This paper reviews the development and current status of computer-supported mental health information systems. It describes and provides principal references both for general and for specialized information systems in a wide variety of application areas. It also comments on some of the special problems and emerging directions of computer applications in the mental health field.

Introduction

In the mid-1960's, Rome spoke of psychiatry as being "on the threshold of a fourth quantum advance" and suggested that computerized mental health systems would "achieve what never has been available before -- a valid data-base for psychiatry's assumptions [and] treatments..." (p. 451). Well over a thousand related articles have appeared in the literature during the past decade-and-a-half, and progress has been monitored by a number of reviews and summaries. It is the purpose of this paper to briefly describe that progress, to identify some of the principal current references for each major application area and highlight its current status, and to comment on some of the special problems and emerging directions of computer applications in mental health.

Dr. Hedlund is also Director of the Mental Health Information Systems Project at the Health Services Research Center/Health Care Technology Center, University of Missouri-Columbia. This paper draws heavily on extensive literature reviews conducted by that Project in preparation for a technical report, annotated bibliographies, and an eventual position paper that will include recommendations to the Center concerning their stimulation, encouragement, and support of mental health information systems research and utilization. Bruce W. Vieweg, M.S., Dong W. Cho, Ph.D., Richard C. Evenson, Ph.D., Constance V. Hickman, B.S., Richard A. Holland, M.A., Susan A. Vogt, Constance P. Wolf, M.L.S., and John B. Wood, Ph.D. have materially contributed to this review.
of tabulations annually" (p.320). By 1963, 35 states met such criteria and participated in this standard statistical reporting program.

Fort Logan Mental Health Center, with NIMH funding, was one of the first mental health settings to automate a relatively comprehensive psychiatric patient record system.10,11 It has been operational since 1961, and is of special interest not only because of its detailed clinical data, its goal-oriented progress notes and evaluation emphasis, but because of its very limited computer requirements. Fort Logan still neither owns nor leases its own computer; it operates its extensive system on a time rental basis either with locally installed remote computer terminals or, for very large jobs, with periodic computer runs at locally available computer centers.

Camarillo State Hospital in California is generally agreed to have been the first large inpatient facility to attempt to computer process comprehensive psychiatric case record data in a time frame that would be prompt enough to be of day-to-day clinical assistance. This system, which was developed with NIMH funding from 1962 to 1965,12 was terminated largely because of inadequate local and state administrative support, funding problems, and the resistance of a tradition-minded staff.

In early 1965, the first real-time, interactive psychiatric information system became operational at The Institute of Living, a 400-bed private mental hospital.13 This system, which was also partially funded by NIMH, has served as an operational model for many other mental health information systems because of its "early emphasis on clinical applications devoted to enhancing individual patient care rather than on automation of hospital business, administrative, and statistical functions." (p. 414). The development of two other large mental health information systems that are still fully operational also began in the mid-1960s. The Missouri Department of Mental Health's state-wide information system provides extensive support to five large mental hospitals, three large community mental health centers, three state schools and hospitals for the mentally retarded, and nine smaller regional centers for the developmentally disabled.14,15 The Multi-State Information System (MSIS), developed under NIMH support at the Rockland Research Institute, provides support for a large number of mental health facilities from many different states and several foreign countries.7,16 These three systems are summarized in Table 1.

The central computers for these three systems range from two mini-computers to relatively large third generation central processing units. Only The Institute of Living system, which was pioneered with a small second generation IBM 1440, was developed specifically for the use of cathode ray or "TV-like" terminals (CRTs) that provide for direct user input and output interactions with the central processor; the other two systems rely on rapid "batch-queue" processing which accepts input messages as soon as the computer can handle them and outputs reports or messages on printers located in a data processing office at the using facility. Although the Rockland MSIS did not originally include computer support for business and administrative functions, it has been developing extensive business applications over the past several years.

The Multi-State Information System is the only general MHIS which is available "commercially." It's software (computer programs), which is compatible with any IBM 360 of 370 model computer, may be purchased for installation on the user's own computer system, or MSIS user applications may be processed by the MSIS computer center at Rockland Psychiatric Institute in Orangeburg, New York.

