care delivery systems. The universality of automation will make access to electronic machines and appropriate programs vital. Major equipment changes will cause prolonged disruptions in the utilization of automated systems unless manufacturers give more attention in the future than they have previously toward developing the necessary support to facilitate these transitions. There must be sufficient programmers and/or systems analysts with knowledge about health care systems, and the medical profession must share the responsibility for maintaining this manpower resource.

As much as possible computer programs and systems should be standardized and disseminated to avoid the costly duplication that occurs when almost every facility has its own computer program and equipment.

Finally, there cannot be too much stress placed upon the possibility of automation shaping practice and health care systems, both negatively and positively. Through the use of automated records, shared libraries, or other information networks, and through a variety of automated educational devices, the format and content of data may (and to some degree should) become less varied and more fixed. Format and content will be influenced by automation techniques, e.g., program languages and storage capacity. How will professional standards be maintained and determined by knowledgeable personnel? We must not be forced to depend heavily upon non-medical personnel with too few medical people who can communicate adequately enough to influence the system appropriately. The medical profession must have sufficient personnel adequately educated in computer technology.

1.2.6 *Appropriate Feedback to User*

The viability of automated record keeping systems in psychiatry is dependent upon supplying the individual clinician who provides the information on a given patient with output data that is useful to him in the management of his patient. Sophisticated use of the information from data banks has been shown to be of value in suggesting to the clinician optimum treatment procedures and in predicting various outcome events, such as early hospital discharge and suicidal potential. This means that the output to the clinician for a given patient must contain a higher level of information integration than was present in the input. However, this necessitates the involvement of clinicians, senior administrators, and other knowledgeable personnel in posing the appropriate questions and the involvement of adequate computer programming resources to deal with these questions over and above the mere maintenance of the system. Adequate funding of automated systems will make these benefits possible; inadequate support will quickly lead to user dissatisfaction, resentment, and the eventual collapse of the entire effort to use automation.

1.3 *Benefits of Automation*

Having discussed the problems which may arise with computer utilization and the cautions to be considered, we might again mention some of the potential or actual gains. These are almost unlimited, and some of the benefits have been noted in the various sections of this report. As stated in the first section of the report, computers will increasingly free people from most information handling tasks that we can anticipate clearly and, probably, from some that we presently cannot anticipate.

In hospitals, laboratories, and now in outpatient facilities computers are improving business practices with better billing, purchasing, personnel records, payroll procedures, and appointment scheduling. Often, costs have been reduced and clerical and other personnel are being freed for more complex tasks.

Tests may be administered and clinical records obtained with improved reliability and accuracy. There will be far greater opportunity for data manipulation to improve case and system management, to gain predictability with data that would otherwise be too complex or cumbersome to handle, and to provide an almost unlimited information file for a variety of future uses.

An increasing number of people can store, retrieve, and share massive amounts of information, e.g. library material, investigative results, and service statistics. The best thinking about optimal patient management can be shared by all clinicians, and this thinking can be constantly updated by the rapid access to large automated medical record files. Educational materials and programs can be shared more easily, and the variety of education processes can be increased with simulation techniques, computer interactive instruction, etc.

1.4 *Future Trends*

As noted earlier, we can expect a number of developments within this next decade that will remove or minimize many of of the obstacles to computer utilization in psychiatry. Time sharing systems with more rapid input and output will greatly increase accessibility, communication between users, and the possibility of large networks. Miniaturization of equipment components soon will increase storage capacity significantly and produce smaller, perhaps less costly, machines, thus further increasing accessibility. Output equipment such as videoterminals and teletypewriters will be more widely used in remote settings to permit greater flexibility and more personal interaction with the machine. Finally, higher level program languages will, to some degree, minimize computer personnel problems, provide easier conversion from one program to another, and simplify the development of automated record systems.

2. *Recommendations*

The Task Force on Automation and Data Processing in Psychiatry makes the following general recommendations in addition to the more specific recommendations contained in the body of this report:

(1) The APA should promote the use of a uniform identification number for psychiatric records, preferably the Social Security number. We believe this is necessary for gaining maximum use of data banks in the improvement of health care. Although we believe this does increase the problems in maintaining confidentiality, legal and technical safeguards for preserving record privacy are available (see other recommendations) and their use would be more effective and appropriate than resisting such a uniform number.

