Barry L. Aaron.

Searle Medidata Automated Multiphasic Health Testing Systems

2524-TH-O

SMI

MULTITEST SYSTEM

- - - - -

WGI

MULTITEST SYSTEM

Medichek Inc.

EAST BAY HEALTH SCREENING CENTER

MULTITEST FACILITY

GEORGE WASHINGTON UNIVERSITY MEDICAL CENTER

DEPT OF CLINICAL ENGINEERING

George and Anna Portes
CANCER PREVENTION CENTER

SPRING VALLEY MEDICAL CENTER

A HEALTH AUTO-DATA SYSTEM

IDENTIFICATION OF CLIENTS ON FRONT COVER

Wyandotte General Hospital
2331 Van Alstyne Blvd.
Wyandotte, Mich. 48192

Alta Bates Hospital
Webster at Regent
Berkeley, Calif. 94705

George and Anna Portes Cancer Prevention Center
33 West Huron St.
Chicago, Ill. 60610

Medichek, Inc.
Route 38 & Hollywood Ave.
Cherry Hill, N.J. 08034

George Washington University Medical Center
2300 K St., N. W.
Washington, D. C. 20037

Health Auto-Data, Inc.
4900 Massachusetts Ave.
Washington, D. C. 20016

IDENTIFICATION OF CLIENTS ON THIS COVER

MEDUC, G.m.B.H.
Bismarckstrasse 94
1 Berlin 12, West Germany

St. Anna Medical Laboratories, Ltd.
1345 St. Clair Ave., W.
Toronto 10, Ontario, Can.

Weston Medical Laboratories
101 River Road
Weston, Mass. 02193

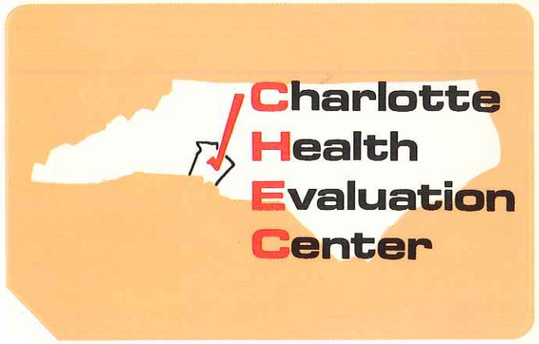
Charlotte Medical Clinic
1900 Brunswick Ave.
Charlotte, N.C. 28207

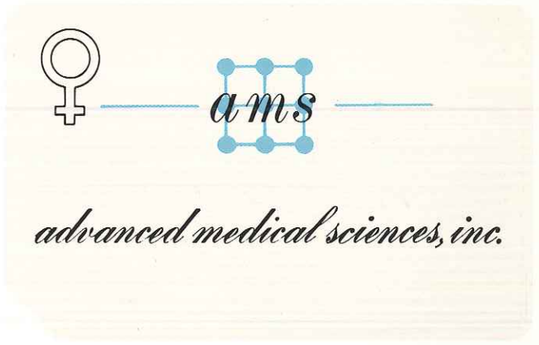
Advanced Medical Sciences, Inc.
1637 Goold St.
Racine, Wis. 53404

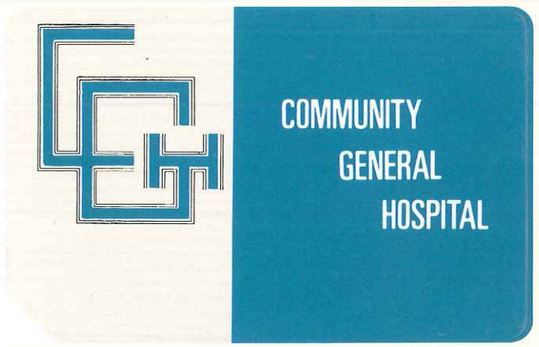
Community General Hospital of Greater Syracuse
Broad Road
Syracuse, N.Y. 13215

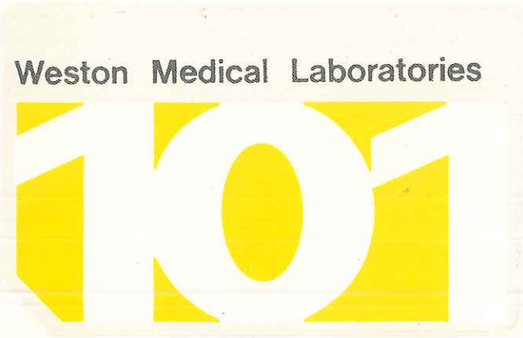
Santa Barbara Medical Clinic
Calle Real at San Marcos Pass Rd.
Santa Barbara, Calif. 93105

AMHT Systems
MED/STAT — Remote history systems









Foreword

The colorful cards reproduced on the four covers of this brochure symbolize a significant and successful approach to the critical problem of increasing the quality and decreasing the cost of health care delivery.

The cards are full-scale reproductions of Patient-Access ID Cards in use by a wide variety of Searle Medidata Automated Multiphasic Health Testing (SMI AMHT) systems. Most are located in the United States, including Hawaii; others are in the United Kingdom, West Germany, Australia, Mexico, and Canada. Some are large; some are small. Most provide a full range of automated and semi-automated multiphasic health tests for a wide variety of examinees; others provide abbreviated multiphasic testing, and still others provide a computer time-shared service for self-administered medical histories, automated electrocardiogram analysis, and other clinical tests.

Diverse as they are, all the AMHT centers represented by their Patient-Access ID Cards share one thing in common. They are clients of Searle Medidata, Inc. of Waltham, Massachusetts, (SMI).

The Patient-Access ID Cards symbolize a bold and innovative systems approach to the methodology employed in the delivery of health care. It is the utilization of computer-based, on-line, real-time, data acquisition program techniques, interactive with biomedical testing instrumentation, to produce a patient data record base of primary importance to the physician.

These institutions are AMHT pioneers; hospitals, clinics, group practices, and specialized health testing services. You will recognize many of them as long-established, highly-regarded leading institutions in the health care community. Others are newly-formed non-profit and for-profit corporations specifically organized throughout the United States and abroad by medical groups to utilize the Searle Medidata AMHT Systems.

Each center is a unique environment, responding to the needs of the medical community in its particular locality. Each system is designed to the specific criteria set by the medical staff of each institution. Large or small... continental United States based, or overseas. . .full-scale, or highly selective in the scope of its testing program. . .they all utilize one of medicine's newest and most powerful tools, a computer-based medical information system. ■

Cover note
Upon entering an SMI AMHT center, each examinee is issued a Patient-Access ID Card that identifies him or her to the computer by code, and to the AMHT center's technologists by name. The card is inserted into a photo-electric card reader built into the data entry console of each station. The institutions symbolized by the Patient-Access ID Cards reproduced on the covers of this brochure represent a typical cross-section of Searle Medidata AMHT systems in operation at the press time of this brochure. A current list of institutions utilizing our Systems is, of course, available on request to Searle Medidata, Inc., at our Waltham, Massachusetts headquarters.

Table of contents

The photographs on pages 2 through 7 were taken at the MMG Health Test Center, Crystal Lake, Illinois, a unit of the McHenry Medical Group, McHenry, Illinois.

A Statement about Searle Medidata, Inc.

The primary activity of SMI is research, development, production, installation and complete support of automated, multiphasic health testing systems and associated computer-based information systems.

SMI is headquartered in Waltham, Massachusetts, and is a wholly-owned subsidiary of G. D. Searle & Co. The talented people who make up Searle Medidata comprise a unique, cohesive team of physical and life scientists, engineers, technicians, and supporting personnel spanning diverse medical disciplines. Unlike many generalized companies who are engaged part time in the field of automating data collection for medical purposes, Searle Medidata's area of concentration is focused on the entire AMHT system as it is utilized in the total delivery of health care.

Weight is taken on automated SMI Autopometer, on-line with computer.

SMI's history spans more than a decade. We first joined forces as a research and development organization in the areas of biochemistry, biophysics and the information sciences. In the late '60's the company directed the talents of its scientific staff solely to development of automated multiphasic health testing systems and related data management systems for health care institutions, areas which have since been, and will continue to be, our major area of concentration.

The varied disciplines of our staff in computer engineering, biomedical instrumentation, medicine, biochemistry, psychiatry, optics, biophysics and mathematics, have been combined to form a team that has created, brought together and produced the system of hardware and software which comprises the SMI Automated Multiphasic Health Testing systems.

During 1968, SMI completed the transition from a research and development organization to an independent and integrated business serving the medical community. In the process, we became the world's dominant producer of automated multiphasic health testing systems. SMI has now installed more actual operating AMHT installations throughout the world than all other organizations combined.

Ten years of pointed research and development by SMI's multi-disciplinary staff has resulted in a notable degree of technical and medical sophistication throughout the system. The major difference between Searle Medidata AMHT systems and others is the real-time, on-line computer techniques we employ — in contrast to batch processing or semi on-line techniques. SMI system capabilities, validated by a record of performance, reliability, and overall operating cost in the many existing SMI installations, has led to rapid user acceptance.

There, of course, remains a large continuing program of research, development and refinement of the various SMI AMHT systems. Not only to maintain SMI's position of leadership, but more importantly, to continue matching system capabilities to the changing needs of the medical profession as AMHT techniques and systems continue to gain widespread acceptance and usage.

SMI is responding to these new challenges. We have the capability to tailor system techniques to solve present needs and foreseeable future requirements. We are continuously involved in the development and system integration of new biomedical instrumentation, and in the refinement of the system's information handling capabilities.

Our medical sciences department, in cooperation with medical centers throughout the world, maintains an active program of analysis and review of new clinical instruments and equipment used by the medical profession, and works in development of new approaches to standardized tests. We are mindful of the need to ascertain that such tests have gained the approval and acceptance of the medical community as validated, clinical techniques.

"Multiphasic Medical Screening System" and "Automated Medical History Taking System" patents.

Headquartered in Waltham, Massachusetts, SMI maintains strong worldwide ties with the health care research and development community through the parent company, G. D. Searle & Co., and their health-care oriented affiliates throughout the world.

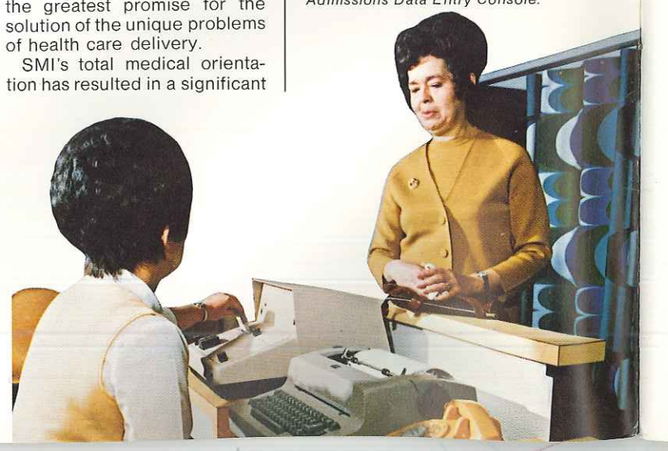
From the start, the medical appropriateness of the Searle Medidata effort has been guided by our medical director and his staff. Observing the needs of the medical profession in their attempts to deliver better and more health care, we have concluded that existing data processing and automated instrumentation techniques which have been used for business and industry generally are not appropriate for medicine. We have therefore sought innovative approaches that hold the greatest promise for the solution of the unique problems of health care delivery.

SMI's total medical orientation has resulted in a significant difference in the acceptance, operation, reliability and economy of SMI systems.

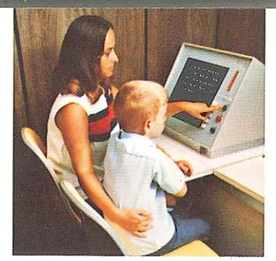
An important amount of new ground has been broken in the development of SMI systems which has been recognized by the granting of two United States patents. The first of these patents entitled, "Multiphasic Medical Screening System," effectively covers the inventions involved in creating the SMI AMHT System. The second patent, entitled "Automated Medical History Taking System," is related to this one portion of our total AMHT system. Other applications for patents have been filed and allowed by the U.S. Patent Office.

While SMI is essentially a medical information systems company, we manufacture the specialized computer subsystems and data terminals necessary to permit on-line operation with available minicomputers. We utilize those existing clinical instruments of independent manufacturers, which meet our performance requirements and have gained medical acceptance although we manufacture the interfaces to link them to the computer. We enjoy the freedom of applying the best combination of available hardware to solve medical testing problems, however we do produce several unique biomedical instruments of our own design. We produce the software necessary to integrate the discrete instruments and the computer together into a medical tool, where the whole system is indeed greater than the sum of its parts. ■

Receptionist inserting Patient-Access ID Card into SMI Admissions Data Entry Console.



Health care delivery and AMHT



Mother answering pediatric history questions at Profile 320 History Taker.

Demands for universally increasing access to improved health care in the United States have prompted a significant and dramatic growth in the use of automated multiphasic health testing. A pioneer in this field is Kaiser-Permanente, Oakland, California. The success of the first Kaiser center led the United States Public Health Service to fund AMHT experimental units that use large multi-purpose computer facilities to serve diverse socio-economic populations in New York, Providence, New Orleans and Milwaukee. The medical community owes much to these pioneer efforts.

The patient today finds it often hard to see a physician for general health care. He encounters problems in making a routine appointment because the physician is too busy to spend much time with health checks or "minor problems." Many remote communities are not even served by a physician. In urban areas, many feel estranged from the health care system, and find access to it is difficult. Indeed, medical care even for middle-class suburban America is largely on a crisis basis.

The practicing physician has a different point of view. Generally speaking, he is now working sixty-hours or more a week, and in all probability it is all he can do to manage the problems of his current practice. He is frustrated by paperwork and feels attacked when asked to prove the quality and justify the rising costs of health care.

To the insurance carriers, the cost of health care is paramount. They are concerned because they find that costs are rising without any apparent control.

From the epidemiologist's and medical investigator's point of view, medical data are not coordinated, are not easily available and in many cases, for all practical purposes, are lost for useful study.

From the point of view of the government, there is an apparent and growing crisis in health care delivery, and their concern is to provide an immediate solution.

The vast majority of meaningful health care contacts are still centered in the doctor's office. The problem revolves around the number of physicians available to serve the nation's health care needs, the number of trained medical-allied personnel available to assist the physician, the medical facilities available in the nation to care for the growing numbers of people who want entry into the health care system, and the uneven distribution of health care access geographically and demographically. Most thoughtful physicians and administrators predict that these existing deficiencies will reach crises proportions by 1974.

Under these conditions, it is necessary to look for help. Help is simply not training more physicians, nor adding more medical-allied personnel, nor necessarily building new and larger facilities. Time and economics prohibit this brute force approach based on a frantic effort to create just "more" of the existing medical complex. The United States will be fortunate if the future supply of physicians and medical-allied personnel simply keeps up with population growth.

Fortunately, there is an important and immediate alternative. Use of the computer and associated information handling techniques can substantially and quickly supplement the physician's reach. In this context, automated multiphasic health testing appears as a meaningful aid in the delivery of improved health care. AMHT should no longer be considered, nor exclusively used, purely as a mass screening device for preventive medicine; AMHT can, should, and is currently also being used for clinical testing on both a routine and specialized level to aid physicians, clinics and hospitals in the scheduling and treatment of their patients.

The concept that the physician should work at his highest skill and do only those things which only he can do, and which only he can do best, is central to the AMHT concept. The physician should practice medicine. Other duties of a routine nature should be handled by his assistants who are trained to operate under his supervision.

Unfortunately, the delivery problem is further complicated because of the shortage of trained medical-allied personnel, who are frequently as overworked as the physicians by whom they are employed. And the load for all continues to increase.

Automated multiphasic health testing can ease this burden for the physician and his assistants alike by mechanizing those many clinical procedures which yield themselves to automation, computerized data collection, analysis and reporting.

Computerized history taking and clinical testing can be accomplished by medical-allied personnel under the direction of a physician. AMHT makes it possible to train an assistant to operate at greater efficiency levels, than it is to train him or her to do the same thing without the task simplification inherent in automated procedures.

Even the patient participates in this work simplification effort and many physicians feel that the involvement of the patient in his own health problem is one of the breakthrough benefits of the new AMHT procedure.

In addition to its increased efficiency over manual methods, computer-based AMHT systems standardize procedures and increase the quality of the clinical data.

In order to provide these benefits, the medical tool of choice must be reliable in day-to-day performance. The SMI AMHT system concept has been designed, engineered, manufactured and validated in diverse medical settings, without compromise towards achieving the highest level of reliability in performance, commensurate with today's technology. The choice of data processor configuration, human engineering programs and built-in software safety checks are just a few examples of SMI's recognition that system reliability, both technical and medical, is fundamental to physician and patient acceptance.

In any system utilizing electronic, mechanical and optical devices, there will be interruptions in service from time to time. Experience in high patient flow situations has shown that such interruptions are insignificant in the SMI system. Nevertheless, SMI has developed and supplies a complete back-up system which assures that testing is continued and that the patient is not inconvenienced should there be an interruption in the service of the basic data processor.

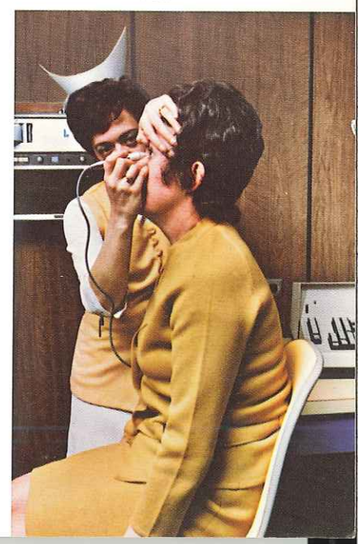
A choice of system configurations is available to meet individual operating conditions. Under conditions of high patient flow rates, utilization of fully-automated or semi-automated instruments interfaced to a computer results in data of great reliability and at low cost.

Under conditions of low patient flow rates however, it may be economically undesirable to employ a high degree of automated clinical instrumentation. In such cases use of an SMI Carrel System configuration permits clinical tests to be made conventionally, while the data is entered directly into the computer through a push button keyboard terminal.

Alternative system approaches (Linear, Carrel, MED/STAT) utilizing various biomedical instruments are discussed in detail in later sections of this brochure. Regardless of the choice of system and instrumentation—fully-automated, semi-automated or manual—the SMI 320 Data Processor interacts with various system components in real-time and in an on-line manner to gather, organize, correlate, store, and report medical information.