Table 2 summarizes the types of information that are contained in various mental health information systems. As can be seen, most clinical content areas may be represented: identifying and demographic data, clinical assessment, treatment, progress and follow-up data. Such computerized information is normally obtained from clinical checklists, rating scales and other standardized forms (or CRT screens) which are completed by clerks, the patient, members of the mental health team or a community informant at various times during or following patient care. This information tends to be highly structured, with a minimum amount of free form narrative and idiosyncratic detail. Although initial attempts have often been made to comprehensively reflect all types of data normally found in a manually kept individual patient record, there has been an increasing tendency to become more selective and to key on data which is most relevant to specific requirements and decision making processes. Types of business and administrative information tend to parallel the computer applications of other medical or non-medical business systems.

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Some of the types of general MHIS uses or applications are classified in Table 3. Bookkeeping and documentation, of course, are the most simple and direct types of application. A wide variety of patient census and statistical reports can be generated, depending upon exact file characteristics and specific needs. Computer-generated clinical reports are also available for individual patients, normally with each type of checklist or clinical data collected -- such reports may include a simple listing of problems, significant findings or treatment procedures, a complex narrative description, and/or quantitative measures of specific behavior (e.g., amount of anxiety, depression, hostility, confusion, etc.). Community mental health consultation and indirect services such as research, in-service teaching and supervision, mental health lecturing, etc., are also documented by some MHIS subsystems. Patient billing and appointment scheduling are simple examples of business or administrative applications closely related to clinical information systems. Other business applications, of course, involve personnel records and actions, budget and accounting operations, property and inventory controls, and the like.

Monitoring individual patient care. Computer-generated reports can provide clinicians, supervisors and other auditors with information about which patients have been worked up to what degree, which patients are receiving what types of treatment for what types of problems, which patients have unusual lengths of stay, which patients are receiving multiple or even antagonistic medications, etc. Computer processing of sophisticated patient assessment and progress reports can yield quantitative and comparative information that highlights patient change (or lack of it), and special computer applications using such data have been developed for facilitating clinical decisions about each patient's response to treatment. The systematic integration of patient problems, treatment objectives or goals, the specific treatment provided, and patient progress can also be computer supported by problem-oriented psychiatric record applications or by the computer-assisted, goal-

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Table 1

<table>
<thead>
<tr>
<th>Institute of Living</th>
<th>Missouri MHISA</th>
<th>Rockland MSISB</th>
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<tbody>
<tr>
<td>Users</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single Private Hospital</td>
<td>No. Dept. of Mental Health</td>
<td>Many states</td>
</tr>
<tr>
<td></td>
<td>- many facilities</td>
<td>Many facilities</td>
</tr>
<tr>
<td>Central Computer(s)</td>
<td>IBM 370/155</td>
<td>IBM 360-67</td>
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<tr>
<td></td>
<td>(Will operate on any IBM 360 or 370 model)</td>
<td></td>
</tr>
<tr>
<td>Remote Terminals</td>
<td>CRTsC - many locations</td>
<td>One location per facility:</td>
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<tr>
<td></td>
<td></td>
<td>Card Reader or CRTsC</td>
</tr>
<tr>
<td>Principal Type(s) of Input</td>
<td>Key-to-disk entry</td>
<td>Card Reader or CRTsC</td>
</tr>
<tr>
<td></td>
<td>CRT</td>
<td>Line Printer</td>
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<tr>
<td>Clinical Applications</td>
<td>Optical Scan</td>
<td>Optical Scan</td>
</tr>
<tr>
<td></td>
<td>Many</td>
<td>Key-to-disk entry</td>
</tr>
<tr>
<td>Business/Administrative Applications</td>
<td>Many</td>
<td>Extensive</td>
</tr>
<tr>
<td></td>
<td>Extensive</td>
<td>Extensive</td>
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</table>

*Mental Health Information System
*Multi-State Information System
*Cathode Ray Terminals
Table 2