(2) The APA should appoint a standing committee to maintain confidentiality and ethical standards, as well as to encourage proper legal safeguards for automated record systems. The membership of this committee should involve other organiza-

tions or individuals representing computer technology and the law. This committee should receive reports of abuses to privacy and channel these reports for any necessary action after appropriate investigation.

(3) The APA should establish a task force to make recommendations for and promote the implementation of educational programs at all levels in automation techniques, data manipulation, biostatistics, and record development. This group should include department of psychiatry chairmen to encourage the addition of courses in medical school curricula. The task force should investigate the most efficient methods of disseminating information to all psychiatrists about automation, in an attempt to prepare them for the inevitable increasing utilization of computers in all areas of the mental health field.

(4) The APA should organize a standing committee to develop, periodically review, and revise standards for the operation of automated record systems, including the computer programs, equipment, and terminology utilized in these systems. This committee also should promote, where possible, the development of standard record forms and data.

(5) The APA should encourage, in every way possible, the continued and expanded support at the state and federal levels, of data banks and automated record systems to maximize their potential for improving patient care. Without such support, output from automated systems will be meager, user dissatisfaction will occur, and the benefits from automation will not be realized.

REFERENCES

Introduction

Kline, N. S. and Laska, E. L. (editors). *Computers and Electronic Devices in Psychiatry.* New York: Grune and Stratton, 1969.

Payne, L. D. "The Basic Principles and Brief History of Computer Technology," *British Medical Bulletin,* Vol. 24: pg. 189, 1968.

"Computers in Psychiatry." *American Journal of Psychiatry,* Vol. 125: pg. 7, 1969 (Supplement).

Data Analysis

Bahn, A. K. "Basic Medical Statistics." Sixteen chapters being serialized in the *Journal of American Women's Association (The Woman Physician),* beginning September, 1969.

Kramer, M. *Applications of mental health statistics.* World Health Organization, Geneva, Switzerland, 1969.

"Computing in Medicine" (whole issue). *British Medical Journal,* Vol. 24, No. 3, 1968.

Reid, D. D. "Epidemiologic methods in the study of mental disorders." World Health Organization, *Public Health Reports,* No. 2, 1966.

BMD Biomedical Computer Programs. Health Sciences Computing Facility, Department of Preventive Medicine and Public Health, University of California, Los Angeles.

Data Banks

Acheson, E. D. "Linkage of Medical Records in Computing in Medicine." *British Medical Bulletin,* Vol. 24: pg. 206, 1968.

Bahn, A. K. and Bahn, R. "Considerations in using social security numbers in birth certificates for research purposes." *Public Health Reports,* Vol. 79: pg. 937, 1964.

Bahn, A. K. "A new psychiatric epidemiology." *Israel Annals of Psychiatry and Related Disciplines,* Vol. 2: pg. 11, 1964.

Bahn, A. K. "Community case registers: Purposes, issues, problems and some solutions." *Proceedings of Community Welfare Research Workshop,* Atlantic City, N.J., May 1965.

Bahn, A. K. "Psychiatric case register conference." *Public Health Reports,* Vol. 81: pg. 748, 1966.

Bahn, A. K., Gardner, E. A., Alltop, L., Knatterud, G. L., and Solomon, M. "Admission and prevalence rates for psychiatric facilities in four register areas." *American Journal of Public Health,* Vol. 56, No. 12: pg. 2033, 1966.

Bahn, A. K. "Research tools for planning and evaluation." In *Community Mental Health.* Edited by Williams, R. H. and Ozarin, L. D. San Francisco: Jossey-Bass, Inc., Vol. 292, 1967.

Bahn, A. K. "Some issues in psychiatric epidemiology." In *Psychiatric Epidemiology and Mental Health Planning.* Edited by Monroe, R. R., Klee, G. D., and Brody, E. B. *Psychiatric Research Report No. 22,* Washington, D.C., 1967.

Baldwin, J. A., Innes, G., Miller, W. M., Dorricott, N., and Sharp, G. A. "A psychiatric case register in North-East Scotland." *British Journal of Preventive Social Medicine,* Vol. 19: pg. 38, 1965.

Baldwin, J. A. "Evaluative functions of a case register." In *Community Mental Health.* Edited by Williams, R. H. and Ozarin, L. D. San Francisco: Jossey-Bass, Inc., Vol. 305, 1967.