The flexibility in matching *system to need* permits the utilization of existing building facilities and instrumentation in a highly efficient manner. ■

Nurse administers a test for intra-ocular pressure employing a Mackay-Marg applanation-type electronic tonometer.



The many faces of AMHT

Paradoxically, all multiphasic health testing systems are essentially the same, and yet different in a number of ways.

Practices from country to country differ; even in the United States procedures differ by region. The number of tests administered and patient-flow rates vary radically from institution to institution. The modular nature of Searle Medidata's instrumentation and computer programming allows a wide variety of customer needs to be met.

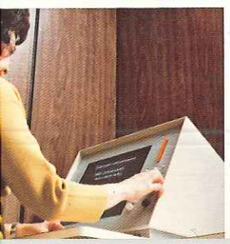
The diversity of requirements of the medical community were initially anticipated by SMI. Consequently, our systems from their conception were designed to respond to individual needs. The basic SMI AMHT system interfaces medical measurements and testing equipment with the computer either directly, or through data entry consoles. While much of our software is standardized, in the interest of worldwide reliability, sufficient flexibility is permitted to accommodate local variations. A number of software conversions, including foreign language record print-out, are accomplished through the use of our special SMI developed Medic Compiler program.

SMI systems have been installed in entirely new buildings specifically designed for the purpose. Other SMI systems are housed in existing facilities. In some cases, the application requires an on-site computer; in others a remote computer is linked to the testing site by telephone line.

Our clients utilize a wide variety of system configurations. However, the principal difference among the various SMI systems is the *customizing* of the operational system parameters for a particular application, patient cross-section, physician preference and the like.

Programmed normal limits for test data comparison, minor localized semantic word changes in the history program, priority of data in the record format and terminal layout for interpretative phrases, are just a few examples of areas in which SMI systems specialists work closely with the individual client to provide an AMHT system that is ideally matched to his particular requirements.

(Above) Measuring height with automated SMI Autopometer. (Below) Examinee at Profile 320 History Taker.



Technologist taking patient's pulse rate.

MAJOR HEALTH CARE TRENDS OF THE SEVENTIES

Pre-Paid Health Programs: Whether one thinks of the Administration's Health Maintenance Organizations (HMO) or the more comprehensive health insurance facilities proposed by other political parties or whether one elects one or more of the in-between variants, it is apparent that there will shortly exist a National Health Insurance program. It will emphasize the maintenance of health based on the concept of *capitation,* i.e. the furnishing of total health care to individuals based on statistical cost projections of their health care needs. AMHT is an obvious cornerstone to the processing of patients and the development and maintenance of pre-paid health programs whether in a hospital, group practice, community or clinic environment.

REVIEW OF AMHT APPLICATIONS TODAY

While pre-paid health programs appear to offer great potential for the widespread application of AMHT, there are many near term and equally important areas of the health care field today that provide sufficient merit for the immediate implementation of the AMHT concept. These will be briefly reviewed on the following pages.

Short-Term General Hospitals AMHT is cost effective. Proper use of the system improves bed utilization, staff utilization, and provides for the creation of improved records. The system is used for pre-admission procedures, pre-surgical procedures, history taking, testing out-patients and for community health screening. Out-patient testing and screening are performed either on-site at the hospital, or off-site in one of more locations within the hospital's area of coverage.

AMHT provides hospitals with a convenient, economical, accurate and reliable way to generate the nucleus of the patient medical record. Standardized patient workups, containing a greater amount of clinical information, well organized and automatically typewritten are a valuable bonus. Properly implemented and administered, the SMI AMHT system results in greater involvement and productivity of the health-care team. It releases practitioners, interns, externs and allied-medical personnel from clerical duties for more important work requiring their medical skills.

Because of the SMI AMHT system's capability to accommodate, at real-time speeds, the large patient load normally associated with hospital environments, the cost per patient is surprisingly low, especially when compared to the more conventional methodology employed today by most institutions. But more importantly, when properly administered SMI Multitest Systems help provide the capacity and cost-saving leverage that hospitals require to cope effectively with skyrocketing health care demands and costs.

SMI mobile-van AMHT system.

(Above) Blood sample is forwarded to laboratory for analysis and entry of findings into patient's computer record by a variety of interface devices. (Below) Blood pressure determination using automatic instrument.

Hospitals Affiliated with University and Medical Schools Teaching hospitals have unique problems and unique opportunities not available to other institutions. An increasing number of such institutions see AMHT as a solution to many pressing problems—training medical personnel, effective use of clinic operations and procedures, and responding to the demand for more and better community health care programs.

AMHT gives medical students the opportunity to work in a computer-based clinical test-center—a creative and productive teaching environment. Teaching hospitals have exposure to very large numbers of patients with a wider variety of health problems then normally encountered in the average general short-term hospital.

Automated skin-fold measurement.

AMHT permits more thorough examination of each patient without increasing medical or technologist time to do so. The efficiency of the testing procedures lowers costs and frees medical staff time resulting in the ability of the institution to give more personalized and professional care to more patients.

Clinical data is standardized through automated system procedures. Patient work-ups are all consistent in format providing a comparable basis for analysis. Correlation of the large masses of data from the many patients seen in AMHT centers located in teaching hospitals can help clinical researchers to refine diagnostic criteria covering a wide range of symptoms. Such criteria, when fully validated and approved by the medical community, will permit advice rules to be programmed, enabling the AMHT computer to suggest probabilities to the doctor in his pursuit of a diagnosis. Interchange of data banks between various AMHT centers will grow, yielding highly reliable diagnostic data correlation.

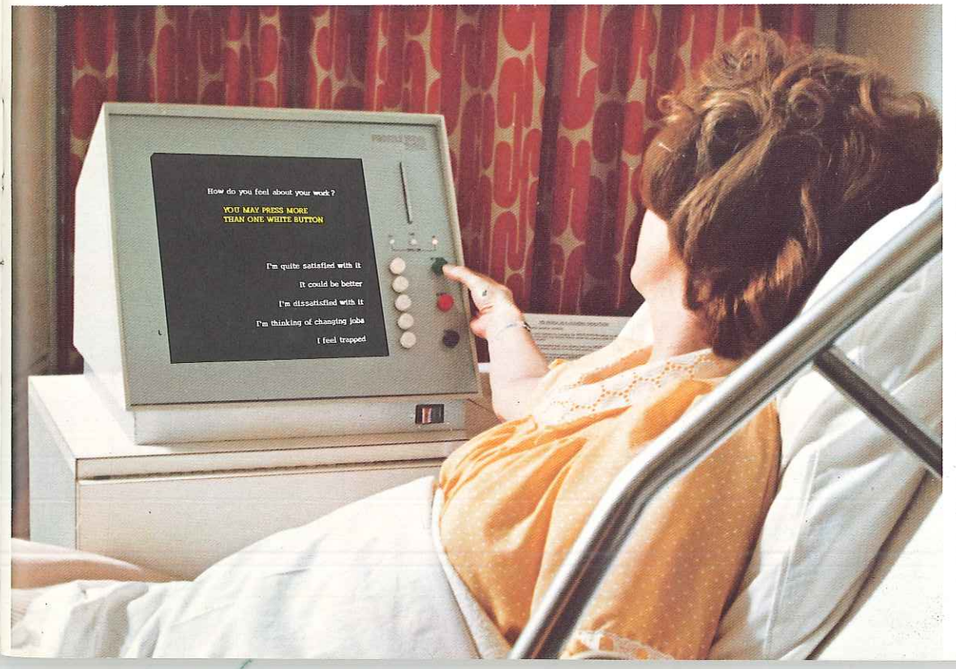
Group Medical Practices Group practice has flourished within the last decade and is likely to continue to do so at an accelerated rate. This type of medical organization lends itself readily as a suitable vehicle for capturing the current trend towards increased medical specialization by the physician to form a unified comprehensive health care team. Population demands for more complete all-encompassing medical care grows exponentially, and much of this is directed to private group practices because funds are now available through many third party payors. Whether a single or multiple specialty organization, the average group practice provides a patient base large enough to benefit economically from an AMHT system.

Another significant factor that makes multitest centers attractive to group medical practices is the growing Health Maintenance Organization (HMO) concept of prepaid group health plans. As these plans grow, they will obviously increase the number of private patient visits to a group facility. AMHT permits the group to open their practice to a rapidly growing patient base, without requiring a corresponding increase in the group's partnership or additional workload burden to the practicing members. AMHT provides greater economical utilization of allied-medical personnel and the group's physical facilities. It allows testing of patients inexpensively, reliably, quickly, and with a minimum of inconvenience. The effectiveness of medical specilization within the multi-speciality group is complemented by AMHT methodology.

Technologist inserts Patient-Access ID Card into X-ray unit for marking 70mm film frame (above) prior to taking chest X-ray exposure (below).

Nurse accepts urine specimen for laboratory examination and subsequent entry on patient's record.

Hospital patient operates Profile 320 History Taker acoustically coupled from her room telephone to a remotely located computer.



Many groups start with a very small AMHT system and subsequently enlarge the tests and the patient flow capability. Some utilize SMI's Linear-Sequential System while others utilize our Carrel System configuration.

The modular and flexible nature and the wide variety of system and instrument options make it possible for the AMHT system to grow with the changing requirement of the group practice approach to the delivery of health care.

Individual Medical Practices AMHT appears to many as a volume sensitive operation—the greater the number of patients processed, the greater the efficiency, and the lower the cost per patient. It may seem impossible that any form of computer-based multiphasic testing could be employed by the very small group practice or the solo medical practitioner. Yet, this is not the case. SMI's time-shared computer concept, MED/STAT, enables the solo practitioner to realize the benefits of AMHT at a very low patient flow rate and in a cost effective manner.

It has been recognized that many physicians are reluctant to refer their patients to a self-standing AMHT center where the medical criteria may not be under their direct control. Many will not have the patient-flow volumes themselves that justify implementing a large scale multitest system in their own practice. Since most of these same physicians do recognize the valid benefits that can accrue as a result of employing the AMHT concept in their practice, SMI has developed the MED/STAT system which

incorporates most of the tests of a large-scale AMHT facility within their own offices, and administered by their own assistants. A leased telephone line links the physician's satellite testing module, (STM) consisting of a Profile 320 History Taker, Admissions/Record Print terminal and Carrel Data Entry Console with an SMI remotely-located, dedicated, time-shared computer. Although the same computer might be line sharing its AMHT routines with as many as sixteen such satellites in a given area, each physician maintains complete administrative control over his AMHT satellite unit. The data management software programs of the full self-standing multitest system are available to him. Patient data is maintained in a proprietary manner acceptable to the medical profession. An SMI MED/STAT satellite testing module is economically viable with patient flow as low as one per hour. Utilizing MED/STAT, the solo practitioner can now spend more time with his patients in actual diagnosis and treatment, and free himself for greater involvement in the health care problems of the community.

Private Clinics/Health Testing Centers A growing number of private clinics and free-standing health testing centers now provide AMHT as a clinical testing service, either on a fee-for-service or fixed contract basis. These independent, privately owned-and-operated clinics and testing centers function as a service bureau for the physicians in the medical community who will refer their patients for routine clinical testing. They also provide services such as pre-employment examinations, executive physical programs, general employee health examinations, and the like to industry, union groups, trade organizations, and insurance companies.

With the additional implementation of MED/STAT satellite testing modules (STM) linked via telecommunication lines to their central facility's 320 Data Processor, these testing centers can now provide their AMHT service programs to a very large population area on a convenient and economical basis.

Industrial Medical Multitest Centers Small business and industrial firms generally utilize commercial laboratories, group practices, or individual practitioners to conduct pre-employment examinations, periodic personnel screening, executive health checks, and psychological evaluations. However, the large-scale industries (consisting primarily of government as an employer, private corporations, unions, insurance companies and fraternal organizations) frequently maintain their own captive medical facility. These facilities are closed to the general public. Participation is restricted only to employees, members, or others who are specifically permitted to utilize the facility.

The reasons for existence of the industrial medical facility vary considerably; however, the advantages of an AMHT system are obvious and universal. The size of the multitest center can vary from a very modest SMI MED/STAT time-shared computer satellite testing module to a full-scale SMI linear sequential type AMHT system. A Searle Medidata multitest system offers the same benefits of economy, efficiency, and reliability to this group as it does to the others. Reports of cost savings, in terms of workman compensation premiums, absenteeism, effective matching of job categories and the like, have been projected high enough to interest industry in general to pursue the AMHT approach with serious planning and action programs.

Mobile Profile 320 History Taker is easily moved where required in hospital.

The scattered site requirements of many industrial health care sponsors make the SMI AMHT mobile van system's approach particularly suitable. One or more vans can be driven to any location. Through use of the SMI MED/STAT system, they can be connected via prearranged telephone line to a remotely located SMI computer.

The additional flexibility permitted by the SMI MED/STAT concept enlarges the capability of bringing industrial medicine to widely dispersed geographic areas. It overcomes one of the drawbacks to the widespread use of the many industrial medical facilities now available to people eligible to participate in an industrial medical program—the inconvenience and time consuming need to travel to the medical facility. The cost of time off-the-job, another one of the major deterrents, is minimized by the use of on site MED/STAT satellite testing modules (STM). This encourages greater participation in the program and consequent enjoyment of the benefits.

Governmental Institutions and Programs No informed individual doubts that the high growth rate of government participation in health care will continue or even accelerate. Government is now the largest single purchasor of health care services. Government recognizes the political implications of the health care problem and knows it must act now. Fortunately, AMHT permits the private medical sector to expand access to health care delivery and respond to this need.

Regional medical programs are now under way to extend service to those who have previously not obtained access to the health care delivery system. The government is making grants, building prototypes and sponsoring studies to provide new ways to deliver better health care to more people. AMHT promises to be one of the more resultful techniques available to accomplish that goal.

The government has aggressively fostered the establishment of Health Maintenance Organizations (HMO) coupled with some form of National Health Insurance. It has been argued by some that the growth of AMHT will load a health care delivery system, which is now unable to cope with the existing demand, with an intolerable number of people with newly discovered disease.

Nurse keys laboratory data, via the Laboratory Data Entry Console, for entry to patient's medical record.

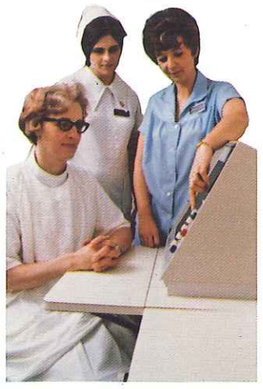
Testing for visual acuity, phoria, steropsis and color discrimination.

This may not actually happen. Garfield, writing in the *New England Journal of Medicine*, says, "Multiphasic health testing can help separate the entry mix of patients into the well, the asymptomatic sick and the sick. This separation makes possible optimum use of the physicians' services, which can be devoted to the area where they are most needed: the care of the sick."[1]

AMHT has obvious implications for increasing the efficiency of health-care delivery to the point where the current number of physicians using their highest skill levels will be able to significantly and dramatically improve the overall distribution of health care in an equitable manner to the total population.

At the local level, a number of Community Health Programs are now in progress sponsored by various state, county and municipal agencies in cooperation with the federal government. For populations, geographically dispersed throughout urban inner-city areas, Community Health Programs seek to provide a manageable access to the prevailing municipal health care system and look to AMHT as a viable method to accomplish this goal.

Hospital technologist explains operation of SMI Profile 320 History Taker to ambulatory patient.



Examinee takes pulmonary test with automated SMI Vitalometer.

View down corridor of mobile van AMHT system with admissions/record print terminal in foreground, Carrel rooms along hallway on right and lab in the background.

The SMI MED/STAT system is particularly well suited for satellite community health center programs. The actual clinical tests and histories are performed at the various remote outlying community health centers and fed into the computer located at a central facility like a hospital. Patient record printout can occur at either or both locations depending upon the medical follow-up procedures employed.

Another variation of the MED/STAT system is the use of a mobile-van health testing facility. Such a van can accommodate an admissions station, two or more MED/STAT Carrels, several SMI Profile 320 History Takers and either a laboratory or chest X-ray station. The mobile-van can, by pre-arrangement, be connected to the centrally located MED/STAT computer site by leased telephone lines. Utilization of this extremely mobile system offers great promise in extending the reach of health care into every area of the community.

The mobile-van also makes it possible to open access to health care even in those remote, sparsely populated rural communities which are now virtually without medical service.

Private Medical Foundations The counterpart of the governmental institution is the private non-profit medical foundation. In this form, the private sector reinforces and supplements programs of the government.

A number of private medical foundations are clients of Searle Medidata. Financial considerations are important and the foundations often depend heavily on private contributions to maintain operation.

While private medical foundations often reflect some specialized interest, many have enlarged their activity to include general health care. For the same reasons that AMHT makes good economic, professional and medical sense in other health care environments, it can be useful to foundations. It is particularly advantageous for medical foundations with limited funds which are committed to extending medical services to large numbers of people.

Commercial Laboratories Searle Medidata includes among its clients a number of commercial laboratories. They provide AMHT services in conjunction with their laboratory analysis services to their physician clients. The utilization of the MED/STAT AMHT time-shared system approach allowing them to develop a network of satellite testing modules in various health care environments, in conjunction with their already existing clinical lab testing services, provides these laboratories with an immediate expansion of their medical service markets.

The SMI AMHT system utilizing the MED/STAT concept offers both cost and time-saving advantages to the commercial laboratory which is already providing a variety of ancillary medical services to its clients. In this instance, the laboratory can transmit its blood-sample analyses to the system's computer for incorporation with other physiological tests and histories in the patient's record which then is sent back over telephone lines to a specific record printer located in each physician's office in the MED/STAT network. This in effect makes the findings of the multitest examination and even the lab determinations quickly available to the physician. ■

(Top) Examinee inside acoustic testing booth takes self-administered audio acuity test. (Bottom) Automatic 12-lead ECG, which can be analyzed with SMI's USPHS Certified ECG Computer Program.

[1]Garfield SR: Multiphasic Health Testing and Medical Care As a Right, The New England Journal of Medicine, Vol. 283 No. 20: 1087-1089, 1970.

The SMI AMHT System . . . a useful tool for all physicians

In reviewing the application highlights on the previous pages, it becomes obvious that AMHT systems must be made available in a variety of sizes, shapes, and medical formats in order to be a medical tool with *best fit* utility for all physicians. A related criterion is the maintenance of the economies of scale over a wide range of patient volumes in order for AMHT to compete favorably on a cost effectiveness basis with other accepted health care delivery methodologies in given situations.