General Mental Health Information Systems:
Types of Data Processed

Typical Types of Patient Information:

a. Identifying and routine demographic data.
b. Admission, patient movement, disposition data.
c. Clinical evaluation and testing information --
   E.g., Mental status examination. Physical examination and medical history.
   Social and developmental history. Problem or symptom scales.
   Laboratory data.
   Psychological screening test data (notably MMPI).
   Special actuarial reports.
d. Diagnoses.
e. Services provided --
   E.g., Number and type of patient contacts.
   Medication information.
f. Progress and patient change information --
   E.g., Automated nursing observations. Special patient progress and adjustment scales.
   Repeated measures from clinical evaluation and testing procedures.
   Goal-attainment scales and ratings.
g. Special post-treatment (follow-up) data --
   E.g., Patient contacts. Collateral information.
f. Standardized problems and problem-specific treatment data.

Community Consultation and Indirect Services Data.

Business and Administrative Systems Data--

E.g., Billing information.
Personnel and payroll data.
Fiscal and accounting information.
Property and inventory accounts.

 oriented progress note. Professional-review functions that involve the monitoring and auditing of individual patient records can also be significantly facilitated by computer support.27-34

Actuarial predictions/suggestions. Large, well-structured and readily accessible clinical data bases of the comprehensive MHIS have supported multivariate statistical studies which have led to sophisticated prediction applications associated with computer diagnosis, the likelihood of danger to self or others, psychotropic drug assignment, patient length-of-stay, and the like.35 Despite strong evidence that the computer and carefully developed prediction models can do at least as well as the clinician whenever explicit criteria are available, such applications continue to meet with a good deal of clinical resistance and skepticism (see, e.g., Hedlund, Evenson, Sletten and Cho36).

Table 3

General Mental Health Information Systems:
Types of Applications

Bookkeeping and Documentation:

a. Patient Census and Statistical Reports.
b. Individual Patient Records.
c. Community Consultation and Indirect Services.
d. Business and Administration Records.

Monitoring Individual Patient Care:

a. Screening and Assessment.
c. Problem or Goal Oriented Progress
   d. Professional Review and Audit (including PSRO).

Actuarial Predictions/Suggestions:

a. Diagnosis.
b. Treatment Choice.
c. Length-of-Stay.
d. Dangerousness to Self or Others.

Program Evaluation and Planning:

b. Outcome Evaluation.
c. Cost-Effectiveness.

Clinical Research.
Program evaluation and planning. Systematic documentation of patient difficulties, treatment procedures, patient progress and follow-up information in a well-structured and readily available computer database obviously also lends itself to evaluation of program effectiveness.37-52 "Process" evaluation -- i.e., the systematic analysis of who does what to whom for what reason -- is readily available for those elements of a mental health program that collect such information. "Outcome" evaluation, of course, requires specific information about patient changes with treatment, and special follow-up applications have been developed to collect and process such types of information.43 To the extent that costs and resources information are an integral part of the MHIS, along with data for the evaluation of treatment efficacy, even cost-effectiveness studies can be undertaken.53 Special computer applications have also been reported concerning utilization review and needs assessment32,54-57 -- to help assure equitable access to mental health care among minority and underprivileged groups.

Clinical research applications, which overlap many of the other types of use, are legion. Careful analyses of systematic data that collect such information can be undertaken.53 Special computer applications have also been reported concerning utilization review and needs assessment32,54-57 -- to help assure equitable access to mental health care among minority and underprivileged groups.

Specialized Mental Health Information Systems

Also increasingly being reported are mental health information systems that are designed for specific mental health program settings, e.g., the community mental health center,39,40,45,44,58-62 alcohol abuse programs,63-65 and mental retardation.66-68 Indeed, two papers in this symposium involve such special settings: Dr. Crawford and his associates will be describing a comprehensive, computer-supported behavioral rehabilitation system that has provided some very promising results in a major pilot study with a school and hospital for the mentally retarded; and John Paton and Dean Mayberry will be discussing a management information system for a mental health center.