Camarillo State Hospital. "Psychiatric data automation project." *Final progress report.* Camarillo, California, 1965.

Gardner, E. A., Miles, H. D., Iker, H. P., and Romano, J. "A cumulative register of psychiatric services in a community." *American Journal of Public Health,* Vol. 58: pg. 1269, 1963.

Gardner, E. A., Miles, H. C., Bahn, A. K., and Romano, J. "All psychiatric experience in a community." *Archives of General Psychiatry,* Vol. 9: pg. 369, 1963.

Gardner, E. A. "The use of a psychiatric case register in planning and evaluation of a mental health program." In *Psychiatric Epidemiology and Mental Health Planning.* Edited by Monroe, R. R., Klee, G. D., and Brody, E. B. *Psychiatric Research Report No. 22,* Washington, D.C.: pg. 259, 1967.

Glazebrook, P. R. In *Record Linkage in Medicine.* Edited by Acheson, E. D. London: Oxford University Press, Vol. 323, 1967.

Hopkins, R. and Gardner, E. A. "Development of a flexible control system in the maintenance of a patient case register." In *Data Acquisition and Processing in Biology and Medicine,* Vol. 3. Edited by Enslein, K. New York: Pergamon Press, Vol. 191, 1964.

Miles, H. C. and Gardner, E. A. "A psychiatric case register: The use of a psychiatric case register in planning community mental health services." *Archives of General Psychiatry,* Vol. 14: pg. 571, 1966.

North Carolina Department of Mental Health, Division of Statistics. *Statistical procedures manual, North Carolina Tri-county psychiatric case study.* New York: Chapel Hill. July, 1964 (mimeographed).

Phillips, W., Gorwitz, K., and Bahn, A. K. "Electronic maintenance of case registers." *Public Health Reports,* Vol. 77: pg. 503, 1962.

"Report of the Panel on Privacy and Behavioral Research." *Science,* Vol. 155: pg. 535, 1967.

Rome, H. P. "Human factors and technical difficulties in the application of computers to psychiatry." In *Computers and Electronic Devices in Psychiatry.* Edited by Kline, N. S. and Laska, E. L. New York: Grune and Stratton, 1968.

Whiting, Joseph P., *Psychiatric Services, System Analysis, and Manpower Utilization,* a comprehensive statement of APA research in psychiatric manpower, along with recent findings about changes among subspecialties, geographic movement among psychiatrists, and distribution of professional activities. 184 pages, cloth bound, American Psychiatric Association, Washington, D.C., 1969.

Automated Clinical Records

Altman, H., Sletten, I. W., Eaton, M. E., and Ulett, G. A. "The Missouri automated standard system of psychiatry: Demographic and mental status profiles of patients with homicidal, assaultive, suicidal, persecutory, and homosexual ideation." Submitted for publication to *Psychiatric Quarterly,* October, 1969.

Binner, P. R. The Fort Logan Mental Health Center Record System: *A Six-year Overview.* Paper presented to the NIMH Conference on Automated Clinical Record Keeping Systems, Kansas City, Missouri, 1967.

Bross, I. D. J., Priore, R. L., Shapiro, P. A., Stermole, D. F., and Anderson, B. B. "Feasibility of automated information systems in the user's natural language." *American Scientist,* Vol. 57: pg. 193, 1969.

Craig, L., Golenzer, F., and Laska, E. "Computer constructed narratives." In *Computers and Electronic Devices in Psychiatry.* Kline, N. S. and Laska, E. (editors). New York: Grune and Stratton, 1968.

Eaton, M. E., Altman, H., Schuff, S., and Sletten, I. W. "The Missouri automated psychiatric history for relatives and other informants." (In press) *Diseases of the Nervous System,* 1969.

Eiduson, B. T., Brooks, S. H., Motto, R. L., Platz, A., and Carmichael, R. "Recent developments in the psychiatric case history event system." *Behavioral Science,* Vol. 12: pg. 254, 1967.

Eiduson, B. T., Brooks, S. H., Motto, R. L., Platz, A., and Carmichael, R. "New strategy for psychiatric research utilizing the psychiatric case history event system." In *Computers and Electronic Devices in Psychiatry.* Kline, N. S. and Laska, E. (editors). New York: Grune and Stratton, 1968.

