SESSION V CONTRIBUTED PAPERS: ON-LINE ASSESSMENT

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Computers in mental health care delivery: A review of the evolution toward interventionally relevant on-line processing

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The history of the application of computer technology to mental health care delivery is reviewed. Three separate trends are identified which suggest movement from batch processing administrative systems toward the development of interventionally relevant clinical systems based upon on-line computer technology. Suggestions for future research are made.

Computers first became widely available to behavioral scientists during the early 1960s. At that time, mental health professionals were optimistic that applications of this technology would lead to major innovations in health care delivery. This paper presents: a historical survey of the subsequent attempts to apply computer technology to bring about these hoped for innovations in health care delivery, a discussion of what has been learned to date from these early attempts, and suggestions for future research. It is hoped, thereby, to present a conceptual statement which is based upon previous reports in the scientific literature, our own efforts and experiences with the Utah Project, and extended discussions with other researchers in the field. As a general theme, we shall attempt to document the evolution from early applications of batch processing computer technology to mental health administrative systems, to what we have come to view as *interventionally relevant clinical systems* supported by on-line computer technology. The impetus for this

paper stems from a recent general disillusionment with progress in the field to date (cf. Lindberg, 1974), and from the current dialogue about how best to realize the promise that computer technology may indeed lead to major innovations in mental health care delivery (cf. the differing proposals by Klein, Greist, & Van Cura, 1975; Lindberg, 1974).

It is our contention that significant progress may be discerned from previous research efforts. We agree with the position articulated by Pollack, Windle, and Wurster (1974), namely, that the major shortcomings of previous research are traceable to the fact that computer "systems [have been developed] for needs which are as yet not specified and for uses which cannot be articulated" (p. 330). However, we also believe that some of the more recent work in the field has been addressed, appropriately, to influencing those clinical decision-making processes which are relevant to improved mental health care delivery.

HISTORICAL SURVEY

The general research area encompassed by the title "computers in mental health care delivery" has but a brief history. Its theoretical base stems, at least in part, from Meehl's (1954) monograph which concluded that statistical or actuarial prediction was equal or superior to clinical prediction. Its technological beginnings stemmed from the

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widespread availability by the early 1960s of moderately priced general purpose computer systems. When viewed in the perspective of the time spans required for the full-scale development of other emerging applications of technology during the 20th century (e.g., communications and transportation), this area of research may be seen to be but in its infancy. Behavioral scientists have been thinking about this problem for just over 2 decades. They have possessed the tools to begin their experiments for less than 15 years. It is from this perspective that the following review is presented.

Three major research trends in the application of computer technology to mental health care delivery may be discerned. The first two trends began nearly simultaneously in the early 1960s, following the marketing of moderately priced general purpose computer systems by several vendors. These trends may be categorized as: (1) the development of automated patient data systems, and (2) the development of automated clinical techniques. The third major trend is more recent. It appears to have evolved conceptually from the successes and shortcomings of the initial two trends, as well as from continuing technological progress which led to the marketing of on-line computer systems by the late 1960s. This more recent trend can be categorized as: (3) the development of interventionally relevant automated techniques.

Development of Automated Patient Data Systems

Hypothesizing that the application of computer technology in mental health care delivery would lead to major innovations, behavioral scientists began to collaborate with computer manufacturers around 1960. The goals of the initial projects arising from these collaborative efforts appear to have been influenced greatly by mental health administrators and computer vendors. Perhaps because of this, early systems emphasized administrative applications, the reduction of paper chart material, and consolidation of patient information into a central file.

In 1962, an IBM 1440 computer system was installed at the Camarillo State Hospital "to develop techniques for handling the data that a psychiatric hospital generates and uses in carrying out its mission" (Graetz, 1966, p. 26). At the same time, a similar system was installed at the Institute of Living (IOL). The goal of the IOL system was to eliminate paper work at nursing stations and throughout the hospital (Glueck, 1974). These projects failed to achieve their original goals, primarily because of the primitive state of the available computer hardware (Glueck, 1974), staff resistance, and an initial underestimation of the complexity of the tasks (Graetz, Note 1). By the middle 1960s, the Camarillo Project was terminated and work in this area was deferred at the IOL Project.