Many specialized mental health information systems, of course, are or could be integral parts of a larger, general MHIS. Computer-assisted screening and history taking that involves the direct interaction of the patient with a teletype or cathode ray computer terminal are typical examples.69-76 Such applications, often referred to as computer-assisted "interviewing," ask the patient a series of standard questions that are usually answered in a yes/no or multiple-choice form. The patient responds to each question that appears on the TV-like screen (or teletype printer) by pressing an appropriate key or touching the screen at an appropriate spot. Sometimes the patient is also required to "type" brief demographic information and/or brief free-form responses to screening and history questions. Data about each patient is thus communicated directly to the computer for storage and processing. One advantage of this type of computer-assisted interviewing is that "branching" techniques can be used to select each successive question depending on the patient's response to previous ones. Thus, a considerable amount of detailed information may be obtained in areas that have special significance for a particular patient without having to burden all patients with detailed questions in areas that do not have personal significance for them (much as in a normal interview situation). Controlled studies conducted with such applications have quite uniformly demonstrated their feasibility and, in terms of general patient acceptability. This type of application will be more fully discussed in Dr. Slack's session on "Introduction to Computer-Patient Dialogue." Although that symposium will be concerned with such applications in medicine, generally, Dr. Greist's paper, "Computer Interview-Beyond Data Collection," provides some very innovative and exciting illustrations within the area of mental health.

A good deal of work has been reported in the development and use of automated equipment for the standardized display of psychological testing materials, and for the recording, scoring and/or interpretation of subject responses.77-85 Many such applications have involved stand-alone configurations of mechanical and electronic equipment e.g., tape recorders with stimulus materials, key boards or other special response panels, and some type of electro-mechanical recording device, all integrated and controlled via paper tape, microswitches and other electro-mechanical circuitry. Most of these applications, however, and virtually all of those that include sophisticated test interpretation and report-writing have involved computer assistance. Although
the proliferation of automated testing procedures has been slower than might be expected -- particularly since standardization and objectivity are the sine qua non of testing -- many controlled studies have demonstrated their reliability and their essential comparability with the same tests when manually administered. Only the computerized scoring and interpretation of the Minnesota Multiphasic Personality Inventory (MMPI) has experienced widespread interest and utilization; and this, incidentally, has been closely associated with the very beginnings of mental health information systems.

It was noted earlier that computer-assisted screening and history taking applications, particularly when they involve direct interaction between the patient and computer, are often referred to as computer-assisted "interviewing." Applications described in that context, however, were essentially standardized "questionnaires," with very restricted response measures. In the 1960s, however, there was also considerable effort to conceptualize and develop computer programs for conducting free-form interviews and psychotherapy. Such applications interfaced a patient (or patient surrogate) with a teletype or cathode ray terminal to interact directly with the computer. Patients typed their responses to computer-generated questions or comments, and the computer-generated reactions were dependent upon recognizing key words or phrases, and pairing those with appropriate interviewer responses which were stored in a large dictionary or look-up table. Although such application programs seemed initially to have considerable promise, they were never used very extensively for interviewing actual psychiatric patients "because of difficulties involved in extracting meaning from the wide range of verbal expressions produced by psychiatric patients" (p. 410). They have been used for heuristic purposes, however, to help train interviewers, and to study natural language processes and interaction rules in dyadic communication. With advances that have been made in our understanding of natural language and in computer technology, with the rather clear evidence that patients can be reliably and acceptably interfaced with the computer either for information gathering or some type of treatment process, and with increasing evidence that even relatively brief psychotherapy (one or two sessions) can have a very significant effect on prepaid medical utilization for as long as five years following the psychotherapy, it would seem appropriate (indeed, urgent) to go on with the development and testing of at least some specialized modes of computerized psychotherapy and patient evaluation.

Computer simulation and modeling has been used in several other mental health related areas, as well as in interviewing and psychotherapy. A closely related area, of course, has to do with the simulation of thought process and personality. The most immediately relevant aspects of this work aside from being basic research which may provide advances not only in computer therapy but in understanding normal and abnormal thought processes more generally, are the computer simulations of Colby and his associates regarding belief systems and neuroses. Another relevant but essentially "basic" area of computer modeling and simulation research is group and social processes.