Laska, E., Weinstein, A., Logemann, G., Bank, R., and Breuer, F. "The use of computers at a state psychiatric hospital." *Comprehensive Psychiatry,* Vol. 8: pg. 476, 1967.

Rosenberg, M., Glueck, B. C. Jr., and Bennett, W. L. "Automation of behavioral observations on hospitalized psychiatric patients." *American Journal of Psychiatry,* Vol. 123: pg. 926, 1967.

Rosenberg, M., and Glueck, B. C. Jr. "Further developments in automation of behavioral observations on hospitalized psychiatric patients." *Comprehensive Psychiatry,* Vol. 8: pg. 468, 1967.

Rosenberg, M. and Ericson, R. P. "The clinician and the computer — affair, marriage or divorce?" *American Journal of Psychiatry,* Vol. 125: (Jan. supplement) pg. 28, 1969.

Shapiro, P. A. "ACORN — An automated code of report narrative." *Methods of Information in Medicine,* Vol. 6: pg. 153, 1967.

Sletten, I. W. and Ulett, G. A. "Computer processing of clinical psychiatric information in the Missouri Division of Mental Diseases." *Missouri Medicine,* pg. 357-361 and 364, May, 1968.

Sletten, I. W., Ulett, G. A., Altman, H., and Sundland, D. "The Missouri standard system of psychiatry (SSOP); computer generated diagnosis." (In press) *Archives of General Psychiatry,* 1970.

Sletten, I. W., Ernhart, C. B., and Ulett, G. A. "The Missouri automated mental status examination: Its development, use, and reliability." Submitted for publication to *Comprehensive Psychiatry,* July, 1969.

Sletten, I. W., Schuff, S., Altman, H., and Ulett, G. A. "A statewide computerized psychiatric system: Demographic, diagnostic and mental status data." Submitted for publication to *British Journal of Social Psychiatry,* October, 1969.

Spitzer, R. L. and Endicott, J. "Automation of psychiatric case records: boon or bane?" (In press) *International Journal of Psychiatry,* 1970.

Ulett, G. A. and Sletten, I. W. "A statewide electronic data-processing system." *Hospital and Community Psychiatry,* pg. 74, March, 1969.

Assessment and Treatment Techniques

Colby, K. M. "Computer aided language development in non-speaking children." *Archives of General Psychiatry,* Vol. 19, No. 6: pg. 641, 1968.

Fowler, R. D. Jr., and Miller, M. L. "Computer interpretation of the MMPI." *Archives of General Psychiatry,* Vol. 21: pg. 502, 1969.

Fowler, R. D. Jr. "The current status of computer interpretation of psychological tests." *American Journal of Psychiatry,* Vol. 125: (supplement) pg. 21, 1969.

Glueck, B. C. Jr. and Stroebel, C. F. "The computer and the clinical decision process: II." *American Journal of Psychiatry,* Vol. 125: (supplement) pg. 2, 1969.

Hedberg, D. L., Houck, J. H., and Glueck, B. C. Jr. "Tranylcypromine-Trifluoperazine combination in the treatment of schizophrenia." (In press) *American Journal of Psychiatry*, 1970.

Klein, D. F., Honigfeld, G., and Feldman, S. "Predictions of drug effect by a successive scoring diagnostic technique." In Wittenborn, R. and May, P. (editors) *Prediction of Response to Pharmacotherapy*. Springfield, Illinois: Charles C Thomas (to be published).

Kleinmuntz, B. "MMPI decision rules for the identification of college maladjustment: A digital computer approach." *Psychological Monographs*, Vol. 74, No. 14, 1963.

Lang, P. J. "The on-line computer in behavior therapy research." *American Psychologist*, March 1969.

Overall, J. E. and Hollister, L. E. "Computer procedures for psychiatric classification." *Journal of the American Medical Association*, Vol. 187, pg. 583, 1964.

Rome, H. P., et al. "Symposium on automation techniques in personality assessment." *Proceedings of the Mayo Clinic*, Vol. 37: pg. 61, 1962.

Rosenberg, M., Glueck, B. C. Jr., and Stroebel, C. F. "The computer and the clinical decision process." *American Journal of Psychiatry*, Vol. 124: pg. 595, 1967.

Smith, W. G. "A model for psychiatric diagnosis." *Archives of General Psychiatry*, Vol. 14: pg. 521, 1966.