Through innovative system design, Searle Medidata can provide the flexibility needed to meet these requirements. The modular design approach to both the hardware mix and computer programs allows SMI to customize AMHT systems to the needs and operational specifications of all given health care delivery situations. In providing this type of flexibility, SMI's fundamental system philosophy is maintained, whereby all test data is handled in a *real-time, on-line computer interactive mode*. This often involves total automation of the test data—from a point where it is available as a voltage to the point where the patient record is typed out for the physician, and simultaneously stored in machine language form on magnetic tape. In other cases, the computer interaction starts with data developed by a technologist's reading, a patient's response, or a specialist's interpretation.

The testing devices that may be used in an SMI Multitest System are medically accepted instruments, in many cases electronically linked into the system by SMI interfaces. While the choice of specific medical instrumentation is often a matter of client preference, there are a number of unique and sophisticated terminals, such as the Profile 320 History Taker and various data entry consoles, that have been developed and manufactured by Searle Medidata for use in all AMHT systems. The ability of the SMI input/output data terminals to communicate and interact on-line simultaneously with our Model 320 Data Processor is a result of a patented combination of SMI multiplexing devices and advanced computer programming routines.

SMI has developed two primary AMHT system configurations based on patient volume, facility size and physical floor plan considerations. The first, Linear Sequential . . . for test-to-test patient flow at a medium to high rate through a large facility. This configuration groups testing functions (other than history) in terms of module stations which have an average duration of no more than ten minutes, so that patients may flow sequentially from one module to another in a smooth fashion. The second, Carrel . . . for testing at low patient volumes within a small to medium facility employs a multiple-function-per station approach in which as many tests as possible are grouped in one station.

These two system configurations are supplemented by the capability of SMI's MED/STAT concept which utilizes the Carrel approach for satellite testing modules linked via telephone line with a remotely located, multi-line, time-shared computer.

Irrespective of choice of system configuration, the following panel of tests is typical of an average SMI AMHT System: Medical History, Anthropometric Measurements, Hearing Measurements, Vision Measurements, Pulmonary Tests, Tonometry Measurements, Cardiovascular Tests, Blood and Urine Laboratory Tests, Chest X-Ray Examination and Pap Smear/Breast Examinations.

Other optional tests and measurements are often included such as Achilles Tendon Reflex, Retinal Photography, Thermography, Peripheral Vascular measurement Dental X-Ray, and specialized Visual Measurements.

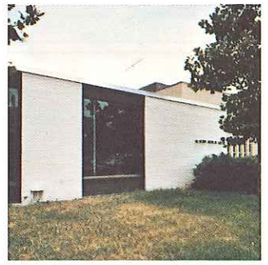
There is no one best facility size and shape for SMI AMHT Systems. Our multitest systems have been installed in free standing centers, community health care facilities, hospital clinics, group practice health appraisal units, and mobile vans.

Regardless of the available variations in AMHT system configuration, facility size, and test/measurements to be performed, SMI's concept of computer-based, on-line *system interaction* is the universal and paramount specification. It provides the following significant benefits: immediate quality control of data, interactive medical history taking, relevant automatic data computation, consistent medical record format, real-time compilation and printout of test results, minimization of human data handling, validated medical protocols, patient management advice rules, tailored medical printout, and automated record management, storage, and retrieval.

The end function of all SMI systems is to give the physician an effective medical tool through efficient and reliable gathering of physical, chemical, physiological, and historical patient data, and to present the data in the form most suitable for his evaluation and best utilization of his professional skills. ■

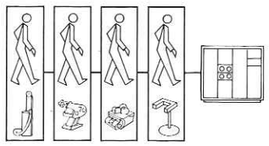
Typical Linear Sequential AMHT system in a large hospital facility.

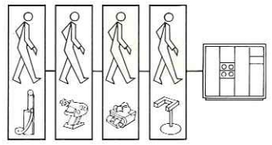
Typical Linear Sequential AMHT system in a group practice facility.

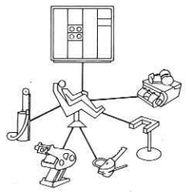


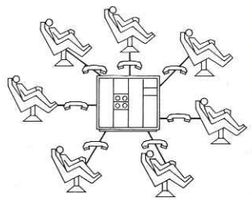
Typical free-standing Carrel AMHT system in a physicians office building.

Typical MED/STAT Satellite mobile AMHT facility.

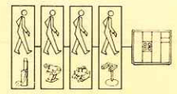
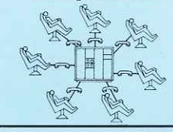




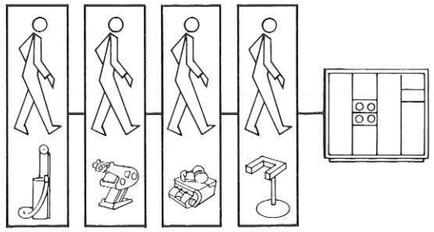




SMI Functional System Types

AMHT Characteristics	Linear Sequential Systems: Local Site Hard-Wired Single-Unit Testing Facility	Carrel Systems: Local Site Hard-Wired Single-Unit Testing Facility	Carrel Systems: Remote Site MED/STAT Multi-Unit Testing Facilities
			
Average Patient Flow	High: 6-12/hour	Low/Medium: 2-4/hour	Low: 1-2/hour/satellite module
Patient Movement	Patient moves from test station to test station.	Tests are concentrated and administered in a few multi-purpose stations.	Tests are concentrated and administered in a single multi-purpose satellite module.
Staff/Patient Manning	Minimum: Number of technicians equal to patient/hr. rate plus 1 each: nurse, administrator and (if required) lab tech.	Minimum: One-to-one staff/patient ratio adequate.	Same as local Carrel system.
Facility Space Requirement	Moderate - Large: variable and proportional to patient flow, patient mix, dressing room requirements, extent of tests panel. About 4500 to 6500 sq. feet required.	Minimum space per Carrel. Patient mix or special dressing room considerations not significant. About 2000 to 3500 sq. feet required.	About 300 to 400 sq. feet per satellite testing module (STM).
Medical Instrument Operation	Predominately an automatic class of instrumentation further modified for a high degree of system automation.	Instruments can be manual or automatic but are not modified for further system automation.	Same as local Carrel system.
Medical History Taker	System automated, patient self-administered, wide variety of History Programs automatically available.	Same as Linear Sequential system.	Same as Linear Sequential system.
SMI Data Entry Terminals	Various station data entry terminals fully system automated. On-line interactive quality control of data routinely provided.	Same as Linear Sequential system.	Same as Linear Sequential system.
Laboratory Data	Entered in computer memory via several optional methods. Data quality controlled and immediately available upon entry.	Same as Linear Sequential system.	Same as Linear Sequential system.
Medical Interpretation Data	Entered in computer via SMI interpretation console data quality controlled and immediately available upon entry.	Same as Linear Sequential system.	Same as Linear Sequential system.
The Medical Record	Automatically typed, priority formatted, permanent tape storage, immediately available on demand.	Same as Linear Sequential system.	Same as Linear Sequential system.
MED/STAT Satellite Add-On Capability	Various remote MED/STAT terminals can be added with additional computer hardware and MED/STAT interface.	Same as Linear Sequential system.	Not applicable.
ECG USPHS Computer Analysis Program	Requires additional magnetic tape interface to computer. An off-line service.	Same as Linear Sequential system.	Same as Linear Sequential system.
Medical Billing Service	Requires additional DECtape and line printer update to computer. An off-line service.	Same as Linear Sequential system.	Same as Linear Sequential system.
Automated Diagnostic Health Testing Modules*	Requires additional complement of specialized optical testing equipment. Requires additional 300 sq. feet facility space.	Same as Linear Sequential system.	Same as Linear Sequential system.

*** Visual Measurement Laboratory**



SMI Linear Sequential Systems

At medium to high patient volumes, SMI Linear Sequential Systems are the most flexible, economical and efficient of the systems offered by Searle Medidata. The larger the patient flow, the greater the degree of realized economic benefits, when translated in terms of staff, space, and instrumentation utilization.

At high patient flow, duplicate or triplicate stations for specific medical tests are added to the system depending on the proportional amount of time each test requires in relation to the others. Given the appropriate duplication of instruments in proper ratio to the time required by each, and recognizing that multiple tests are sometimes logically grouped in a single station, it is possible to achieve total utilization of most instruments in every station continuously by sequential processing of patients from instrument to instrument.

The Linear Sequential System accommodates the greatest degree of system-automation possible. A distinction between system-automation and "automatic operation" is important. System-automation is used here to define testing under direct and interactive communication with the computer, e.g., the SMI Profile 320 History Taker. "Automatic operation" implies the direct connection of the medical testing device to the computer and direct functioning without human step-by-step manipulation; however, the resulting instrument output is normally communicated to the computer through a separate on-line data input device, and in the process may be converted (analog to digital) or analyzed (waveform analysis).

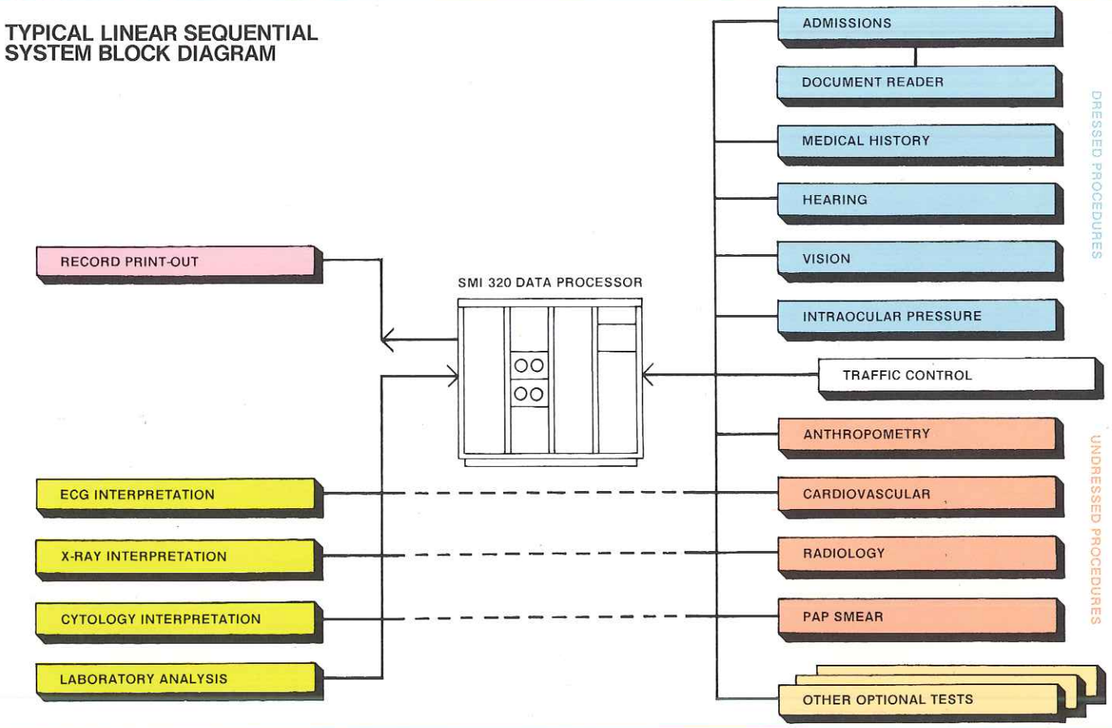
A large number of the medical instruments in SMI's Linear Sequential System are fully automated and the resultant data may be directly linked in an on-line, real-time interactive mode to the computer. These are: Profile 320 History Taker, SMI Autopometer, Skinfold Caliper, Vitalometer, Photomotograph, Self-administered Audiometer, ElectroCardioAnalyzer, Tonometer, Pressurometer, and Technician-administered Audiometer and Vision tester. Other instruments that are automatic or semi-automatic interact, data-wise, with the computer through an SMI Data Entry Console's push-button keyboard. Most devices of this nature usually require interpretive analysis of the output data by a specialist. Three-channel ECG Recorders, Fundus Cameras, all type of X-ray units and most lab equipment are typical of this type equipment. Regardless of the degree of automated or automatic instrumentation, the vital dimension of quality control in test/measurement accuracy and overall data specificity is maintained.

Automation of the testing sequence is carried even further, when appropriate, to the extent that the testing operation is patient self-administered as opposed to technician administered.

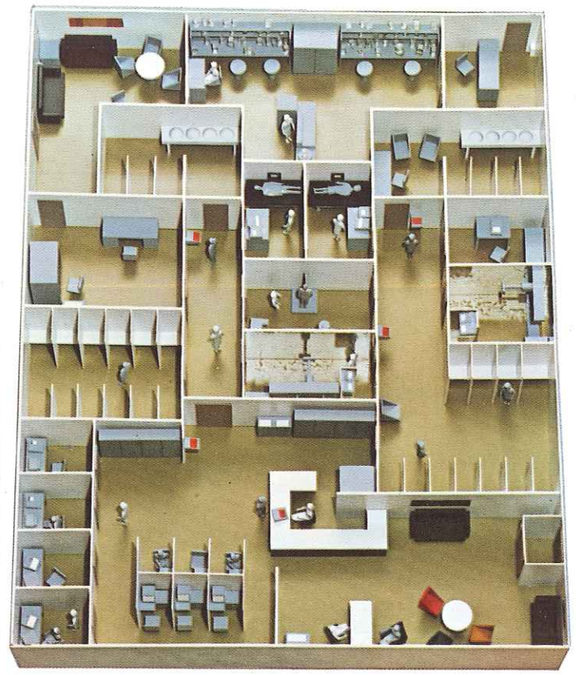
Floor space requirements for Linear Sequential Systems will vary anywhere from 2000 sq. ft. as a minimum to 7,000 sq. ft. or better. Certain amenities for the comfort and convenience of both the patients and the staff, such as size of reception area, staff lounge, number of administrative offices on site, auditorium facility, etc., are optional additions normally predicated upon the client's wishes, as opposed to mandatory system requirements. In many situations, such a system will be planned for installation in an existing facility that already has laboratory, X-ray, and other services available, not necessarily all in the immediate area of the proposed AMHT system itself. Since many of those same areas do not become involved with patient traffic flows, there is little or no utilization problem.

The floor plan, system block diagram, and patient flow schematic on this page constitute one typical example of an SMI Linear Sequential System. In this instance, certain assumptions have been made regarding patient mix, panel of tests and measurements, laboratory facilities and the like. SMI has the experience to tailor specific systems to fit specific needs. The wide variety of SMI systems already installed demonstrates our system can be planned on a best fit basis for a wide variation of client needs and requirements. ■

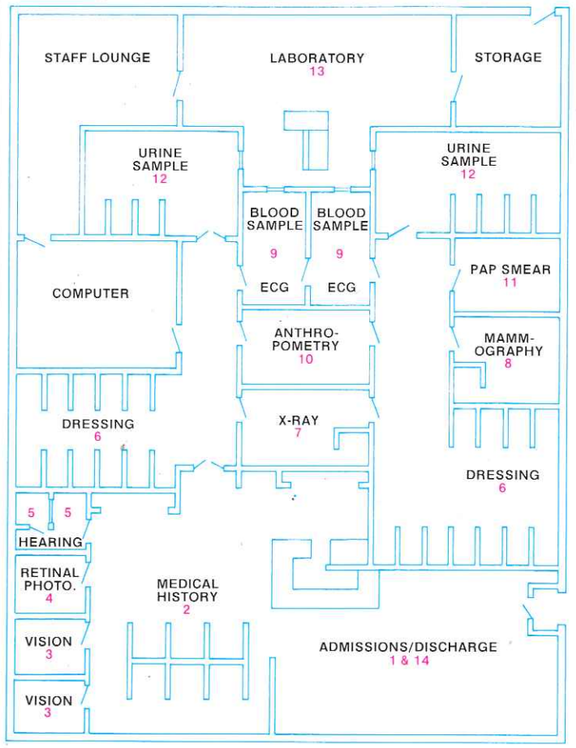
TYPICAL LINEAR SEQUENTIAL SYSTEM BLOCK DIAGRAM



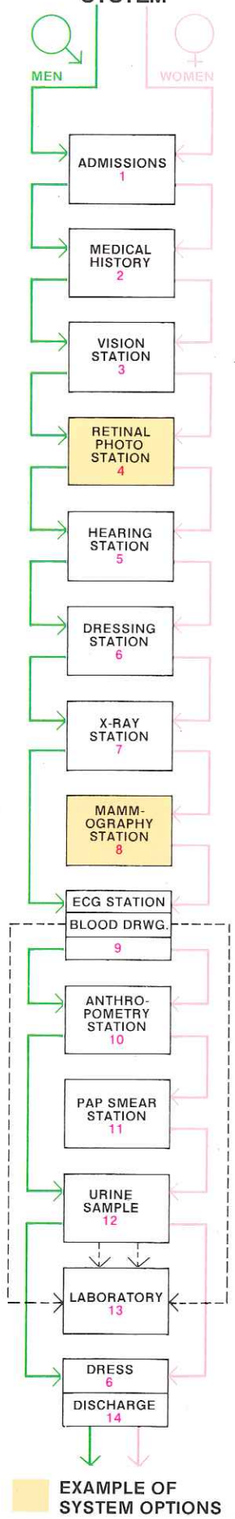
Scale Model of Typical Linear Sequential Center

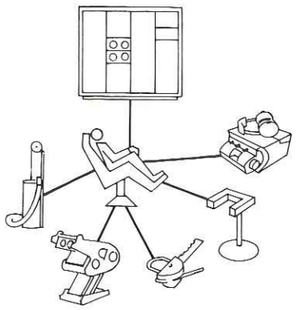


TYPICAL FLOOR PLAN OF LINEAR SEQUENTIAL CENTER



TYPICAL PATIENT FLOW LINEAR SEQUENTIAL SYSTEM





SMI Carrel Systems

The basic difference between the Carrel System and the Linear Sequential System is the manner in which the patient's data is collected and the reduction of patient traffic flow.

Because the average patient flow rate associated with a Carrel System is low, it is more efficient and economical to bring, in essence, the instruments to the patient, which is directly opposite the approach taken in Linear Sequential Systems which use separate and distinct test stations.