Areas of computer modeling and simulation in mental health that may have more immediate, practical impact have to do with the areas of diagnosis, clinical prediction and mental health management, evaluation and planning. Computer-generated diagnosis and clinical predictions have already been briefly mentioned in the context of general MHIS applications. Both empirical and rational models for computer diagnosis have received a great deal of attention. Although such efforts have resulted in a number of operational applications, the overriding constraint on the validity of computer diagnosis continues to be the reliability of clinical diagnosis, itself. Spitzer, Endicott, Cohen, and Fleiss conclude that improvements in the raw data and the computer algorithms may lead to some improvement in computer diagnosis, but that a quantum jump in the validity of computer diagnosis awaits substantial improvement in the validity of the diagnostic system itself (p. 202). This change in the traditional psychiatric diagnosis system has already begun with the planned revision of the diagnostic manual of the American Psychiatric Association. More explicit diagnostic criteria being incorporated into this revision ("DSM-III") will make it possible to improve computer diagnostic models greatly, and to bring psychiatric diagnosis much closer to being "a matter of definition." As such, the majority of cases will probably be most validly diagnosed via a logical, decision-tree model (such as that of Groist, Klein, and Erdman), and supplemental statistical models can pro-
vide probability information for question-
able cases, i.e., those that don't quite fit the operational criteria for a specific diagnostic category.

Computer simulation and modeling in mental health management have been reported with regard to optimal staffing allocations in mental health facilities,118-119 program evaluation and planning in geriatric and mental retardation facilities,120,121 and teaching administrative skills required in the management of a community mental health center.122 One of the papers in this symposium, "What is the Question (For Which The Data In a Mental Health Management Information System is The Answer)?" by Dr. Quarton and associates, will deal with a very interesting use of computer simulation in training mental health professionals how to use data in decision making processes. Other relevant computer simulation applications (though not exclusively in psychiatric settings) include the development of models for studying and optimizing emergency room utilization,123 patient scheduling and outpatient procedures, 124-127 and the prediction and control of patient census.128 Such applications have demonstrated considerable value in the management, planning, and evaluation of specific or relatively circumscribed health care settings. As Flagle129 points out, however, when one attempts to extend such models to large scale systems, a number of problems arise that relate more to the diffusion of authority and decision-making (i.e., indefinite rules and criteria) than to technical limitations.

Mental health related computer applications in neurology, pharmacology and psychophysiology have largely been related to the analysis and display of psychophysiological measures, especially the electroencephalogram (EEG) and somatosensory evoked potentials. A great deal of work has been done in attempting to quantify and automate the analysis of these measures,130-132 and to differentially relate these to various psychiatric or neurologic diagnostic groups. The work of Fink133 and of Itil134 with computerized EEG analysis has also provided impressive evidence of its potential usefulness in differentiating the efficacy of psychoactive drugs with particular types of patients. Much has also been written about the use of automated EEG analysis in sleep laboratories,135,136 and about computer assistance, more generally, in psychophysiological research.137-146

The promise for computer applications in neurology and psychophysiology is epitomized by a recent article in Science,147 which describes "a new automated, computer-centered technology and a new strategy for diagnosis and remediation of brain dysfunction" (p. 1393). This methodology, called "neurometrics," uses highly refined EEG and somatosensory evoked potentials to identify specific brain profiles that can be correlated with the brain profiles of homogenous groups of persons with known types of brain dysfunction.

Signal variability, frequent artifacts, and the absence of absolute standards continue to be some of the variables which retard or limit the development and usefulness of automated psychophysiological measures discussed in this section.130,148-150

Automation of behaviorally-oriented treatment programs or behavior modification, particularly desensitization training for anxiety and phobic reactions, has been reported in many settings. Even more than with automated testing, however, instructions, stimulus presentation, response recording and/or reinforcement administration for these applications have been accomplished principally via electronically controlled tape recordings, audio-visual films, slide projectors and other electro-mechanical equipment, and with only infrequent direct computer linkage. Of particular note, however -- because of the frequent claim that automation of treatment procedures will suffer from their impersonal nature -- has been the consistent finding, in many controlled studies, that these automated behavior modification techniques have been equally as effective as normal, clinical administration of similar procedures. Except for research studies (principally with non-patient subjects), the Biofeedback treatment literature makes little reference to automation or computer support. This is somewhat surprising in view of the highly technical and instrumented nature of this specialized treatment.