Spitzer, R. L. and Endicott, Jean. "DIAGNO II: Further developments in a computer program for psychiatric diagnosis." *American Journal of Psychiatry*, Vol. 125: (supplement) 1969.

Spitzer, R. L., Endicott, Jean, Fleiss, J. L., and Cohen, J. "The psychiatric status schedule: A technique for evaluating psychopathology and impairment in role functioning." *Archives of General Psychiatry*, Vol. 23: pg. 41, 1970.

Stillman, R., Roth, W. T., Colby, K. M., and Rosenbaum, C. P. "An on-line computer system for initial psychiatric inventory." *American Journal of Psychiatry*, Vol. 125: pg. 8, 1969 (supplement).

Simulation Techniques

Abelson, R. P. "Computer simulation of 'hot' cognition." *Computer Simulation of Personality*. Edited by Tomkins, S. S. and Messick, S. New York: John Wiley and Sons, Inc., 1963.

Abelson, R. P. and Carroll, J. D. "Computer simulation of individual belief systems." *American Behavioral Scientist*, Vol. 8: pg. 24, 1965.

Baker, P. B. "The internal organization of computer models of cognitive behavior." *Behavioral Science*, Vol. 12: pg. 156, 1967.

Bellman, R. "Mathematical model of the mind." *Mathematical Biosciences*, Vol. 1: pg. 287, 1967.

Bellman, R. and Friend, M. B. *On the construction of a simulation of the initial psychiatric interview*. (Paper presented at American Psychiatric Association annual meeting, May 1964).

Bellman, R., Friend, M. B., Kurland, L. *Psychiatric interviewing and multi-stage decision process of adaptive type*. The Rand Corporation, RM-3732-NIH, 1963.

Borko, L. (editor). *Computer Application in the Behavioral Science*. Englewood Cliffs, New Jersey: Prentiss Hall, 1962.

Buckley, W. *Modern systems research for the behavioral scientist*. Chicago: Aldine Publishing Company, Vol. 490, 1968.

Churchman, C. W. "An analysis of the concept of simulation." *Symposium on simulation models*. Hogatt, A. C. and Balderson, F. E. (editors). Cincinnati: South-Western Publishing Company, 1963.

Cogswell, J. F. *Clinical diagnostic model via computer simulation*. U.S. Government Research Report No. 13, pg. 133, 1963.

Colby, K. M. "Computer simulation of change in personal belief systems." *Behavioral Science*, Vol. 12: pg. 248, 1967.

Colby, K. M. "Programming in a computer model of neurosis." *Journal of Mathematical Psychology*, Vol. 1: pg. 405, 1964.

Colby, K. M. *A programmable theory of cognition and affect in individual personal belief systems*. (In press)

Colby, K. M. "Experimental treatment of neurotic computer programs." *Archives of General Psychiatry*, Vol. 10: pg. 220, 1964.

Fink, D. *Computers and the Human Mind*. New York: Anchor Books, 1966.

Gullahorn, J. and Gullahorn, J. *A Model of Elementary Social Behavior, Computers, and Thought*. New York: McGraw-Hill Book Company, Inc., 1963.

Loehlin: *Computer Simulation of Person*. New York: Random House, 1968.

Martin, E. W. "Electronic Data Processing." Illinois: Richard D. Irwin, Inc., 1965 (as quoted by Naylor, T. H. and Gianturco, D. T. in *Archives of General Psychiatry*, Vol. 15: pg. 294, 1966).

McGuire, M. T., Lorch, S., Coleman, R. "A model for the study of dyadic communication." *Journal of Nervous and Mental Disease*, Vol. 146: pg. 221, 1968.

Naylor, T. A. and Gianturco, D. T. "Computer simulation in psychiatry." *Archives of General Psychiatry*, Vol. 15: pg. 293, 1966.

Starkweather, J. A. "Computer simulation of psychiatry interviewing." In Kline, N. S. and Laska, E. *Computers and the Electronic Devices in Psychiatry*, New York: Grune and Stratton, 1968.

Stillman, R., Roth, W. T., Colby, K. M., Rosenbaum, P. "An on-line computer system for initial psychiatric inventory." *American Journal of Psychiatry*, Vol. 125, No. 7, 1969.