Despite these initial setbacks, developmental work continued on automated patient data systems. Recently, administrative data bases have been expanded to collect clinical information systematically through the use of self-report inventories and structured interviewing techniques. The primary objectives of these systems continue to be the development of readable charts and the collection of standardized patient data. Such systems are advantageous in that they insure the collection of comparable patient data across treatment units, and even across multiple mental health care delivery institutions.

After the early deferral referred to above, continuing progress at the IOL Project has led to the development of an extremely sophisticated automated patient data system (Glueck, 1974).

The Multi-State Information System (MSIS), which is based at the Rockland State Hospital (Laska, Logemann, & Weinstein, 1971; Laska, Logemann, Honigfeld, Weinstein, & Bank, 1972), accumulates and processes data derived from 300,000 patients annually. These patients are treated in no less than 700 psychiatric facilities in seven different states. The MSIS emphasizes traditional administrative statistics such as census, patient movement, and drug utilization, and concise and objective recording of traditional clinical functions, such as the psychiatric anamnesis and the mental status examination (Laska, Note 2).

The Missouri Standard System of Psychiatry (SSOP), which is based at the Missouri Institute of Psychiatry (Sletten, Ulett, & Hedlund, Note 3), attempts to integrate administrative and clinical information derived from psychiatric facilities located throughout the state of Missouri. The SSOP utilizes a series of standardized forms which are forwarded to a central computer system for processing. This system has important innovative capabilities for gathering data in less traditional clinical areas, such as social functioning and community adjustment.

The Computer Support in Military Psychology System (COMPSY), which is based at the Walter Reed Hospital, is a clinically oriented Army-wide psychiatric information system that is being developed to "objectify, systematize, and make available data concerning psychiatry from [the patient's] identification in the field, through [his] hospital course and treatment, to [his] reintegration within the community" (Morgan, Note 4).

Other, less well-known automated record-keeping systems are in operation at the Langley Porter Neuropsychiatric Institute (Strotz, Malerstein, & Starkweather, 1969), the Norristown State Hospital (Lipton, Lawton, Kleban, McGuire, DeRivas, & Cosell, Note 5), the Reiss-David Child Study Center (Eiduson, 1966), the Singer Community Mental

Health Center (Ulett & Sletten, 1971), the Fort Logan Mental Health Center (Wilson, 1974), and the Forest Hospital (Meldman, Note 6).

Development of Automated Clinical Techniques

The second major trend in the history of the application of computer technology to mental health care delivery also began in the early 1960s. The goals of this trend were to automate psychological, psychiatric, social work, and nursing procedures and techniques. In this research area, the initial program objective has usually been to determine whether a standard clinical technique could be automated. Several differences from the first trend may be noted. The behavioral scientists, rather than mental health administrators or computer vendors, appear to have determined what information and instruments should be computerized. Individual research programs have tended to be molecular rather than molar in scope. Finally, the effect of these projects has been to simulate, rather than to monitor, clinical practice.

Psychological testing. Psychological testing is the clinical area which has received the most attention from computer-oriented behavioral scientists. Early efforts in this area were aimed solely at mimicking human scoring and interpretation of test results. In recent years, however, attempts have also been made to include automated administration of tests.

Computerized systems for several personality instruments have been developed. Beginning with the Mayo Clinical Program (Pearson, Swenson, Rome, Mataya, & Brannick, 1965), the most common application of computer technology to psychological testing is MMPI interpretation. Fowler's (1972) review lists seven different commercial MMPI interpreting services. Computerized interpretation programs have also been developed for several other standard personality instruments, namely, the Rorschach (Piotrowski, 1964), the California Psychological Inventory (Finney, 1966), the Sixteen Personality Factor Questionnaire (Karson & O'Dell, 1975; Eber, Note 7), the Sentence Completion Test (Veldman, 1967), the Holtzman Ink Blot Test (Gorham, 1967), and the Kelly Role Construct Repertory Test (Space, 1975). Recently Lushene, O'Neil, and Dunn (1974) reported the development of a system in which the MMPI was administered, scored, and interpreted by an on-line computer system. Kleinmuntz and McLean (1968) have developed a system which not only administers the MMPI, but also branches through the item base, depending upon the patient's responses to previous items.