Three other specialized computer applications which might be briefly noted are the psychiatric case registers, which keep track of admissions and patient movements in all psychiatric facilities throughout a defined geographic region and link information on each patient as he/she receives services at any of the mental health facilities involved,5,7 special computer programs that have been developed to monitor, evaluate and provide continuous support for the deinstitutionalization of chronic mental patients and follow-up
services provided to them, and computer techniques for processing and analyzing natural language.

It is believed that the reduction in computing costs and the immensely increased computing capacity brought about by microprocessors and mini-computers will not only greatly enhance the development of computer applications in virtually all of these areas, but that such technical progress will make increasingly feasible the widespread dissemination and use of those applications which prove to have merit. Dr. Meldman’s paper, “Microprocessor Technology for Psychiatrists,” will discuss these promises in greater detail.

Closing Comments

In 1973, Pollack, Windle and Wurster emphasized that new funding patterns for mental health were bringing with them high priority requirements for accountability and documentation of services, and that information systems for clinical practice were still in the research stage. These observations fully anticipated some of the current trends as reported in a previous symposium paper, "Mental Health Information Systems: Some National Trends" -- namely, that bookkeeping and documentation applications, including patient monitoring for accountability and program evaluation, are currently well accepted and are receiving high priorities in most MHIS planning, but that patient monitoring for clinical decision making is taking a rather distant back seat.

There is little question but what current political, social, judicial and economic pressures are providing a strong impetus for more systematic and effective mental health data systems. This press towards accountability, however, is a two-edged sword; while it provides the necessary leverage to improve general information systems, it also tends to promote documentation applications rather than applications which are more directly related to improving patient care.

Many other reasons have also been posited for the slow acceptance and proliferation of real clinical information systems in mental health, and for their relative lack of impact on clinical decision making. E.g.: lack of top-level agency support; lack of adequate funding; the basic difficulty of transferring research projects to operational settings; the piggy-backing of many clinical applications on statistical reporting systems; the “softness” of clinical data; the ambiguity of mental health goals and criteria; the lack of an overall guiding conceptual framework for MHISs; uncritical acceptance of traditional mental health concepts and records procedures as models for computer applications; the lack of a standard clinical language and an inability to gain wide acceptance for standard or highly structured clinical forms; complex data collection and distribution systems which have sometimes been unable to insure either timely or reliable information return; duplication of clinical reporting procedures (one manual and the other computerized); the distrust of mental health clinicians for information which has been obtained or processed “impersonally”; resistance related to issues of privacy and confidentiality; and the lack of clinical commitment to making computer technology work for mental health needs.

Reasons cited on the more technical side are such things as: repeated underestimation of the amount of time it takes to initially translate even relatively simple concepts into computer applications; the lack of adequate input devices for high-volume entry from a wide variety of clinical settings; the stereotyped nature of computer-generated reports; and the frequent inaccessibility of computer stored data for special needs.

An overriding and still pervasive, negative influence has to do with what some observers perceive as the resistance of mental health clinicians to virtually
any technological change. The thesis here is that the mental health industry (particularly the clinical services segment) is essentially pretechnological, with "an emphasis on individually provided services, a minimal number of tools, lack of standardization, and the apprenticeship system (watching and copying the craftsman) as the major way of learning the relevant vocational skills" (p. 1073); and that it "construes every technical innovation as a mechanistically insensitive encroachment on medicine's responsibility for the personal and intuitively sensitive provision of care" (p. 40). As Rome also notes, such reverence for the art of clinical practice -- sometimes as if it needed no justification other than its vaguely humanistic objective -- has traditionally subordinated reliance on impersonal technical aids because it viewed them as inflexible, intrusive, and as tantamount to exercising a lesser degree of professional skill.

It is indeed a paradox that social forces rather than clinical prescription have fostered much of the current development of general mental health information systems. There are, however, a number of very exciting and potentially very beneficial clinical applications in various stages of development and use. The further proliferation and success of these types of systems awaits not only their demonstrated usefulness but some basic changes in the receptivity of potential clinical users.

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