Weizenbaum, J. *ELIZA, a computer program for the study of national language communication between man and machine*. Comm. ACM 9, No. 1, pg. 36, 1966.

Psychophysiologic Applications

Clinical Laboratories

Blaivis, M. A. and Mencz, A. H. "Improved standardization and peak analyses utilizing a process control computer with autoanalyzer systems." *Automation in Analytical Chemistry, Technicon Symposia*, Vol. 1: pg. 133, 1967.

ECHO Member's Newsletter, Vol. 11, No. 8, 1968.

Etter, I. R. "Requirements for a data processing system for hospital laboratories." *Proceedings, AFIPS*, 1967 (Fall Joint Computer Conference).

Evenson, M. A., Hicks, G. P., Keenan, J. A., and Larson, F. C. "Application of an on-line data acquisition system using the LINC computer in the clinical chemistry laboratory." *Automation in Analytical Chemistry, Technicon Symposia*, Vol. 1: pg. 137, 1967.

Gould, H. E. "Computer automation in the clinical laboratory." *Automation in Analytical Chemistry, Technicon Symposia*, Vol. 1: pg. 141, 1967.

Hicks, G. P., Gieschen, M. M., Slack, W. V., and Larson, F. C. *Journal of the American Medical Association*, Vol. 196, No. 11, 1966.

Lettelier, G., Bleackley, L. M., Labarre, J., and Pack, R. A. "Data processing in an automated biochemical laboratory, progress report." *Automation in Analytical Chemistry, Technicon Symposia*, Vol. 1: pg. 127, 1967.

Pribor, H. C. "In-lab computer links directly to instruments." *Laboratory Management*, June, 1968.

Seligson, D. *Journal of Chronic Diseases*, Vol. 19: pg. 509, 1966.

Slack, W. V., Hicks, G. P., Reed, C. E., and Van Cura, L. *New England Journal of Medicine*, Vol. 247: pg. 194, 1966.

Slack, W. V., Peckha, B. M., Van Cura, L. J., Carr, W. J. *Journal of American Medical Association*, Vol. 200 pg. 224, 1967.

Electroencephalography

Brazier, M. A. B. (editor). "Computer techniques in EEG analysis." *Electroencephalographic and Clinical Neurophysiology*, Vol. 20: pg. 1, 1961 (supplement).

Brazier, M. A. B. "The application of computers to electroencephalography." *Computers in Biomedical Research*. Stacy, W. R. and Waxman, B. D. (editors). New York: Academic Press, Vol. 1: pg. 295, 1965.

Burch, N. R., Nettleton, W. J., Sweeney, J., and Edwards, R. J. "Period analysis of the electroencephalogram on a general purpose digital computer." *Annals of the New York Academy of Sciences*, Vol. 115: pg. 827, 1964.

Cohn, R., Leader, H. S., Weihrer, A. L., and Caceres, C. A. "Computer mensuration and interpretation of the human electroencephalogram (EEG)." *Computer Analysis of Electroencephalograms*, Digest of the 7th International Conference on Medical and Biological Engineering, Stockholm, 1967.

Drohocki, Z. "L'integrateur de l'electroencephalographic quantative." *Review of Neurology*, Vol. 80: pg. 619, 1948.

Fink, M., Itil, T., and Shapiro, D. "Digital computer analysis of the human EEG in psychiatric research." *Comprehensive Psychiatry*, Vol. 8: pg. 521, 1967.

Kaiser, E., Peterson, I., Sellden, U., and Kagawa, J. "EEG data presentation in broad-band frequency analysis." *Electroencephalography and Clinical Neurophysiology*, Vol. 17: pg. 76, 1964.

Leader, H. S., Cohn, R., Weihrer, A. L., and Caceres, C. "Pattern of the clinical electroencephalogram with a digital computer." *Electroencephalography and Clinical Neurophysiology*, Vol. 23: pg. 566, 1967.

Rodin, E. "A system of coding EEG reports for use by electronic computers." *Electroencephalography and Clinical Neurophysiology*, Vol. 13: pg. 795, 1961.

Electrocardiography

Caceres, C. A. "Electrocardiographic analyses by a computer system." *Archives of Internal Medicine*, Vol. 111: pg. 196, 1963.

Caceres, C. A. et al. "Computer aids in electrocardiography." *New York Academy of Sciences*, Vol. 118: 1964.