Several instruments for the measurement of intellectual functioning have been automated, namely, the Slosson (Hedl, O'Neil, & Hansen, 1973), the Peabody Picture Vocabulary (Space, 1975), and WAIS (Elwood & Griffin, 1972). This work is

particularly interesting because of the specialized on-line equipment which has been developed for computerized administration.

Psychiatric techniques. Automation has been applied to such psychiatric techniques as the psychiatric examination, diagnostic decision making, and computer-conducted patient interviewing.

Early efforts in automating the psychiatric examination involved structuring the interview used by a skilled clinician. Structured interview instructions and recording sheets were developed which were modeled after the usual clinical interview. The recording sheet was designed to be compatible with computer input devices, such as the optical scanner. Structured interview schedules have been developed for this purpose and are presently used by the MSIS (Laska, Simpson, & Bank, 1969), the IOL Project (Donnelly, Rosenberg, & Fleeson, 1970), and the SSOP (Sletten, Ulett, & Hedlund, Note 3). Additional structured interview schedules have been developed at the Biometrics Laboratory of the New York State Psychiatric Institute and include the Psychiatric Status Schedule (Spitzer, Endicott, Fleiss, & Cohen, 1970), the Psychiatric Evaluation Form (Herz, Endicott, Spitzer, & Mesnikoff, 1971), the Current and Past Psychopathology Scales (Endicott & Spitzer, 1972), and the Mental Status Schedule (Spitzer, Fleiss, Endicott, & Cohen, 1967).

Structured interview schedules, although extremely relevant for research purposes, have little clinical utility when used only for standard data collection. Much more can be gained if printed reports are automatically generated for the clinician from the data collected using one of these structured interview schedules. SCRIBE (Laska, Morrill, Kline, Hackett, & Simpson, 1967), NOVEL (Craig, Golenzer, & Laska, 1968), and PROSE (Johnson, Cole, & Williams, 1975) are computer programs which have been developed to generate such printed reports from structured interview data.

To date, the major clinical contribution of computer-interpreted psychiatric interview schedules has been the generation of a DSM-II diagnosis. Work in this area was pioneered by Spitzer and Endicott (1968) with the development of the DIAGNO and DIAGNO II programs. Ninety-four ratings derived from a structured interview provide input to the DIAGNO II program. This program then generates as its output one of 44 DSM-II diagnoses or a statement of either "nonspecific illness" or "no illness." These computer-derived diagnoses have been shown to agree with clinicians' diagnoses as well as clinicians agree with each other (Spitzer & Endicott, 1969). A newer version of this program, DIAGNO III, has 79 possible DSM-II diagnoses, lists the alternative diagnoses for which there is "strong evidence" and "some evidence," and prints out the rationale for the diagnostic decision (Spitzer & Endicott, 1974).

Other automated diagnostic techniques which are not based upon input derived from structured interviews have been developed by Kraus (1972), Overall and Gorham (1963), Overall and Hollister (1964), and Stroebel and Glueck (1972).

Two approaches to total automation of the psychiatric interview have been undertaken. Both require the use of on-line computer technology. The first approach is best represented by the work of Colby, Watt, and Gilbert (1966), who have attempted to develop a program whereby psychiatric patients can be "interviewed" directly by a computer terminal connected to an on-line computer system using free-form language input. Hilf (1972) has since reported, however, that this program proved to be "incapable of conducting useful interviews" (p. 410). In that same report, a modified computer interview which used a human translator was described. Hilf, Colby, Smith, Wittner, and Hall (1971) have also reported a system where both the patient and the clinician were seated at on-line terminals and the computer was used to mediate their interaction. Given the present state of computer technology and the expense of these systems, it appears that this approach will be limited to research applications for the foreseeable future.