In actual practice, a limited number of testing areas yields the best patient flow pattern and equipment utilization of the Carrel System. The patient will start at the admission station where he is identified to the computer and receives a Patient Access ID Card. He then proceeds to a Profile 320 History Taking station. At the conclusion of his history, he will enter the Carrel station where most of the medical testing instruments are located and where the majority of the scheduled tests and measurements are performed.

Following this, the patient may be sent to a single-function test station, usually of a specialized nature like chest X-ray.

The medical instrumentation used in the Carrel station is not system-automated, although many of the devices may themselves be automatic. Regardless, the basic benefits of the SMI on-line, real-time system concept are still provided through utilization of our Carrel Data Entry Console by the attending technologist.

Taking advantage of the computer interaction that inherently exists between the Carrel Data Entry Console and the Model 320 Data Processor, the attendant follows an agreed upon pre-programmed sequence of tests and measurements. These are indicated by the computer on the console's lighted control panel, which still retains the necessary data quality control functions of the SMI system concept. By like token the record printout of the Carrel System is identical with the medical record printout of the Linear Sequential System.

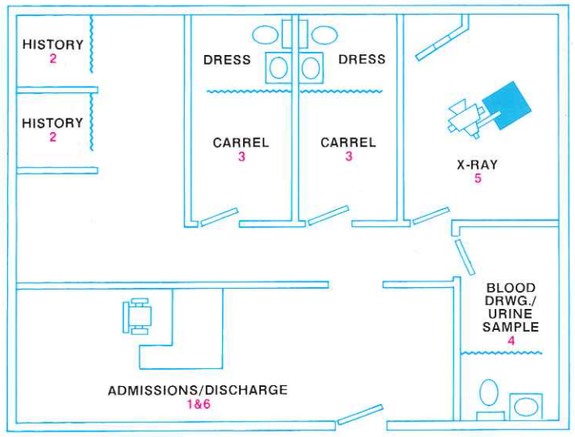
In many respects, the Carrel configuration is an excellent way to provide AMHT services in those situations where coincident with low patient volume, space itself is at a premium.

Existing facilities and existing medical instrumentation can be easily utilized with the Carrel System. The same technologist administers substantially all the physiological tests to the patient, which often leads to easier technologist/patient rapport. This relationship, plus the compact, yet comfortable, arrangement for the patient permits the attendant to administer the test battery in a minimum of time.

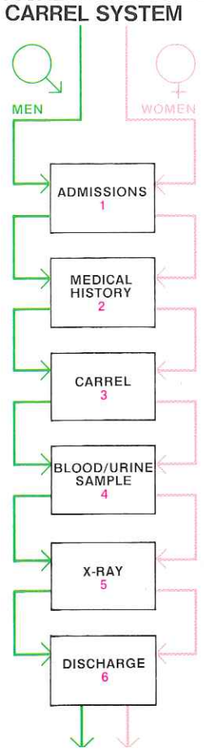
The same degree of flexibility in the type and number of tests associated with the Linear Sequential System is engineered into the Carrel System. While much of the software is standardized, sufficient flexibility is permitted to accommodate local variations requested by the medical management of the AMHT system.

The accompanying floor plan illustrates the relative compactness of the typical Carrel System. This particular configuration would accommodate at least three to four patients per hour. ■

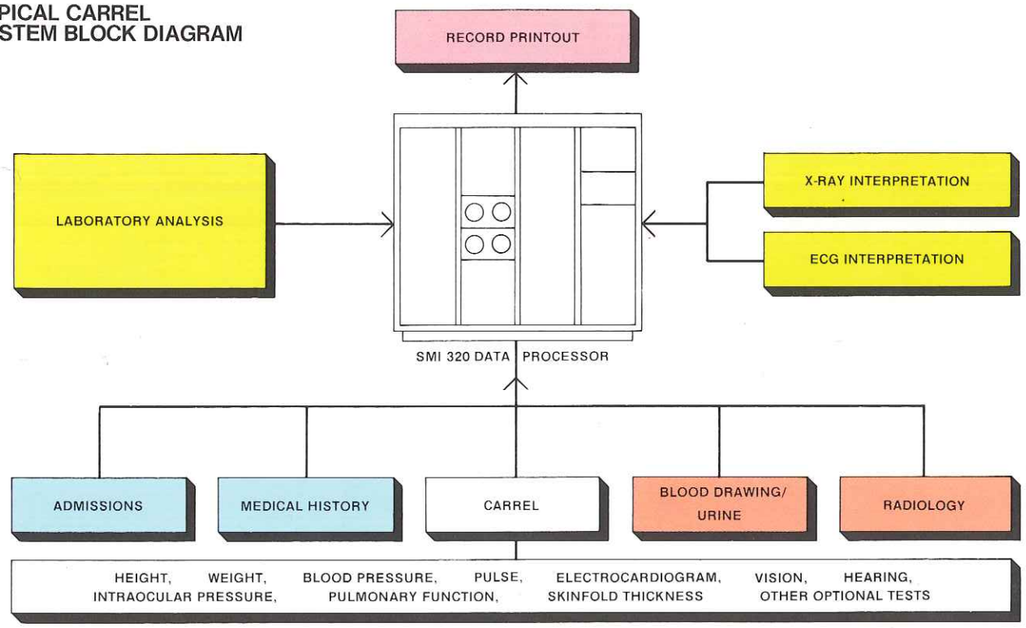
TYPICAL FLOOR PLAN OF CARREL SYSTEM



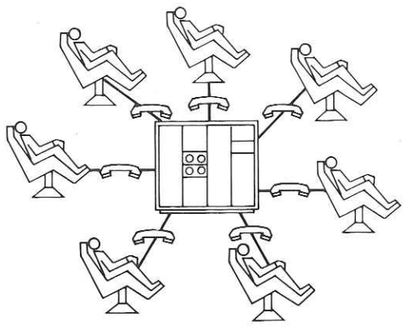
TYPICAL PATIENT FLOW CARREL SYSTEM



TYPICAL CARREL SYSTEM BLOCK DIAGRAM



Typical Carrel Area



SMI MED/STAT Systems

Searle Medidata Remote Multi-Line, Time-Shared AMHT Systems

MED/STAT is a multiple-line, time-shared, computer-based medical multitest system. It permits a variety of remotely-located input/output data terminals to interact in real-time with a central data processor via conventional leased telephone lines.

OBJECTIVES OF THE SYSTEM

The broad objective of the SMI MED/STAT System is to extend the many recognized advantages of AMHT to a wide spectrum of health care environments, including the average physician's office. MED/STAT significantly reduces the typical AMHT system's large-scale patient flow requirements, self-standing computer facility and associated dedicated system space. MED/STAT can provide add-on satellite capability to all SMI Linear Sequential local multitest systems. It is ideally suited for immediate direct system expansion for all local-site SMI Carrel Systems.

A basic function of a MED/STAT AMHT installation is to automate the medical work-up. We define medical work-up here as varying combinations of medical history, physiological and biochemical tests and measurements, and physical examination. Its very nature makes it particularly appropriate for the application of data acquisition and processing techniques. The work-up is routinely done to evaluate a person's health and to detect and identify the presence of disease, dysfunction, and other abnormalities. It is routinely done in varied circumstances—as an admission procedure, as part of a diagnostic effort, in early disease detection programs, and for industrial and administrative requirements to name the more common applications. But whatever the circumstance, it is most obvious that the work-up is a routine event, performed countless times every day in a given health care system.

It is equally clear that performing this type of patient work-up is costly. Time, supplies, equipment and space are consumed in acquiring the data; more resources are consumed in processing the data; and still more in using the data, particularly if it is inaccurate or disorganized.

MED/STAT minimizes the consumption of local medical resources in the patient work-up process by accurately, rapidly, economically, and effectively performing the following tasks:

a) acquiring or facilitating the acquisition of source data,
b) recording, evaluating, and organizing the total data base obtained on the patient, and
c) preparing one integrated report which permits efficient use by the physician and associated segments of a given health care system.

GENERAL SYSTEM DESCRIPTION

MED/STAT is simply an AMHT System approach in which a number of specific medical testing environments are separately located from each other, and from the remotely located computer which each shares in an interactive mode in real-time and on-line. In terms of system configuration and operational design, each of these AMHT testing environments is an extension of the SMI Carrel System concept.

From the equipment point-of-view, the SMI MED/STAT System consists of four basic parts:

a) The central Data Processor, SMI Model 320,
b) The SMI Multiplexer/Transponder communications interface,
c) The satellite SMI Data Terminals, and
d) The medical testing instrumentation.

From the facility point-of-view, the MED/STAT System is a network consisting of two basic parts:

a) The facility housing the central Data Processor, and
b) Several separate and independent satellite testing/medical modules, located in individual physicians' offices, hospitals, group practices, laboratory service companies, industrial medical departments, etc. These various MED/STAT units are designated as *satellite testing modules* (STM). Specific STM functions may include on a singular or combined basis, history taking, Carrel testing, ECG analysis, specialized diagnostic examinations, and medical billing services.

MED/STAT DATA PROCESSOR SYSTEM

The MED/STAT Model 320 Data Processor is a unique configuration of available equipment and specially manufactured items developed by Searle Medidata to serve specifically as a multi-line, time-shared, medical information data-processing system. Its system combination of patented hardware and software represent significant technological breakthroughs in computer-based AMHT system design.

SMI's data processor consists of a central processing unit, core and disc storage, magnetic and paper tape capability, and special line scanning and multiplexing devices. The Model 320 Data Processor utilizing the SMI DB-1 Data-Break Scanner and a MED/STAT LM-16 Line Multiplexer can handle a maximum of sixteen (16) satellite communication channels. The remote end of each channel ties into a MED/STAT LT-3 Transponder which interfaces the data path servicing a variety of input/output terminals that constitute each particular satellite testing module (STM).

THE COMMUNICATION CHANNELS

The communication channels have been designed so that the Model 320 Data Processor interacts in an on-line, real-time mode with the various remotely-located satellite testing modules. A channel consists of a data modem at the computer site connected to a transponder at each satellite site by standard, leased, non-switched, voice-grade, full-duplex-quad (four wires or equivalent) telephone lines. Because signal transmission

SMI MED/STAT Admissions Console

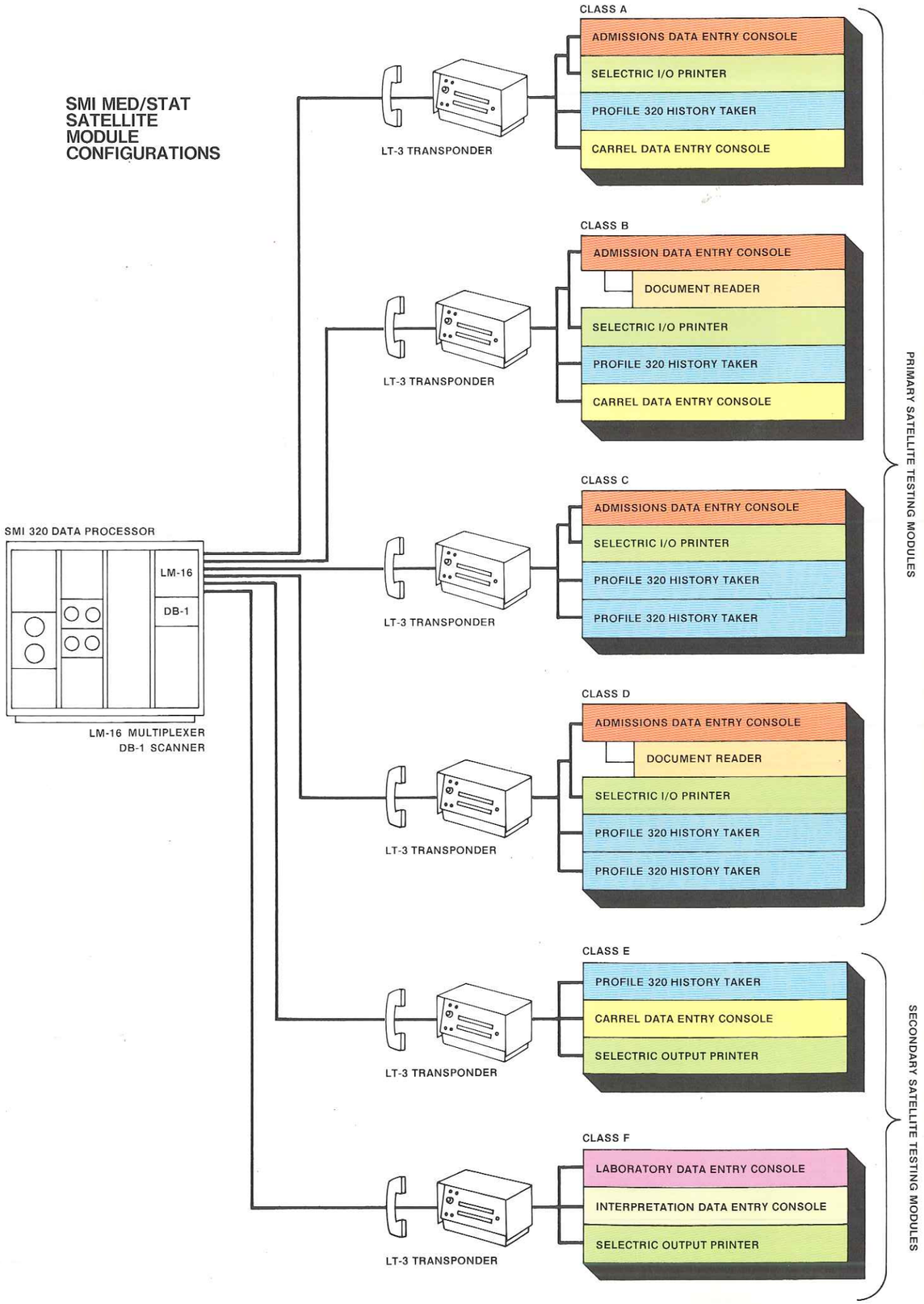
time is influenced by the type of telephone network available, the length of time required for a round trip transmission of data can be adjusted up to a maximum of six milliseconds.

The leased line supplied by the telephone company can be in the form of a twisted pair, a twisted pair combined with coax cable, or a twisted pair combined with microwave. The actual configuration is obviously dependent upon the distance to be travelled, the specific telephone exchange, and the switching network in a given location of the country. Leased line prices are normally quoted by straight air miles between the two points regardless of how the phone company gets you there.

One communication channel is required for each MED/STAT satellite testing module. A medical facility which utilizes more than one STM will require additional communication channels. Each free-standing MED/STAT System has a maximum capacity of 16 communication channels.

Line Multiplexer: The SMI LM-16 MED/STAT Line Multiplexer is used in conjunction with the DB-1 Scanner and the LT-3 Line Transponder to provide a communication system from the computer to up to a maximum of 16 remote STM sites. The SMI DB-1 Scanner is capable of providing on-line interaction with as many as 48 data terminals simultaneously. The LM-16 Line Multiplexer converts the information from three terminals on each of sixteen lines or 48 specific system locations to a format compatible with the system scanner. Information is received, stored, processed and transmitted by this communications interface and the computer. The main functions it performs are timing

SMI MED/STAT SATELLITE MODULE CONFIGURATIONS



of data and identification of source of data. It is the sophisticated design of the scanner, multiplexer and transponder interface plus its associated software programs which make the MED/STAT System technically feasible. The multiplexer also provides monitoring capability to allow more efficient servicing procedures without complete interruption of the system.

Line Transponder: The SMI LT-3 Line Transponder is the interface at the remote STM site between the input/output data terminals and the telephone line connected to the central data processor. In conjunction with the multiplexer/scanner combination at the 320 Central Data Processor the transponder provides the timing function to allow up to three data entry terminals to communicate over one telephone line. Since all telecommunication lines will be of different lengths and therefore different delays, the transponder equalizes the delays so that all information looks the same to the computer. In addition the line transponder acts as an on-site monitor to allow ease of check-out and service of the terminals connected to it.

MED/STAT DATA TERMINALS

A terminal is here defined as any data entry device in a MED/STAT System, that is on-line to the 320 Data Processor, like the Profile 320 History Taker, or a Carrel Data Entry Console. Since each communication channel has a maximum capacity of three terminals, a MED/STAT System network can accommodate as many as 48 SMI Data Terminals.

Specific groupings of input/output SMI Data Entry Terminals will constitute an individual class of satellite testing module. Regardless of communication channels used and module configurations implemented, the number of data terminals of a given type in any MED/STAT System network cannot exceed the following:
16 Admissions Data Entry Consoles/Selectric typewriters
16 Carrel Data Entry Consoles
16 Profile 320 History Takers

Optional terminal mix is available requiring a substitute trade-off among the terminal groups above for either 5 Laboratory Data Entry Consoles and/or 3 Interpretation Data Entry Consoles.

Each class of satellite testing module is characterized by the number and types of terminals it can include. While a number of pre-defined satellite testing module configurations are available to fit most individual user requirements, SMI's system design contains sufficient flexibility to allow for additional variations to be provided.

SATELLITE TESTING MODULES (STM)

Each class of STM may consist of several different input/output SMI Data Entry Terminals. As a rule, there may be a maximum of three on-line data terminals per communication channel, regardless of mix in a given MED/STAT STM. Each STM can be administratively programmed to operate autonomously or in combination with other modules in the same MED/STAT network.