Caceres, C. A. "The use of computers in electrocardiography: The present and the future." *Academy of Medicine of New Jersey Bulletin*, Vol. 11, No. 2, 1965.

Dobrow, Robert J., et al. "Accuracy of electrocardiographic measurements by computer." *Computers, Electrocardiography and Public Health — A Report of Recent Studies*. Minneapolis, Minnesota: Control Data Corporation, 1966.

Freiman, A. H. and Steinberg, C. A. "The analysis of simultaneously recorded cardiovascular data with the digital computer." *Annals of the New York Academy of Sciences*, Vol. 115: pg. 1091, 1964.

Krasnoff, S. O., et al. "Acute myocardial infarction: Feasibility of utilizing electronic data processing apparatus to investigate a large series of cases." *Circulation Research*, Vol. 11: pg. 591, 1962.

Rikli, A. E., Telles, W. E., Steinberg, C. A., Carbery, C. A., Freiman, A. H., Abraham, S., and Caceres, C. A. "Computer analysis of electrocardiographic measurements." *Articulation*, Vol. 24: pg. 643, 1961.

Rikli, A. E., et al. "Metrology in cardiac disease detection." *Annals of the New York Academy of Sciences*, Vol. 115: 1964.

Stark, L., Okajima, M., and Whipple, G. "Computer pattern recognition techniques." *Communication of the ACM*, Vol. 5, No. 10, 1962.

Whipple, G. A., Dickson, J. F., Horibe, H. "Remote, on-line, real-time computer diagnosis of the clinical electrocardiogram." *Communications of the ACM*, Vol. 8, No. 1, 1965.

Whiteman, John R., et al. "Automation of electrocardiographic diagnostic criteria." *Journal of the American Medical Association*. Vol. 200, No. 11, 1967.

Concept Exchange Systems

Berul, L. H. *Information Storage and Retrieval: A State of the Art Report*. Philadelphia: Auerback Corporation, 1964.

Committee on information in the behavioral sciences, communication of systems and resources in the behavioral sciences. Division of behavioral Sciences, National Academy of Sciences-National Research Council, Publication #1575, Washington, D.C., 1967.

Cuadra, C. *Annual Review of Information Science and Technology*, Vol. I and II. New York: John Wiley & Sons, 1966 and 1967, respectively. Vol. III and IV. Encyclopaedia Britannica, Inc., Chicago, 1968 and 1969, respectively.

Lancaster, F. W. *Information retrieval systems: Characteristics, testing, evaluation*. New York: John Wiley & Sons, Inc., 1968.

Licklider, J. C. R. *Libraries of the Future*. Cambridge, Massachusetts: MIT Press, 1965.

Wilson, P. T. "Psychiatric information-exchange programs." *Hospital and Community Psychiatry*. Washington, D.C.: American Psychiatric Association, 1969.

Computer Facilitated Training

1. "Computer assistance for instruction." In: *International Science and Technology*, August 1967. pp. 29-97.
2. Frye, Charles H. "CAI languages: Capabilities and applications." *Datamation*, September 1968. pp. 34-37.
3. "Information." *Scientific American*, 215(3), September 1966.
4. Joint Economic Committee, Congress of the United States, August, 1966. "Automation and Technology in Education." *A Report of the Subcommittee on Economic Progress*. Washington, D.C., Superintendent of Documents; U.S. Government Printing Office. 1966.
5. Rogers, James L. "Current problems in CAI." *Datamation*, September 1968. pp. 28-33.
6. Rome, Howard P. "Human factors and technical difficulties in the application of computers to psychiatry." *Computers and Electronic Devices in Psychiatry*, Kline, N. S.; Laska, E., eds. New York and London: Grune & Stratton, 1968. pp. 37-44.
7. Schwartz, H. A., Long, H. S. "Instruction by computer." *Datamation*, September 1966. pp. 73-80.
8. Silberman, Harry F. "Applications of computers in education." *Programmed Learning and Educational Technology*. 5(1):7-17, January 1968.
9. "Special report on technology for education." In: *International Science and Technology*. August 1967. pp. 29-97.
10. Zinn, Karl L. "Programming conversational use of computers for instruction." *Proceedings of 23rd National Conference Association for Computing Machinery*, Princeton, N. Jersey: Brandon/System Press, Inc., 1968. pp. 85-92.