A second approach to total automation of the psychiatric interview involves systems in which the computer presents a series of true-false or multiple-choice questions to which the patient must respond. This approach utilizes branching logic in order to avoid irrelevant questions. Examples of this approach include computerized interviews for obtaining information about the psychiatric history (Maultsby & Slack, 1971), suicide risk (Greist, Gustafson, Strauss, Rouse, Laughren, & Chiles, 1973), drug use (Greist, Klein, Van Cura, & Erdman, Note 8), and psychiatric target symptoms (Greist, Klein, & Van Cura, 1973). Recently, an interview program for psychodiagnosis has been reported by Brooks and Kleinmuntz (1974).

Social history. Computerization of the social history has been undertaken using both patient self-report and structured interview methods. The Briggs History Record (Briggs, Rouzer, Hamberg, & Holman, 1972) is a self-report system which has been administered, scored, and interpreted by computers in at least two locations (Johnson & Williams, 1975; Lushene, Note 9).

A social history using a card sort has been developed at the Walter Reed Hospital (Morgan, Note 4). A self-administered history has also been developed at the Foothills Hospital (Pearce, Note 10). In addition, structured interview methods for computerization of the social history are used by the MSIS (Laska, 1974) and by the SSOP (Sletten et al., Note 3).

Nursing techniques. Automated nursing notes have been developed at the IOL (Rosenberg & Glueck, 1969; Rosenberg, Glueck, & Bennett, 1967).

Items of information are collected in checklist format about treatments and behaviors. Following computer analysis, results can be reported in a manner which reveals trends in behavioral change in relationship to treatments administered (Stroebel & Glueck, 1970).

Development of Interventionally Relevant Automation Techniques

Despite the wide variety and the considerable accomplishments of projects undertaken during the 1960s, by the early 1970s there was an undercurrent of discouragement in the field (Klein et al., 1975). Behavioral scientists with an interest in computerization had concentrated their efforts on automation projects, the goals of which were greatly influenced by mental health administrators or computer manufacturers, or upon projects of personal interest to themselves. They had not consulted with clinicians regarding what was really needed to assist them in performing a better job of providing mental health care. As a result, clinicians tended to view with skepticism the early attempts to apply computer technology to mental health care delivery. These initial negative reactions by clinicians served as the catalyst that has resulted in what has been identified as the third major trend in the field, which began in the early 1970s. Its general goals are to develop "need-based," or "interventionally relevant," applications of computer technology for mental health care delivery. The focus of these projects is to provide solutions to previously identified problems which exist in the domain of mental health care delivery. The computer is viewed as but a tool to provide the clinician with data that will be of assistance in decision making. Many of these computerized procedures were actually developed in the earlier pioneering work of the 1960s, but they were viewed then as endpoints in themselves, and not merely as mechanisms to assist in clinical decision making.

Interventionally relevant research begins with a comprehensive analysis of a total mental health care delivery system. The system and its decision points are flow charted. Strengths, weaknesses, and problems are identified. Based upon this systems analysis, changes in subsystems are proposed which are judged to be likely to lead to improvements in the performance of the total mental health care delivery system. Where an application of computer technology is deemed necessary to effect these improvements, this application may be considered to be an interventionally relevant automation project.

Pioneering work in this trend was performed both at the SSOP and at the IOL Project. Specific problems in clinical decision making were identified on treatment units. Areas in which computer-generated information could be expected to lead to improvement in important aspects of day-to-day clinical decision making were identified, and computerized applications were then implemented.

One early area of research involved using the computer and its data base for the assignment of psychotropic drugs (Altman, Evenson, Sletten, & Cho, 1974; Evenson, Altman, Cho, & Sletten, 1974a; Evenson, Altman, Cho, & Sletten, 1974b; Sletten, Altman, Evenson, & Cho, 1973; Evenson, Altman, Sletten, & Cho, Note 11). Other similar research efforts include projects that attempted to predict the likelihood of treatment success (Mirabile, Houck, & Glueck, 1971), length of stay and elopement (Evenson, Altman, Cho, & Sletten, 1973), and the danger of the patient to others (Hedlund, Sletten, Altman, & Evenson, 1973).

Linkenluoker and McCarron (1974) have recently presented an innovative strategy for computerized assessment of juvenile delinquents. This system generates specific diagnostic statements and recommendations for individualized treatment programs for individual delinquents. It was developed to provide court officials with needed information that had been available previously, but at prohibitive cost and after unacceptably long delays.