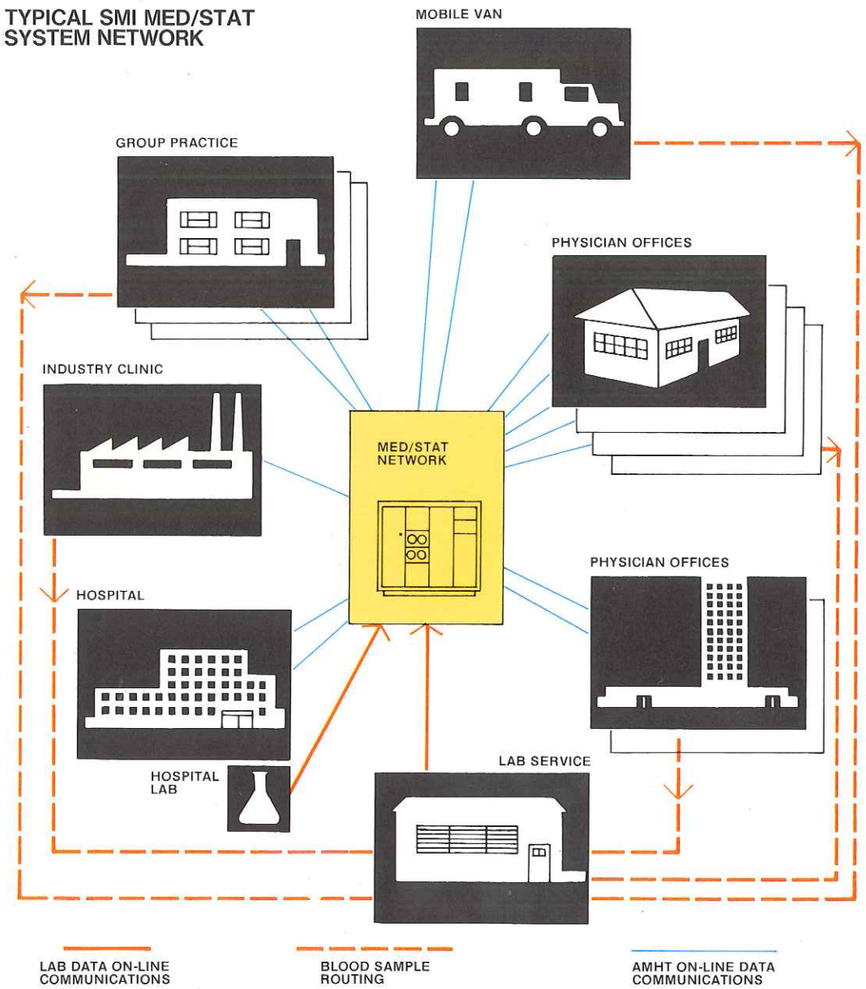
Primary STM Classes Each MED/STAT Class A STM contains an SMI Admissions Data Entry Console/Selectric, Profile 320 History Taker, and a Carrel Data Entry Console. The Selectric typewriter does double duty—both the admissions routine and record printout. It obviously does one or the other at any given time, not both simultaneously. On request, the patient's record can be printed immediately upon completion of testing, or maintained in computer storage until a later time. The Profile 320 History Taker can present a number of different history programs. The Carrel Data Entry Console can be used in conjunction with the full array of medical equipment for the more conventional patient work-up, or it may be used with simply a discrete set of instruments for applications such as pre-employment screening or an insurance examination.

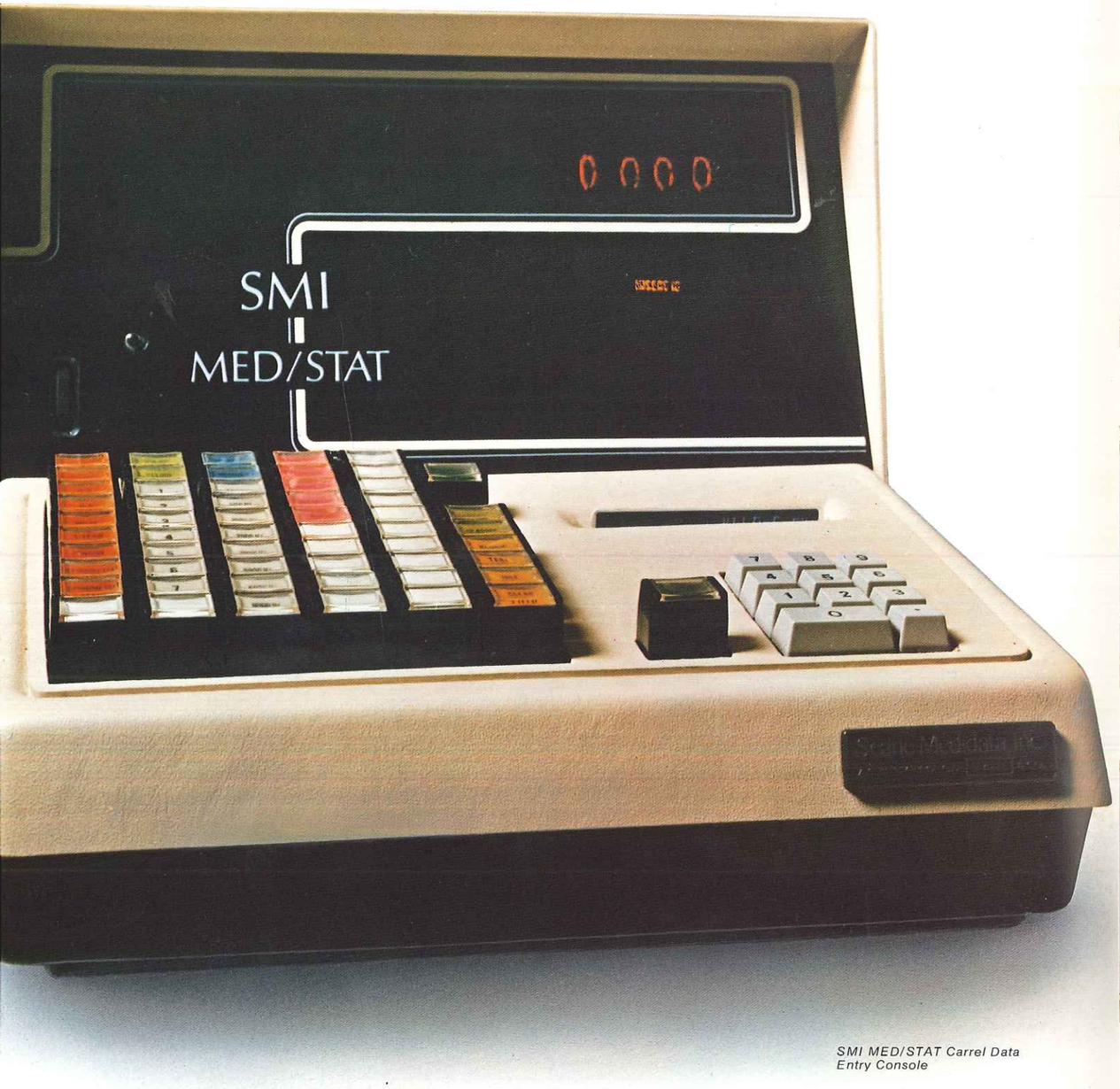
The medical tests and measurements themselves, in terms of time span, will vary depending upon the extent of test protocol and instrumentation used. A true patient throughput rate will vary from a low of one-patient-per-hour to a high of three-patients-per-hour for a Class A MED/STAT STM.

The addition of an SMI Document Reader converts the Class A into a Class B satellite testing module. Now the Selectric performs a triple function, since it is required for Document Reader operation in addition to admissions and record printout. The Document Reader provides an excellent low-cost alternative method for entering interpretative data, e.g., X-ray, ECG, to the patient's record since these types of services are usually decision-oriented and require no real time interaction with the data processor. It also provides a ready, dependable and simple back-up system in the case of service interruption.

Class C and D MED/STAT

TYPICAL SMI MED/STAT SYSTEM NETWORK





SMI MED/STAT Carrel Data Entry Console

SMI MED/STAT SYSTEMS

satellite testing modules are utilized for history-taking only. Histories are patient self-administered on SMI Profile 320 History Takers. A variety of SMI history programs can be stored in the Central 320 Data Processor and utilized simultaneously on separate consoles, as required. The later addition of a Carrel Terminal(s) can be made to broaden the scope of a history-only installation into full AMHT testing.

Secondary STM Classes Because its usefulness is related directly to system expansion either in terms of patient volume or testing functions, a Class E STM is defined as a secondary add-on type of MED/STAT *expansion* module. Since this class of module does not include a separate Admissions terminal, it must be used in conjunction with one of the four primary class modules. Through programmed source code and a print queue list assignment, the computer treats such a combination of modules, each utilizing separate communication channels, as a single unit AMHT facility. Increased patient flow requires dividing the print function between two Selectrics. Adding an STM (Class E) consisting of one Carrel Data Entry Console, one Profile 320 History Taker, and one Selectric typewriter to either a Class A or a B module would double the patient throughput rate of a given user facility, especially with a second Selectric that can be dedicated to medical record printout, while the first Selectric continues to be used with the Admissions Terminal and/or Document Reader.

It is also possible to establish a satellite *service* module (Class F) which can enter interpretative or laboratory data into the computer for eventual reporting to any one of the STMs which initiated the specific patient's record. This type of module provides on-line data entry into the central computer for analysis and/or interpretations of laboratory samples, electrocardiograms, Pap smears, chest plates, and similar test outputs obtained originally at a primary STM location and delivered to the remote location for off-line processing.

Even though it may exist by itself in a given location such as a laboratory or specialist's office, a Class F service module is also considered a secondary add-on to the primary classes of MED/STAT modules. Instead of improving patient flow like the Class E module, it provides for expanded system capability relative to servicing the patient's record with specific updates. Depending upon the programmed assignment of various STM source codes in the MED/STAT network, it has the ability to update patient records belonging to a specified set of remote modules.

Special Purpose STM Classes MED/STAT can include the SMI USPHS certified ECG Computer-Analysis Program as an important addition to the capability of a satellite testing module. The ECG Computer Program is available as an add-on option to MED/STAT satellite users, or as a separate ECG service to a non MED/STAT client without requiring him to perform other multitest functions.

Users of the ECG service who are MED/STAT clients, and have an STM with a Selectric printer, can receive the resultant ECG analysis (short-form) either as an integral part of the patient's record, or as a specific option printout only. The long-form analysis report can be mailed or hand-carried as a completely independent report without reference to the MED/STAT AMHT Medical Report for the same patient.

Users of MED/STAT ECG Computer Analysis service who do not utilize a satellite module of any nature can receive the resultant ECG analysis (long-form or short-form) either by mail, or over conventional Telex network lines through a standard on-site teletypewriter. MED/STAT clients can exercise the same option of installing a Telex network line if they prefer receiving the long-form report independently of, and separately from, their MED/STAT Patient Medical Record printout.

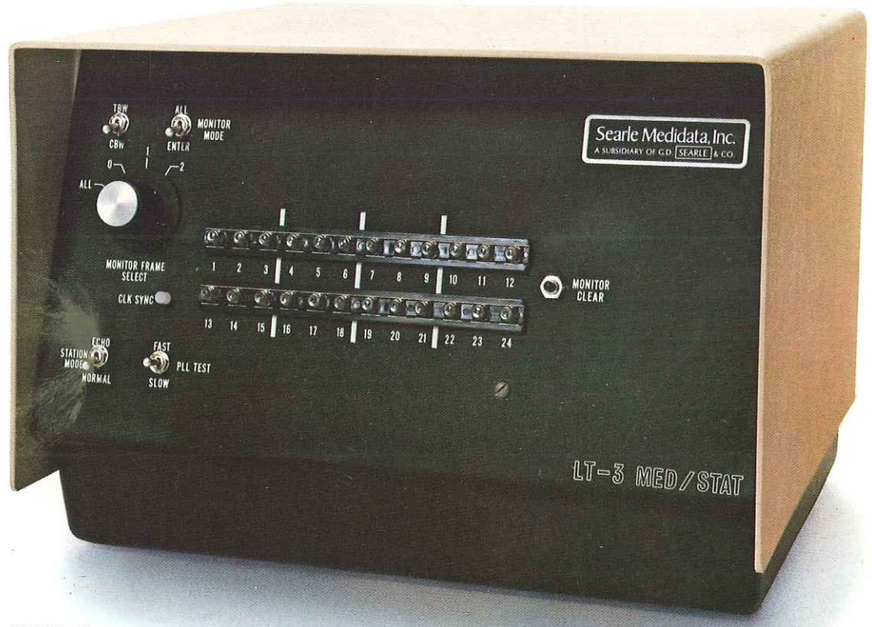
In any case, the originating ECG module transmits the patient ECG signal to the MED/STAT 320 Data Processor via a standard dial-up telephone line, which is independent of the leased telephone line communication channel used for MED/STAT satellite module operation. The ECG data is then analyzed by the computer on an off-line basis at scheduled intervals when it is not being used for AMHT functions.

Another class of special-purpose satellite configurations is the Automated Diagnostic Health Testing (ADHT) module, e.g., Visual Measurements Laboratory. In this instance, such a satellite testing module may be an independent specialized module in a MED/STAT network or used in combination with other classes of modules in a single AMHT MED/STAT satellite facility. An ADHT satellite testing module of this nature provides for additional in-depth testing and examination in highly specialized medical areas such as vision, cardiovascular, gastrointestinal, etc., prior to examination by the appropriate medical specialist. Patients may be referred to this type of testing facility either directly by the primary physician or as a result of computer-generated advice rules subsequent to the conventional AMHT screening procedures and evaluation of specific test results.

A typical MED/STAT ADHT satellite testing module usually consists of an Admissions Data Entry Console/Selectric typewriter, specialized history program utilizing the SMI Profile 320 History Taker, and a Carrel Data Entry Console programmed to administer the battery of specific diagnostic tests associated with the medical area of specialization.

MEDICAL TESTING INSTRUMENTATION

The medical instrumentation used in conjunction with the SMI Carrel Data Entry Console in a specific MED/STAT STM is not linked in an on-line system automated mode to the Data Processor. The medical instruments used in connection with the patient work-up will be medically accepted, unmodified off-line equipment normally used for patient testing for vision, hearing, weight, height, blood pressure, pulse, electrocardiogram, intraocular pressure, pulmonary function, skinfold thickness and other optional tests.



SMI LT-3 Transponder located at each satellite site

SMI PROFILE 320 HISTORY TAKER

The medical history remains one of the physician's most basic and useful diagnostic tools. Asking the questions and hearing the answers takes much valuable physician time, and writing or dictating the history for subsequent typing also takes time. The MED/STAT System utilizes the SMI ORNSAH program (Ordinally Ranked, Nested, Self-Administered History) and other SMI History Programs which are used in conjunction with the SMI Profile 320 History Taker. Through on-line computer interaction, the patient provides his own basic history. The resultant printout, which is automatically typed, highlights the clinically significant areas, and provides a starting base for the physician in evaluating and managing his patient's health.

A choice of ORNSAH program modes can be made by the attendant at the history console itself. "Initial Visit, Full History" . . . "Initial Visit, Directed History" . . . "Return Visit, Full" . . . "Return Visit, Directed" . . . and "Directed Only" are the basic selections available. The time for completing the history will vary from 15-30 minutes depending upon the program mode selected for each patient. Other major history types such as Pediatrics, Psychiatric, Blood Bank, may also be utilized simultaneously in a MED/STAT System's satellite network.

SATELLITE MODULE OPERATING CHARACTERISTICS

The normal sequence of operation would be to activate the satellite testing module at the Admission Data Entry Console, and then directing the data processor to "Admit" a patient to the system. A prepunched reusable Patient Access ID Card is assigned to the patient by the receptionist. The SMI 320 Data Processor will

open a record in its memory for administrative and statistical data about the patient by typing a series of questions on the Selectric console. As the computer prints-out each question, the receptionist types-in the correct response, such as name and address, and the data processor records it in the proper place in the patient's record.

When admission is completed, the receptionist takes the patient to a Profile 320 History Taker, inserts the Patient Access ID Card into the card reader slot which activates the console, instructs the patient in the use of the History Taker, and returns to other duties.

When the history is completed, the receptionist, or a technologist, is called. The patient is guided to the testing carrel, and the battery of medical tests is begun. In many cases, the testing instruments will all be located in the carrel area where most of the tests will be performed. The patient's ID card is first inserted into the card reader slot of the Carrel Data Console, and as each test is completed the technologist keys the result into the console.

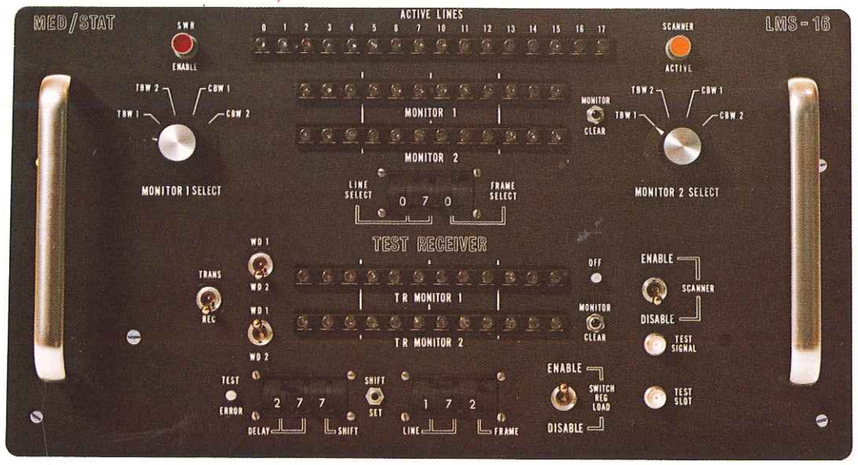
The console has rows of test buttons on one side, and a 10-digit keyboard on the other. To record a test, the button for that test is depressed, and the numeric value or code is then entered on the keyboard.

Tests which might be performed, and which could be provided for in the MED/STAT System, are listed below. The test schedule is completely variable; tests not desired are simply omitted.

Height
Weight
Spirogram
Skinfold Thickness
Visual Acuity
Auditory Acuity
Blood Pressure
Pulse Rate
*Electrocardiogram
Tonogram
*Pap Smear
*Chest Plate
*Blood Drawing

For tests which must await further interpretation or processing (those starred above) a notation that the tests were done is entered into the computer to facilitate record management at the time the record printout is called for. The receptionist can determine at that time whether a record is still awaiting a laboratory test result, or specialist's interpretation, or whether the test was omitted altogether.

Results of the subsequently processed interpretations and findings can be entered into the 320 Data Processor either on



SMI LM-16 Line Multiplexer located at central data processor site

mark-sense forms via a Document Reader, or through the use of SMI specialized Data Entry Consoles normally used in a Class F satellite module, or a combination of the two. Obviously, the optimal data entry procedures will be determined by where and by whom this type of off-line data analysis is done, and by the availability of terminals at the interpretation/laboratory sites.

In many cases, particularly for hospital admission, it will be necessary to perform and record a physical examination immediately following the AMHT testing sequence. An optional program can be provided that permits the use of at least 13 of the remaining (normally blank) push buttons on the Carrel Data Entry Console for entering the positive findings of the physician upon completion of his examination of the patient. A coded work sheet is provided containing several hundred diagnostic phrases from which the physician may choose. The physician's examination data is normally formatted in the patient's record immediately following the patient's history profile.

At any time during the testing sequence or when all results have been entered into the patient's record in the computer, the report can be typed-out on the Selectric printer, utilizing upper/lower case formatting. MED/STAT Medical Reports are identical in every respect with those of local hard-wired Linear Sequential or Carrel SMI Systems. Three basic types of medical reports are available for each patient: Complete, Summary, and Partial. A variety of information can be printed-out at any time on request via the print controls on the Admissions Data Entry Console e.g., "Summary, Abnormal Findings Only" . . . "Partial, Laboratory and Interpretation Only" . . . "History Only" . . . "Full Report" etc.

MED/STAT OPERATIONAL SPECIFICATIONS

In the development of the MED/STAT System, SMI has produced several major design breakthroughs in both hardware and software. Rather than dwell on the detailed technicalities of engineering design, and computer programming techniques, it is more important to understand the benefits MED/STAT Systems offer at the operational end—the user's Satellite Module.

MED/STAT Network Operational Specifications

1. The SMI 320 Data Processor has the capability to simultaneously provide a variety of history program types, e.g., ORNSAH, Pediatrics, Psychiatric, Blood Bank, etc.
2. Normal limits for various tests and measurements will be programmed into the SMI 320 Data Processor, based upon the client's medical criteria which varies usually for different geographical areas, population profiles, etc.
3. The SMI Carrel Data Entry Console panel layout of standard tests and measurements can vary according to each STM user's preference in a given MED/STAT network.
4. The MED/STAT system will provide all the advantages of SMI's standard computer programs for data record management.
5. MED/STAT's design capability permits the use of mobile vans as satellite modules, either through leased line or conventional switch-grade telephone line communication channels.

MED/STAT Satellite Operational Specifications

1. While MED/STAT will print the *same record format* for all modules on a given network, it can provide individualized headers on the printout record for a given STM, or combination of satellite testing modules in a specific MED/STAT System network.
2. In terms of computer interaction, each of the 16 MED/STAT communication channels can be construed as being "administratively independent" of one another by virtue of the associated computer software programs. In terms of programming, a "Source" is identified with a communication channel or combination of channels and through the assignment of source codes, the computer can differentiate between MED/STAT satellite channels linked to a variety of remote satellite sites. This involves the following important operational options:

(a) printout isolation between sources, be it a single channel or combination of channels

(b) allowable multiple printout access rights for printing records belonging to other sources.

(c) rights to direct records originating at one source to be printed at other sources.

The record printout source code options of the MED/STAT software support program provides important system flexibility in terms of user application. Example. A physician in his office can use a primary satellite testing module (such as Class A) at the end of one MED/STAT communication channel that is completely isolated from all other channels in the network in terms of patient data, record printout, etc.

Another physician might arrange to have his patient's records also printed-out at his local hospital's admissions/medical record department on demand by himself only, or on demand by either party—assuming the hospital is in the same MED/STAT Network.

Should the lab service company that performs the blood chemistry analyses for the physician also be a part of the same MED/STAT network, they can enter the lab results directly into his patient's computer record file. All the physician need do is provide the lab with his specific satellite communication channel source code.

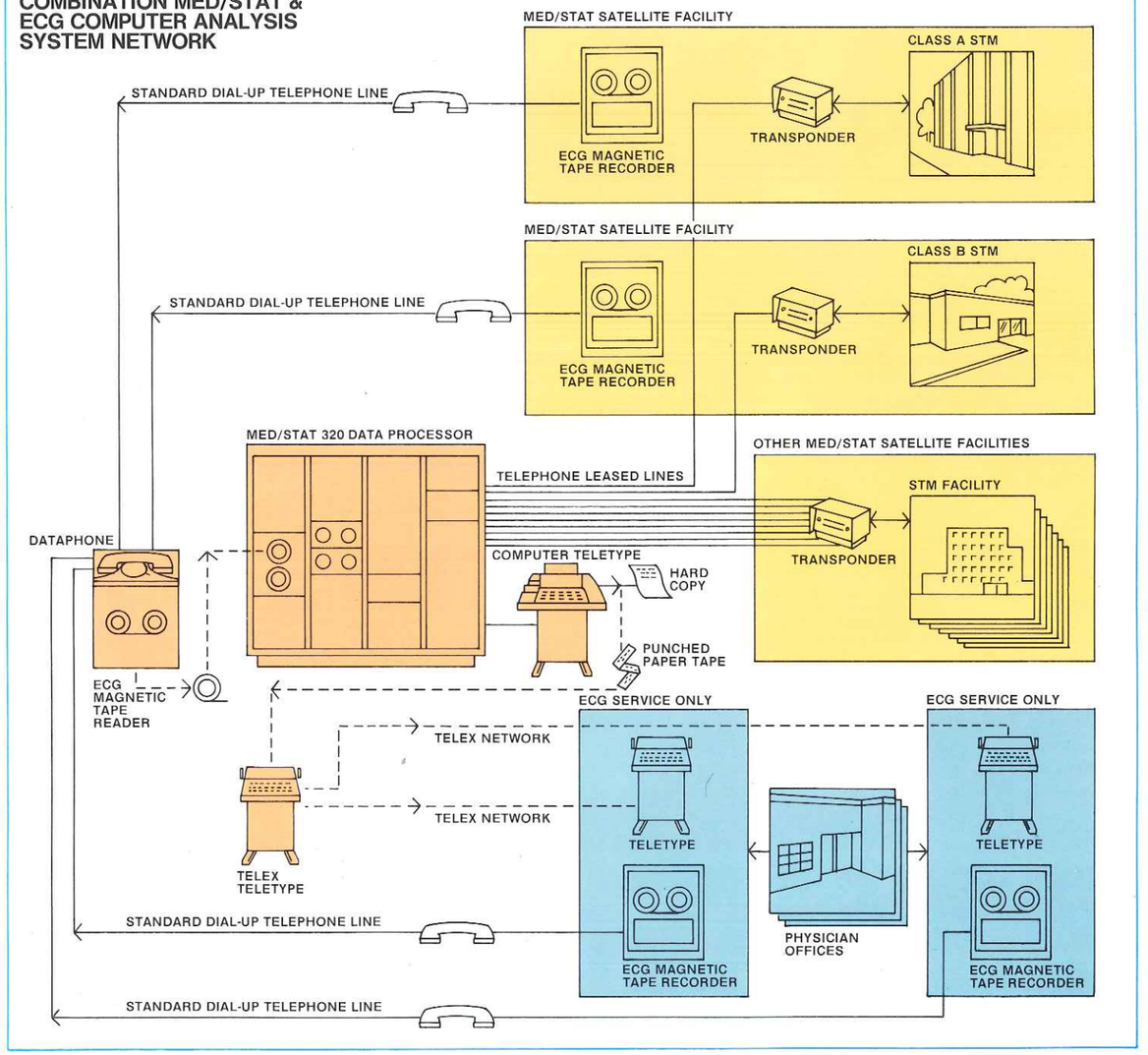
MED/STAT BROADENS MEDICAL SPECTRUM OF AMHT APPLICATIONS

The foregoing discussion on the SMI MED/STAT system describes the basic principles of its operation, and the many system variations that it provides for interfacing AMHT benefits with the diverse specific needs of a broad category of health care environments.

The discussion of a system with such a large range of possibilities is of necessity long, and perhaps complex. In actual fact, MED/STAT is simply the automation of a patient work-up, through the use of conventional, medically accepted instrumentation linked to a time-shared computer using leased telecommunication lines. Although specific guidelines have been discussed a MED/STAT can be easily tailored to suit most individual user physician requirements.

SMI MED/STAT system concept brings the benefit of AMHT to all segments of the medical community regardless of location and size. Patient flow rate economics are highly favorable, investment is minimized, entrance into AMHT is widened. The benefits of AMHT through MED/STAT make good economic sense for the physician, his associates and his patients. The significant saving of time results in broadening the delivery of high-quality health care now. ■

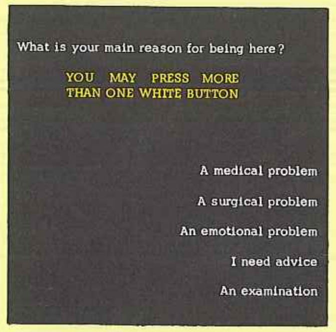
COMBINATION MED/STAT & ECG COMPUTER ANALYSIS SYSTEM NETWORK

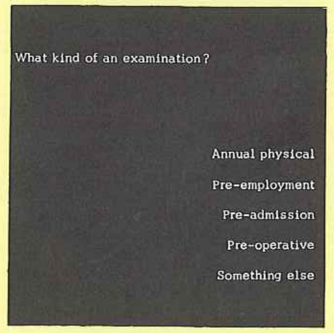


Printout format

The culmination of Automated Multiphasic Health Testing is, of course, the medical report; all else is prelude. The system, the instrumentation, the techniques and the procedures are meaningless regardless of their sophistication, if the test results are not quickly presented to the physician in a concise, priority-formatted and legible form containing the information he requires, with the flexibility to meet his changing needs.

SMI medical reports meet all the basic criteria. Physicians have the flexibility to request the full report, the summary report, or specific sections of the complete report if they so desire. Individual multitest centers can designate their own coding system of patient identification, establish their own physiological normal ranges, and make a number of format changes to tailor the basic report to fit their requirements. The sample report presented here generally exemplifies the physical characteristics of all SMI reports. The following centerfold insert shows examples of various patient reports.



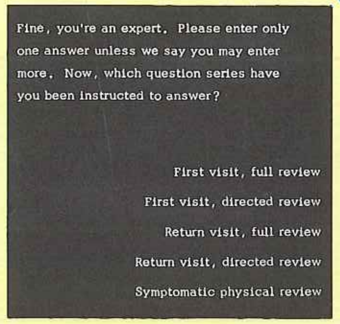


Name and address of physician to whom report will be sent.

Patient's name.

Patient's sex and age (also used for computer calculation for various tests and measurements).

One of 5 ORNSAH history options. (See history display below.)



Confirmed by patient from history. (See adjacent history displays.)

Patient has indicated her primary health problem by answering the "Health Rater" question which permits patient to rank each problem. (See history display at right.)

Date, time and Patient Access ID Card number is stored internally in computer to identify a specific patient's file.

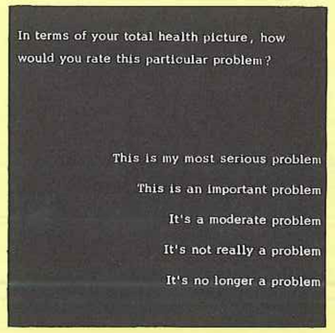
Report heading is customized for each user.

Patient's hospital, clinic or social security number.

Local code assigned by multitest center to identify patient category, e.g., pre-employment examination, executive physical.

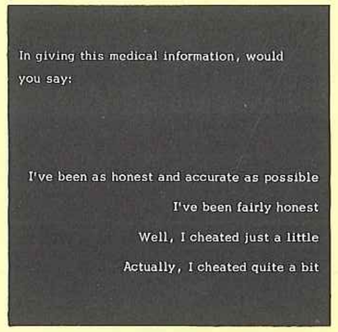
Consecutive number of patient admitted to multitest center.

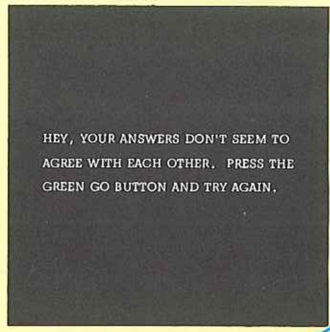
```
                    Weston Medical Laboratories
                         Multitest Report


Sara Lynn                                        Class C
Send to:   Susan Lindsey M.D.                    Rec. ser. no. 0-1236
           18 5th Avenue
           Boston, Mass.

Female age 45                                    6/17/1971    10:20
Residence:  76 N. Smith Rd.                      Patient no. 6300
            Cambridge, Mass.                     Unit no. 876

Medical History:  Return visit, directed.

Reason for visit: Annual physical.

PRIMARY PROBLEMS (patient's estimate):
      Has had pain or burning with urination for a short time.

SYMPTOMATIC REVIEW, POSITIVE RESPONSES:

   GENERAL HEALTH:
      She feels her health is generally good, but not recently.
She has had no recent change in weight.
      Coffee: Has been drinking 6-10 cups/day for over 5 years.
      Smoking habits:  Unchanged.
      Drinking habits: Unchanged.
      Medicines: Regularly uses analgesics.

   URINARY:
      Reports nocturia twice a night starting just recently which
is not changing.  Has noticed a change in size or force of urinary
stream.

   PSYCHOLOGIC:
      Reports waking up frequently.  She worries a great deal.
Is occasionally anxious or upset.  Has never seen a psychiatrist
or psychologist.

PERTINENT NEGATIVES:
      Denies urine incontinence, dribbling, enuresis, difficulty
starting or hesitancy with urination, polydipsia, cramps in feet
and ankle swelling.
```



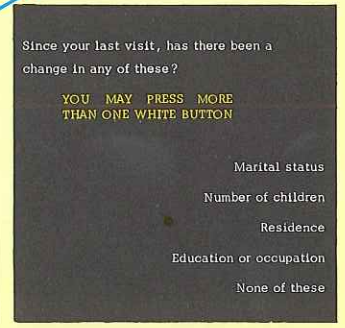
Computer does not assume any negative answers. Only pertinent negatives are reported resulting from patient's direct denial to a specific question.

Patient's own estimate of reliability of her responses to history questions. Computer disallows inconsistent answers by displaying error messages to patient at time history is taken. (See history displays at right.)





Return visit interval history records only changes since patient's prior visit. (See history display below.)




```
Sara Lynn

GENERAL INFORMATION (changes only):                        Page 2
  Exercise:          Under one hr./week bicycling, jogging or walking
                     No time/week in sports or exercise program
  Travel:            Less than one hr./week in active hobbies
                     Visited Europe in past year.
 Family health change:  Father is living and ill with cancer.
 Patient's statement of accuracy:  honest as possible.
```

Major categories of measurements are separated for easy reading.

Irrespective of test parameter sequencing, results are listed in medically accepted order of importance.

Normal range values set by medical staff of individual multitest center.

```
Sara Lynn
                                                             Page 3
--------------------------------------------------------------
                      PHYSIOLOGICAL DATA
ECG
CHEST X-RAY         taken
                    omitted
--------------------------------------------------------------
ANTHROPOMETRIC MEASUREMENTS:
     height       63.0 inches
     weight      115.0 pounds
     triceps skinfold        20.0 mm  (average thickness)
--------------------------------------------------------------
HEARING:
        Hz      low    /    middle          /        high
 left           500   1000   2000   3000   4000   6000
 right           15     12     12     13     16     13
                 12     15     13     14     13     12
--------------------------------------------------------------
VISION:
 acuity
         both eyes          far (20 ft)        near
         right eye           20/20             20/20
         left eye            20/20             20/20
 color vision                20/20             20/20
 stereopsis                  normal
 phoria (pr. diop.)          88.5%
       vertical              0.17 l
       lateral               +2.33             0.50 r
                                              -1.50
--------------------------------------------------------------
OCULAR TENSION:   normal range 14 - 20 mm Hg
    left eye  15 mm Hg           right eye  15 mm Hg
--------------------------------------------------------------
CARDIOVASCULAR:
    blood pressure        erect  120/70
    pulse rate            75
--------------------------------------------------------------
RESPIRATORY MEASUREMENTS:  vital capacity
    forced      3000 ml = 95% of predicted
    one-second  2600 ml = 87% of total
```

```
Sara Lynn
--------------------------------------------------------------   Pa
PAP SMEAR:
      unsatisfactory specimen
BREAST EXAMINATION:
      left breast    normal
      right breast   normal
--------------------------------------------------------------
URINALYSIS:
      pH           6.0
      gluc         neg
      ket          neg
      blood        neg
      prot         ++
URINE MICROSCOPIC:
      wbc          very numerous
      rbc          0-1/h.p.f.
      casts        absent
--------------------------------------------------------------
HEMATOLOGY:
      wbc   t/cmm      value         normal range
      rbc   m/cmm      12.0   **      4.5 - 11.0
      hct   %           5.0           4.2 - 5.4
      hgb   g          40              37 - 47
      mcv   cu mic     14.0          12.0 - 16.0
      mch   mmg        80.0   **     82.0 - 97.0
      mchc  %          28.0          27.0 - 31.0
                       35.0          32.0 - 36.0
--------------------------------------------------------------
BLOOD CHEMISTRY:
      tot pr  g%       value         normal range
      alb     g%        7.0           6.0 - 8.0
      cal     mg%       6.0   **      3.5 - 5.0
      phos    mg%       9.0           8.5 - 10.5
      chol    mg%       3.0           2.5 - 4.5
      gluc    mg%     200             150 - 300
      uric    mg%      70              45 - 150
      t bili  mg%       5.0           1.5 - 8.0
      alk p   mu/ml     0.5           0.1 - 1.0
      ldh     mu/ml    50              30 - 85
      creat   mg%     125              90 - 200
      sgot    mu/ml     1.0           0.7 - 1.4
      a/g     ratio    20              10 - 50
                        6.0   **      1.1 - 2.2
--------------------------------------------------------------
-- = no data entered
** = outside normal range
--------------------------------------------------------------
```

Computer calculated from internally stored data on patient's age, sex and height.

Test results outside of normal range highlighted by double asterisks.

Basic printout options

The medical report is the focal point . . . the end product of the SMI AMHT system. Like the other elements of the system, it is completely flexible to fulfill the specific needs of each multitest center and the physicians it serves.

The SMI 320 Data Processor has collected the test data in an on-line, real-time mode as the patient has proceeded through the battery of tests in the AMHT system. It has stored that data in active computer file, usually awaiting the laboratory findings and the interpretative data from the several medical specialists involved.

There is, however, no need for the physician to wait for the patient's report to be completed by including the interpretation or laboratory data. The technologist at the center can *at any time* request the computer to print out the patient's data which has been stored up to that time. At a later time a record of any portions of the data that have not been previously printed can be requested.

SMI has the capability to accommodate both input and output in different national languages as well as English. Record headings can be deleted or changed to suit user requirements. For example, a group practice/hospital can eliminate the output taken up with a mailing address; it can be converted to other information which the user might care to include in its AMHT reports.

For each system, the input sequence of interpretation data will vary, the entry of lab findings may vary, and the patient test chronology through the center may vary. In any case, the SMI 320 Data Processor reports the information it collects into a standard printout format order. The patient data is presented according to recognized medical priority, irrespective of data entry sequence.