An interventionally relevant automation program currently is underway at the Veterans Administration Hospital in Salt Lake City and the University of Utah College of Medicine. This project began with a comprehensive systems analysis of the mental health care delivery system which existed at the VA facility in 1971 (Williams, Johnson, & Bliss, 1975). As a result of that analysis, it was concluded that a coordinated series of specialized treatment units could be expected to lead to improved patient care. Furthermore, it was concluded that systematic monitoring of clinical change would be helpful to assess the correctness of intake triage dispositions to the various specialized treatment units, and to assess whether the system of specialized treatment programs was capable of satisfying the needs of patients residing within the catchment area served by the facility.

A separate clinical assessment unit was proposed to perform evaluations of patients prior to intake triage decision making, and again prior to discharge. Traditional clinical procedures required for comprehensive standardized diagnosis and assessment were considered to be too costly since they usually are performed only by highly trained professional staff, too time consuming since multiple interviews and delays for composing and transcribing reports are required, and, finally, too aversive for professional staff since the tasks quickly become routine when performed repetitively. To minimize these problems, it was determined to develop a computer-assisted system to expedite the assessment process. An on-line, rather than a batch process, computer system was required in order to gather, interpret, and print results of patient data quickly

enough for real-time clinical decision making. Certain data could be gathered directly from patients using interactive cathode ray tube terminals (CRTs). Other routine data could be collected efficiently by paraprofessional personnel who, prompted by structured interview schedules presented on the CRTs, could enter information into the computer system. The computer could then perform analyses of these data, and generate assessment reports, in order that results could be used to assist professional clinical staff members with intake and discharge decision making. Based upon these predetermined clinical criteria, an on-line computer support system was designed (Coie, Johnson, & Williams, 1975).

The system now in operation at the Utah Project uses automation in order to complete a timely, inexpensive, and comprehensive evaluation of psychological, medical, and social problems for intake decision making (Johnson, Giannetti, & Williams, 1975; Johnson & Williams, 1975). Because data obtained at intake are maintained in computer storage as long as a given patient is in an active treatment status, and because the assessment unit functions independently of treatment units, relatively unbiased measurement of treatment outcome is easily accomplished by repeated assessment prior to discharge from active treatment status.

Automation at the Utah Project is interventionally relevant because it was developed in order to solve mental health care delivery problems which were determined after thorough systems analysis. The computer does far more than mimic the clinician; it provides the means whereby he can improve decision making at intake, and whereby he can receive unbiased standardized evaluations regarding the efficacy of his treatment interventions.

DISCUSSION

During the course of the first 15 years of research on the application of computer technology to problems of mental health care delivery, clearly discernible developmental trends may be identified. Initially, large-scale data gathering and tabulation systems were implemented to assist in the processing of administrative information. Despite such shortcomings as generally poor acceptance by clinicians (Hedlund, Note 12), the continuing viability of these systems suggests that they do have utility (Newton, Note 13). Secondly, a number of clinical techniques were automated. Research in this area has been notable for the diversity of clinical techniques which have been shown to be amenable to automation. While many methodological problems have been noted (e.g., Hedlund, Morgan, & Masters, 1972; Karson & O'Dell, 1975), and acceptance by clinicians remains poor, wide acceptance of automated personality test inter-

pretation programs (Fowler, 1972) lends credence to this area of research endeavor. Finally, interventionally relevant computer research is now underway. This research holds promise of bringing about important innovations because it builds upon the success and failures of previous work, and because it aims to harness the unique capabilities of computer technology to systems theory in order to evolve new methods and procedures for mental health care delivery.

Throughout the past 15 years, there has been movement from the use of batch processing computer technology to on-line technology. This movement reflects a change in direction from computer applications in administrative areas that do not require on-line solutions (Morgan & Crawford, 1974) to research which is clinically relevant. As knowledge has progressed, it has become increasingly apparent that the unique capability of computer technology is high-speed data manipulation. Computer processing makes it possible to store, access, calculate, and combine large quantities of quantified data which would have been impossible in the past without a large number of support personnel and extended periods of time. Because of this, clinicians can now be provided with new forms of information relevant to their treatment decision making. Since these interventionally relevant decisions occur in real-time, strategies which rely upon on-line computer support systems are now required.