Each medical report is printed out in upper and lower case characters. The entire report is therefore highly legible and it is extremely simple to differentiate among the various functions or titles of the various tests which are being reported. A set of double asterisks (**) highlights each abnormal test value. A set of double hyphens (--) marks each test for which no data was entered.

The SMI AMHT report is divided into five basic data areas: 1) Patient identification, 2) Medical history, 3) Physiological data, 4) Laboratory data and 5) Interpretation data. A variety of printout options are available at all times.

COMPLETE FULL REPORT

The *Full Report* can be printed when all the patient data has been entered into the computer. It is a complete and detailed exposition of all the data in the five basic areas. It includes a complete report of the medical history and presents complete tables of the physiological, laboratory, and interpretation data.

TWO SUMMARY REPORTS

A second basic option is the *Summary Report,* available in two versions:

a) Complete Summary and

b) Abnormals Only Summary.

The five basic areas are printed out in an abbreviated form. Tables of values are omitted, and pertinent phrases are used in place of a full exposition. Only salient information is reported in the medical history category of either version. Only those values outside the predetermined normal range are printed out in the physiological, laboratory and interpretation categories of the Abnormals Only Summary report; the Full Summary includes both normals and abnormals in the last three categories.

FIVE PARTIAL REPORTS

A third basic printout option is the *Partial Report* which includes five options. Unlike the summary, the partial printout is identical with the data content of the full report for the option that is exercised. These options are:

a) Patient Identification Only, used for billing, records and other administrative tasks.

b) Patient Identification, plus the Medical History which is printed out in full

c) Patient Identification, plus the Laboratory Findings, plus the Interpretative Data; all printed out in full

d) Patient Identification, plus Physiological Data which is printed out in full

e) Patient Identification, plus the Laboratory Findings, plus the Physiological Data, plus the Interpretative Data, all printed out in full -- only the medical history is omitted. ■

COMPARISON OF TYPICAL SMI MEDICAL REPORT PRINTOUT OPTIONS *The category "Other Tests" will vary widely for each multitest center, depending on which of the many test options available are incorporated.*	**COMPLETE FULL REPORT:** Complete and full data on all categories including tables of test values. **SUMMARY REPORTS:** Brief phrases covering all categories, no tables of test values. **PARTIAL REPORTS:** Identical full data (including tables of test values) to that printed in the Complete Full Report for any specific category requested.							
	COMPLETE FULL REPORT	SUMMARY REPORTS		PARTIAL REPORTS				
		Complete	Abnormals Only	Patient ID Only	ID + History	ID + Lab. + Interp.	ID + Physio.	ID + Lab. + Physio. + Interp
PATIENT IDENTIFICATION	F	F	F	F	F	F	F	F
MEDICAL HISTORY	F	S/B	A		F			
Primary Problem	F	B	A		F			
Important Problems	F	B	A		F			
Symptomatic Review, Positive Responses	F	S	A		F			
Symptomatic Review, Negative Responses	F	S	A		F			
General Information	F	S	A		F			
PHYSIOLOGICAL DATA	F	B	A				F	F
Anthropometric	F	B	A				C	F
Hearing	F	B	A				F	F
Vision	F	B	A				F	F
Ocular Tension	F	B	A				F	F
Cardiovascular	F	B	A				F	F
Respiratory	F	B	A				F	F
Other	F	B	A				F	F
LABORATORY DATA	F	B	A			F		F
Urinalysis	F	B	A			F		F
Urine Microscopic	F	B	A			F		F
Hematology	F	B	A			F		F
Blood Microscopic	F	B	A			F		F
Blood Chemistry	F	B	A			F		F
Other	F	B	A			F		F
INTERPRETATION DATA	F	B	A			F		F
ECG	F	B	A			F		F
Chest X-ray	F	B	A			F		F
Other	F	B	A			F		F

Legend: A, Abnormals only. B, Brief phrases only. F, Full category data. S, Salient data only.

The adjoining table shows the basic components of the medical record, standard to every system, which are called out using different print options.

Searle Medidata, Inc.
Waltham, Mass.

Class C
Rec. ser. no. 0-0377

Henry Richards
Send to: Martin Crossley M.D.
859 Ridge Rd.
Waltham, Mass.

Male age 43
Residence: West Linden Road
Concord, Mass.

6/18/1971 15:25
Patient no. 4050
Unit no. 735

Medical History: Directed only.

Reason for visit: Medical problem.

PRIMARY PROBLEMS (patient's estimate):
Has become unusually tired or sluggish. Reports constant fatigue.

IMPORTANT PROBLEMS (patient's estimate):
Reports facial puffiness.

SYMPTOMATIC REVIEW, POSITIVE RESPONSES:

GENERAL HEALTH:
He feels his health is generally good, but not recently. Is troubled with sprained back or neck due to a motor vehicle accident. He has had no recent change in weight.

ENDOCRINE:
Reports generally finding room temperatures too cool.

PSYCHOLOGIC:
He describes life as too demanding. Has never seen a psychiatrist or psychologist.

PERTINENT NEGATIVES:
Denies headaches, skin or scalp problems, swollen glands, exophthalmia, eating much without weight gain, neck swelling, jumpiness, hyperpigmentation, change in glove or shoe size, polydipsia, cramps in feet and ankle swelling.

Patient's statement of accuracy: honest as possible.

Weston Medical Laboratories
Multitest Report

George F. Kenney
Send to: Thomas Hartley M.D.
45 Carlton St.
Cambridge, Mass. 02139

Class A
Rec. ser. no. 0-1235

Male age 42
Residence: 538 W. Spring St.
Lincoln, Mass.

6/17/1971 10:16
Patient no. 7376
Unit no. 654

Medical History: Return visit, full.

Reason for visit: Pre-admission physical.

PRIMARY PROBLEMS (patient's estimate):
Reports breathing difficulty which occurs while exercising, began about a year ago and is getting worse. Several times a week has awakened at night due to shortness of breath.

IMPORTANT PROBLEMS (patient's estimate):
Reports unproductive cough, which is getting worse. Has had no hemoptysis. The cough is about the same all day.

SYMPTOMATIC REVIEW, POSITIVE RESPONSES:

GENERAL HEALTH:
He feels his health is generally poor.
Coffee: Has been drinking 3-5 cups/day.
Smoking habits: Unchanged.
Change in drinking habits: Has been drinking more. Reports having 3-4 drinks at any one time. Usually drinks beer. Never was a problem drinker.
Weight change: Has lost about 10 pounds without dieting.

ENVIRONMENTAL EXPOSURES:
Reports daily exposure to dust.

E.E.N.T.:
He wears glasses frequently.

UPPER G.I.:
Appetite is described as good.

PSYCHOLOGIC:
He describes life as generally satisfactory. Has never seen a psychiatrist or psychologist.

SYMPTOMATIC REVIEW, NEGATIVE RESPONSES:
No known current symptoms relative to C.N.S., skin, ear, nose, chest pain, cardiac or hypertensive disease, gastrointestinal, urinary or genital problems.

GENERAL INFORMATION (changes only):
Children: Had a natural child.
Residence: Single family house with spouse and children.

Exercise: Under one hr./week bicycling, jogging or walking
2-4 hrs./week in sports or exercise program
1-3 hrs./week in active hobbies

Patient's statement of accuracy: honest as possible.

PHYSIOLOGICAL DATA

ECG normal

ANTHROPOMETRIC MEASUREMENTS:
height 72.0 inches
weight 185.0 pounds
subscapular skinfold 20.0 mm (average thickness)
triceps skinfold 22.0 mm (average thickness)
body fat 25 % (from ht., wt., & skinfold)

HEARING:

	low	/	middle		/	high	
Hz	250	500	1000	2000	3000	4000	6000	8000
left	10	11	10	15	10	12	10	12
right	12	13	10	11	15	10	12	13

VISION:

	far (20 ft)		near	
acuity				
both eyes	20/18	g	20/18	g
right eye	20/18	g	20/18	g
left eye	20/18	g	20/18	g
color vision	abnormal **	g		
stereopsis	88.5%	g		
phoria (pr. diop.)				
vertical	1.50 r **	g	1.50 r **	g
lateral	-1.66 **	g	-6.00 **	g

g = glasses worn for test

OCULAR TENSION: normal range 14 - 20 mm Hg
left eye 15 mm Hg right eye 15 mm Hg

CARDIOVASCULAR:
blood pressure erect 120/65
pulse rate 72

RESPIRATORY MEASUREMENTS: vital capacity
forced 3640 ml = 73% of predicted **
one-second 2300 ml = 63% of total **

CHEST X-RAY INTERPRETATION (14 x 17):
emphysema, left and right
lung fibrosis, left
consider follow-up P-A and lateral

URINALYSIS:

pH	7.0
gluc	neg
ket	neg
blood	neg
prot	neg

URINE MICROSCOPIC:

wbc	0-3/h.p.f.
rbc	0-1/h.p.f.
casts	absent

HEMATOLOGY:

		value	normal range
wbc	t/cmm	6.5	4.5 - 11.0
rbc	m/cmm	5.4	4.6 - 6.2
hct	%	46	42 - 52
hgb	g	15.0	12.0 - 18.0
mcv	cu mic	85.1	82.0 - 97.0
mch	mmg	27.8	27.0 - 31.0
mchc	%	32.6	32.0 - 36.0

BLOOD CHEMISTRY:

		value	normal range
tot pr	g%	7.2	6.0 - 8.0
alb	g%	4.0	3.5 - 5.0
cal	mg%	9.3	8.5 - 10.5
phos	mg%	3.1	2.5 - 4.5
chol	mg%	210	150 - 300
gluc	mg%	85	45 - 150
uric	mg%	6.5	2.5 - 8.5
t bili	mg%	0.6	0.1 - 1.0
alk p	mu/ml	55	30 - 85
ldh	mu/ml	145	90 - 200
creat	mg%	0.9	0.7 - 1.4
sgot	mu/ml	30	10 - 50
a/g	ratio	1.3	1.1 - 2.2

-- = no data entered
** = outside normal range

Weston Medical Laboratori
Multitest Report

George F. Kenney
Send to: Thomas Hartley M.D.
45 Carlton St.
Cambridge, Mass. 02139

Class A
Rec. ser. no. 0-1235

Male age 42
Residence: 538 W. Spring St.
Lincoln, Mass.

6/17/1971 10:16
Patient no. 7376
Unit no. 654

Partial Printout - Lab and Interp Only

ECG normal

CHEST X-RAY INTERPRETATION (14 x 17):
emphysema, left and right
lung fibrosis, left
consider follow-up P-A and lateral

HEMATOLOGY:

		value	normal range
wbc	t/cmm	6.5	4.5 - 11.0
rbc	m/cmm	5.4	4.6 - 6.2
hct	%	46	42 - 52
hgb	g	15.0	12.0 - 18.0
mcv	cu mic	85.1	82.0 - 97.0
mch	mmg	27.8	27.0 - 31.0
mchc	%	32.6	32.0 - 36.0

BLOOD CHEMISTRY:

		value	normal range
tot pr	g%	7.2	6.0 - 8.0
alb	g%	4.0	3.5 - 5.0
cal	mg%	9.3	8.5 - 10.5
phos	mg%	3.1	2.5 - 4.5
chol	mg%	210	150 - 300
gluc	mg%	85	45 - 150
uric	mg%	6.5	2.5 - 8.5
t bili	mg%	0.6	0.1 - 1.0
alk p	mu/ml	55	30 - 85
ldh	mu/ml	145	90 - 200
creat	mg%	0.9	0.7 - 1.4
sgot	mu/ml	30	10 - 50
a/g	ratio	1.3	1.1 - 2.2

-- = no data entered
** = outside normal range

RENE DU BOIS PAGE 3

DATES PHYSILOGIQUES

EXAMENACION DE PAPANICOLAOU NORMAL

MESURAGES ANTHROPOMETIQUES:
HAUT.
AVDP.
PLI DE P
PLI DE P
GRAS DE

AUDITION (MAI
HZ
GAUCHE
DROIT

VISION:
ACUITE
LES DEU
L'OIEL
L'OIEL
VISION DE COU
VISION STEREOS
PHORIA (PR. D
VERTICA
LATERAL

TENSION OCULA
L'OIEL
L'OIEL

CARDIOVASCULA
PRESSIO
POULS

French

FRED LINDERMAN SEITE 3

PHYSIOLOGISCHE DATEN

ANTHROPOMETRISCHE MESSUNGEN:
GROESSE
GEWICHT
HAUTFALTE
KOERPERFET

HOEREN (RUDMOSE
BEREICH /
HZ
LINKES OHR
DE
RECHTES OHR

SEHEN:
SCHAERFE
BEIDE AUG
RECHTES A
LINKES AU
FARBSEHEN
HETEROPHORIE (D
SENKRECHT
SEITLICH
TIEFENSEHEN

AUGENDRUCK:
LINKES AU
RECHTES A

KREISLAUF:
BLUTDRUCK
PULSFREQU

ATMUNG:
VITALKAPA
1-SEKUNDE
ZITAET *

ROE-BEFUND:
NORMAL

German

KEN F. NEY PAGINA 3

DATOS FISIOLOGICOS

E.C.G. HA SIDO TOMADO

MEDIDAS ANTROPOMETRICAS:
TALLA 1.84 METROS
PESO 83.3 KILOGRAMOS
SUBESCAPULAR DOBLEZ DE LA PIEL 20.0 MM (GROSOR PROMEDIO)
TRICEPS DOBLEZ DE LA PIEL 22.0 MM (GROSOR PROMEDIO)
GRASA EN EL CUERPO 25 %(EN RELACION A LA TALLA, PESO & DOBLEZ DE LA PIEL)

AUDICION (MAICO): DECIBELIOS

	BAJO /		MEDIO		/	ALTO		
HZ	250	500	1000	2000	3000	4000	6000	8000
IZQUIERDO	10	11	10	15	10	12	10	12
DERECHO	12	13	10	11	15	10	12	13

VISION:	LEJANA (6 M)		CERCANA	
ACUIDAD				
AMBOS OJOS	6/5	L	6/5	L
OJO DERECHO	--		6/5	L
OJO IZQUIERDO	6/5	L	6/5	L
VISION DEL COLOR	INCIERTA	L		
ESTEREOPSIS	88.5%	L		
FORIA (PR. DIOP.)				
VERTICAL	1.50 D **	L	1.50 D **	L
LATERAL	-1.66 **	L	-6.00 **	L

L = LENTES USADOS PARA EL EXAMEN

TENSION OCULAR:
IZQUIERDO 15 MM. HG. DERECHO 15 MM. HG.

CARDIOVASCULAR:
PRESION ARTERIAL ERECTO 120/65
MEDIDA DEL PULSO 72

MEDIDAS RESPIRATORIAS: CAPACIDAD VITAL
FORZADO 3640 ML = 73% DEL PRONOSTICO **
UN SEGUNDO 2300 ML = 63% DEL TOTAL **

INTERPRETACION DE LA RADIOGRAFIA DEL PECHO (14 X 17):
** FORMATO DE INTERPRETACION INCORRECTO
EXAMEN REPETIDO, EXAMEN PROGRESIVO Y ANORMALIDAD PULMONAR

Spanish

SAMPLE PAGE REPRODUCTION:
FOREIGN LANGUAGE
AMHT REPORTS

RENE DU BOIS PAGE 3

DATES PHYSIOLOGIQUES

EXAMENACION DE PAPANICOLAOU NORMAL

MESURAGES ANTHROPOMETIQUES:
HAUT.
AVDP.
PLI DE P
PLI DE P
GRAS DE

AUDITION (MAI
HZ
GAUCHE
DROIT

VISION:
ACUITE
LES DEU
L'OIEL
L'OIEL
VISION DE COU
VISION STEREOS
PHORIA (PR. DI
VERTICA
LATERAL

TENSION OCULA
L'OIEL
L'OIEL

CARDIOVASCULA
PRESSIO
POULS

French

FRED LINDERMAN SEITE 3

PHYSIOLOGISCHE DATEN

ANTHROPOMETRISCHE MESSUNGEN:
GROESSE
GEWICHT
HAUTFALTE
KOERPERFET

HOEREN (RUDMOSE
BEREICH /
HZ
LINKES OHR
DE
RECHTES OHR

SEHEN:
SCHAERFE
BEIDE AUG
RECHTES A
LINKES AU
FARBSEHEN
HETEROPHORIE (D
SENKRECHT
SEITLICH
TIEFENSEHEN

AUGENDRUCK:
LINKES AU
RECHTES A

KREISLAUF:
BLUTDRUCK
PULSFREQU

ATMUNG:
VITALKAPA
1-SEKUNDE
ZITAET *

ROE-BEFUND:
NORMAL

German

KEN F. NEY PAGINA 3

DATOS FISIOLOGICOS

E.C.G. HA SIDO TOMADO

MEDIDAS ANTROPOMETRICAS:
TALLA 1.84 METROS
PESO 83.3 KILOGRAMOS
SUBESCAPULAR DOBLEZ DE LA PIEL 20.0 MM (GROSOR PROMEDIO)
TRICEPS DOBLEZ DE LA PIEL 22.0 MM (GROSOR PROMEDIO)
GRASA EN EL CUERPO 25 %(EN RELACION A LA TALLA, PESO & DOBLEZ DE LA PIEL)

AUDICION (MAICO): DECIBELIOS

	BAJO /		MEDIO		/	ALTO		
HZ	250	500	1000	2000	3000	4000	6000	8000
IZQUIERDO	10	11	10	15	10	12	10	12
DERECHO	12	13	10	11	15	10	12	13

VISION:	LEJANA (6 M)		CERCANA	
ACUIDAD				
AMBOS OJOS	6/5	L	6/5	L
OJO DERECHO	--		6/5	L
OJO IZQUIERDO	6/5	L	6/5	L
VISION DEL COLOR	INCIERTA	L		
ESTEREOPSIS	88.5%	L		
FORIA (PR. DIOP.)				
VERTICAL	1.50 D **	L	1.50 D **	L
LATERAL	-1.66 **	L	-6.00 **	L