SUGGESTIONS FOR FUTURE RESEARCH

In this paper, it is emphasized that applications of systems theory, rather than applications of improved computer technology, *per se*, offer the greatest promise for critical examination and enhancement of conventional practices in mental health care delivery. It must be acknowledged, however, that constraints imposed by computer technology do set limits on practical applications of systems theory. For example, the advent of minicomputer technology has greatly increased the range of computer applications now possible at a reasonable cost. Minisystems, which possess much greater computing power than the systems installed initially at the IOL and the Camarillo State Hospital, can be purchased at one-tenth the cost of those original systems. It is our contention that the simultaneous application of systems theory and sophisticated on-line computer technology, which is only now approaching fruition, will positively and significantly impact mental health care delivery in the future.

Future applications of systems theory and computer technology should aim to provide the clinician with new types of information which he has always needed, but has been unable to obtain heretofore. This information should be specifically

germane to the decision-making requirements of the clinician. Because such applications will be aimed at augmenting the clinician's decision-making processes, rather than attempting to replace or monitor them, clinician acceptance should follow rapidly.

Behavioral scientists working in this area should attempt to utilize decision and systems theory, which follows a well-defined strategy. The decision processes in mental health care delivery must be subjected to a thorough systems analysis (cf. Schaefer, Note 14). Relevant patient care decisions, and data requirements for each decision, must be specified. For each decision, the following must be determined: (1) decision-relevant input information requirements, (2) criteria for various decision alternatives, and (3) possible outcomes associated with each decision alternative. Where information is not available in any of these specific areas, computerized data base techniques may be employed to obtain such information. Once data are available, computer algorithms can be constructed to provide probabilistic information about possible outcomes.

As an example of how decision and systems theory may lead to an interventionally relevant application of computer technology, consider the initial patient flow decision that must be made by a mental health treatment facility whenever a new applicant applies for care, namely, should, or should not, that applicant be admitted for care? Relevant input information required for this decision might include the following: eligibility for treatment at that facility; adequacy of the applicant's present environmental support system; and nature, severity, and disabling quality of symptomatology. Basic criteria for the decision to admit for care might include: the applicant is eligible for care at that facility, and there is some probability of improvement in one of the available treatment programs. Outcomes associated with the decision to admit for care might include: amount of improvement measured at discharge and measurement of disabling effects related to psychiatric hospitalization, *per se*. Outcomes associated with the decision to deny admission might include: self-injurious behaviors such as suicide, behaviors injurious to others, and dependence upon other social agencies.

If data regarding input-decision-outcome combinations can be collected from a clinical data base which is sufficiently large, computations can be performed in order to provide information about the relative severity of symptoms and the likelihood of improvement, as well as the probabilities of occurrence of each identified outcome related to each decision choice. Once this information is available to the clinician responsible for the admissions decision, it seems likely that his decision-making ability will improve. Furthermore, the system may be so designed that data gathered from all previous patients are automatically used to update probability

computations, thus leading to additional improvements because of the "learning capabilities" of the system. Such a system should lead to improved patient care, due to its salubrious effect on clinical decision making.

Several other obvious clinical decision-making situations in which interventionally relevant approaches would be helpful include: determination of the type of overall treatment plan for a given patient, the type of specific treatments (e.g., medications, talk therapies, behavior modification, etc.), adjustments to the overall treatment plan, the time and type of discharge, and the kind of posthospitalization treatment. In each case, specification of decision processes would dictate information needs that can be provided through applications of computer technology and which cannot be provided through current clinical methodologies.

On-line computer technology, appropriately applied to tasks identified by prior systems analysis as interventionally relevant for gathering, storage, analysis, and reporting of clinical data, may be expected to provide clinicians with the information needed to improve day-to-day and hour-to-hour patient care. If such interventionally relevant applications of computer technology can be effected, then the earlier hopes that computers may facilitate improvements in mental health care delivery will begin to be realized.

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