L = LENTES USADOS PARA EL EXAMEN

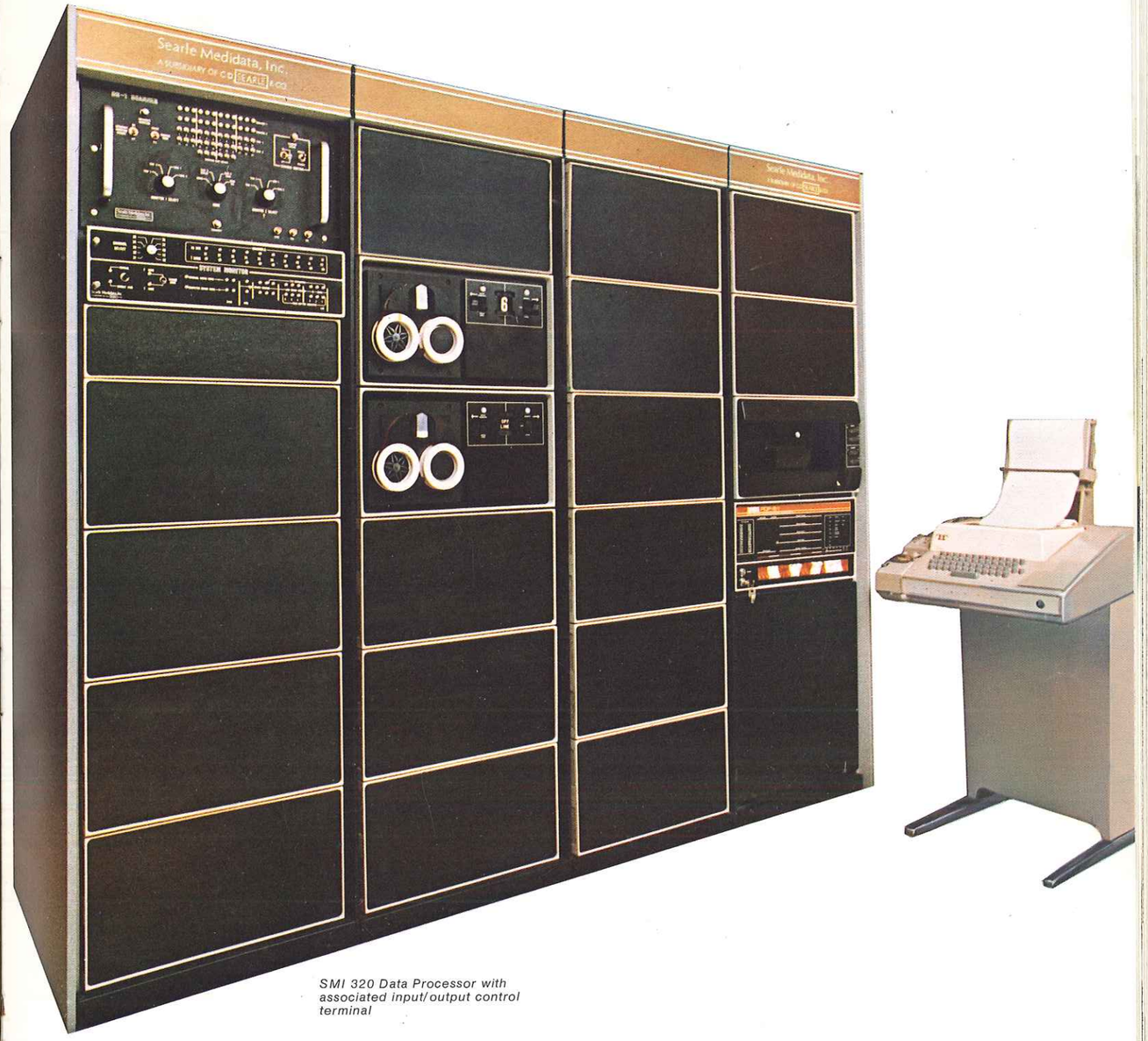
TENSION OCULAR:
IZQUIERDO 15 MM. HG. DERECHO 15 MM. HG.

CARDIOVASCULAR:
PRESION ARTERIAL ERECTO 120/65
MEDIDA DEL PULSO 72

MEDIDAS RESPIRATORIAS: CAPACIDAD VITAL
FORZADO 3640 ML = 73% DEL PRONOSTICO **
UN SEGUNDO 2300 ML = 63% DEL TOTAL **

INTERPRETACION DE LA RADIOGRAFIA DEL PECHO (14 X 17):
** FORMATO DE INTERPRETACION INCORRECTO
EXAMEN REPETIDO, EXAMEN PROGRESIVO Y ANORMALIDAD PULMONAR

Spanish



SMI 320 Data Processor with associated input/output control terminal

The 320 Data Processor . . . focal point of all SMI AMHT systems

Information processing is a major task in the operation of a multitest system. Each measurement must be entered, checked, and recorded . . . patient identification must be ascertained and verified . . . equipment must be calibrated . . . and the entire collection of data for each patient must finally be organized into a compact, legible report. In all SMI Multitest Systems, this function is successfully carried out by our Model 320 Data Processor, a small digital computer that allows for on-line, simultaneous operation of a large number of data terminals, both local and remote.

On-line computer technology increases the effectiveness of a multitest system by providing immediate feedback, quality control, fewer possibilities for operator errors, and rapid preparation of reports.

A DEC PDP-8 Class computer main frame equipped with auxiliary core and disk storage—total of 20K or more words of core storage and 256K words of disk storage—together with associated SMI scanners and multiplexer units comprise the Model 320 Data Processor. The various SMI Data Entry Consoles and an appropriate SMI Data-Break Scanner allow the computer to interact with the medical instrumentation to form a real-time, on-line, medical information communication network.

MEDICAL INFORMATION COMMUNICATION NETWORK

Searle Medidata has designed and constructed a medical information communication system that matches the requirements of the various input/output terminals to the data-handling and device-addressing capabilities of the SMI Model 320 Data Processor. In a local Linear Sequential or Carrel System, a single data path consist-

ing of three coaxial cables links all the data terminals to the data processor. For remote system variations, such as MED/STAT, system linkage between the data terminals and computer is accomplished using conventional telecommunication lines interfaced with multiplexing/transponder circuits. In either situation, each data terminal taps into the line to send and receive data. The line originates at an SMI designed and built electronic scanner, which has direct access to the computer storage via the single-cycle data break. The scanner obtains a sequence of words for transmission on the communication network from the memory, and stores the received data back into computer memory at a duty rate of twenty times per second per data terminal. This basic data acquisition system design provides direct computer entry of measurements and immediate verification by the computer, thereby permitting close control to be maintained over the accuracy of the data submitted for inclusion in the patient's record.

PROGRAMS

Like most multi-terminal on-line systems, the SMI AMHT system requires a large library of programs to handle its many simultaneous activities. They are divided into Supervisor Programs, which perform primarily administrative tasks, and Worker Programs, which perform the actual medical business of the system.

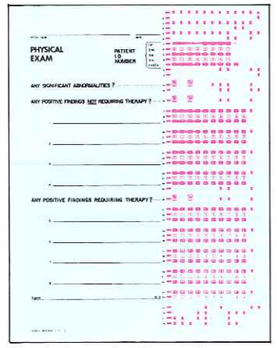
Supervisor Programs The Supervisor Programs schedule the Worker Programs, control the peripheral devices including the scanner, and maintain the patient directory tables.

The Supervisor Program carries out its scheduling mission through a sequentially allocated service-queue. Service-queue items are of three types: a) *Station items,* generated by the terminals or other programs, b) *Input/output resume items,* generated by the peripheral device control programs and c) *Program items,* which provide a means for one program module to schedule the operation of another.

The largest supervisory task in terms of core space and execution time is the control of input and output. The software of the SMI Multitest System supports the standard computer peripherals, including Teletype keyboard and printer, Selectric printer, line printer, disk, drum and DECtape. Additional keyboards and printers, depending upon the particular system configuration, are attached to the data communication network and are treated as standard peripherals by the Supervisor Program. Interrupts are serviced according to a tri-level software priority structure.

The final task of the Supervisor Program, after program scheduling and input/output processing, is scanner control. The multitest system Supervisor Program has the added task of maintaining the tables used by the scanner in order to provide the complex interface between the Worker Programs and the terminals. The scanner communicates with the processor primarily via a direct path to core storage. Interrupts are only used to inform the computer that data from the scanner is waiting.

Worker Programs Although the Supervisor Program performs many important control functions, the actual productive computing is carried out by the Worker Programs. Each medical test station is somewhat different from any other, and each has its own data processing requirements. However, a number of functions are common to most of the Worker Programs in the SMI system. They are: a) Sequencing of station operations; b) Data conversion (decimal to binary) and/or scaling; c) Validity checking of input data from stations by comparison against normal limits, physiological limits, and equipment limits; d) Computation from input data of quantities to be stored in the patient record; e) Updating the patient record by storing the computed test results; and f) Feedback to the station operator including normal displays and alarms.



Physical examination mark-sense card used in SMI Multitest System

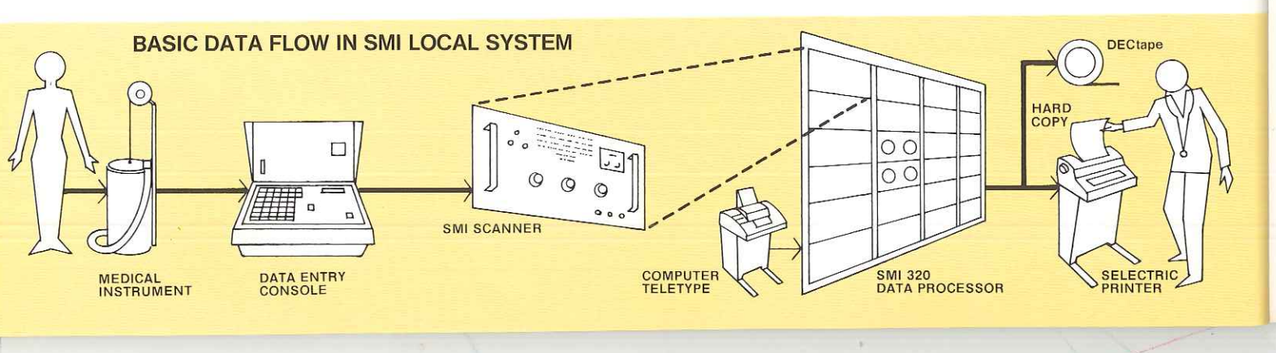
SMI MEDIC COMPILER

The users of any multitest installation will inevitably require custom variations in the report format, such as changes in the phraseology of the narrative history, inclusion of optional specialized tests, and different local standard limits for significant abnormalities. In most instances, our international clients have required that the record printout be made available in their own national languages.

As a result of these requirements, SMI has developed its own Medical Data Information Compiler—a special purpose language and compiler processor used for report generation with greater flexibility in formatting than can be provided by straightforward programming.

A report specification language (Medic) has been designed to facilitate the production of varied report formats. The language includes declaratory statements which describe the format of the patient record. Once the record organization is known, procedural statements permit selection of items from the record for printing in many different formats. For the medical history, text fragments are printed—some unconditionally, but most determined by logical combinations of the patient's answers to the questionnaire. Numeric results require printing of text headings, extraction of data from the record, conversion of binary or binary-coded decimal data to text for printing and more logical decisions for indication of unusual results. The language also allows specification of headings to be placed on each page of the report, format-control characters to control the positioning of items on the page, and case shift characters to permit printing of text in upper and lower case.

The compiler for the report specification language has been implemented on a large computer (IBM 360/65). The output of the compiler is in the form of coded instructions which are loaded onto the disk of the Model 320 Data Processor. These instructions are executed by the report generation worker program in the multitest software system. The report generator program is activated by the admission station's worker program upon command by the operator of the terminal. Thus, a standard report generator program will produce a specific medical report format in each system, depending upon the compiled code which has been loaded onto the disk. ■



Wayne Clayton
Send to: Edward Pilat M.D.
45 Carlton St.
Glenview, Ill. 60601

Male age 22
Residence: 859 Ridge Rd.
Glenview, Ill. 60601

Admissions and discharge

Data Entry Consoles are essential components of every SMI Multitest System. They are the interface between the automated medical instrumentation, and/or the attendant and computer. They are computer input/output data terminals.

In the Linear Sequential System, there are as many Data Entry Consoles as there are individual stations. Each station may incorporate one or more tests. In the Carrel System, the Carrel Data Entry Console is the single interface for the great majority of tests, most of which are performed within the Carrel area. The Carrel Data Entry Console is merely a specialized data entry terminal. Both systems require similar additional administrative and interpretation Data Entry Consoles.

The SMI Admissions Data Entry Console described on this page is an *administrative* console. The following pages describe the major variety of specialized data entry consoles along with the normal test/measurement functions associated with each one.

It is these SMI Data Entry Consoles that are utilized in an on-line, real-time, interactive mode with the computer. It is through these Data Entry Consoles that quality control is maintained over the input data.

Instrument specifications common to all the Data Entry Consoles are presented on page 37. A description of the quality control aspects common to all the Data Entry Consoles is described on page 32.

The Admissions/Discharge Station obviously serves as the entry and exit point for patients to the AMHT center.

The admissions receptionist communicates with the computer through the combined interaction of the Admissions Data Entry Console and associated Selectric typewriter.

Selectric Input/Output Writer

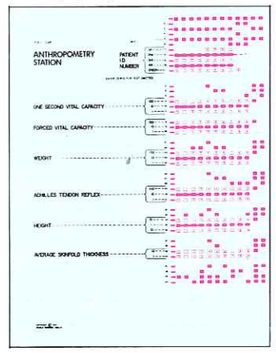
She inserts both her own identification card and an assigned, coded Patient Access ID Card into the console unit.

The date of admission, as well as the patient number, are vital to identify each individual patient to the computer. The patient's name is typewritten on a pressure-sensitive tape and affixed to the face of his Patient Access ID Card. This identifies the patient by name to the various attendants as he proceeds through the AMHT system. Any special instructions to the computer, such as a specific test contraindication are entered at this time.

Document Reader

The SMI Document Reader is an optional system component associated with the Admissions Data Entry Console. One of its principal uses is to provide a means to record and store data should there be an interruption in the function of a system component, thereby maintaining minimum interruption to normal patient flow. SMI provides a library of pre-printed mark-sense forms corresponding to

Anthropometry Mark-Sense Card



the basic test/measurement functions employed in the average AMHT system. Hence the SMI Document Reader permits immediate and efficient conversion of the system to an optional batch processing mode.

Special forms have been developed for routine use to enter results of the physician's examination itself, or other specialized routines such as procto/sigmoid examinations, etc.

At the conclusion of all the scheduled tests, the patient returns to the admissions/discharge station.

The attendant inserts the Patient's Access ID Card into the same console that she used originally to admit the patient. After the computer verifies that all the patient's on-line tests have been recorded, his medical record is automatically transferred into a standby magnetic tape file awaiting the arrival of off-line data such as, laboratory results, X-ray and electrocardiogram interpretations. The attendant can immediately request an interim patient report by pressing the "Print" button on the Admissions Data Entry Console.

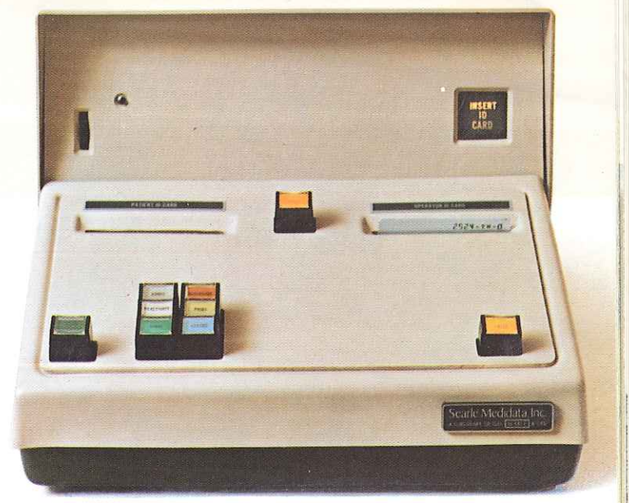
When the record is complete, including both immediate and delayed interpretative data, the receptionist requests a printed report by pressing the appropriate console key. Depending upon the status of the patient record stored in the computer at a given time, the following printout options are available upon request from the Admissions Data Entry Console: full record, patient identification only, patient identification plus history, patient identification plus laboratory and interpretive data, patient identification plus physiological data, patient identification and all data except history, full summary report and patient identification plus abnormals only.

This complete report, including all test results and medical history, is delivered to the patient's referring physician. The completed patient's record is also automatically transferred from the standby file to the archival magnetic tape file. Here it is indexed and preserved for future use. As an option, the stored data may also be transferred to industry compatible tape for additional data manipulation and reporting on larger computer systems.

Another type of administrative terminal is the Traffic Control Console. One or more of these consoles may be part of the system. They function both as a test station status display and as a patient progress monitor. Through a series of panel lights corresponding to the various functions in the screening facility, they continuously reflect station availability. When a Patient Access ID Card is inserted in the Traffic Control

SMI Traffic Control Console

Console, the patient's status in the test sequence is displayed. He may then be directed toward an available station by the simple matching of the tests yet to be done and the free stations, as exhibited by the lights on the face of the console. ■



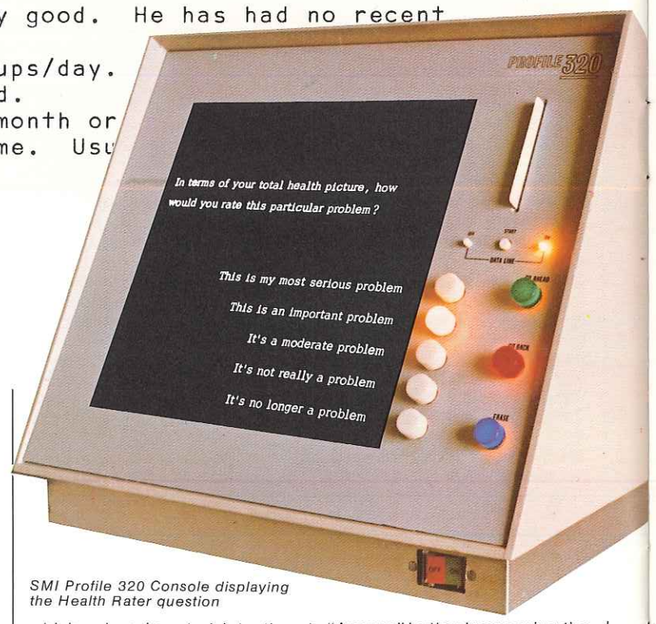
SMI Admissions Data Entry Console

Medical History: Initial visit, full.

Reason for visit: Pre-employment physical.

SYMPTOMATIC REVIEW, POSITIVE RESPONSES:

GENERAL HEALTH:
He feels his health is generally good. He has had no recent change in weight.
Coffee: Has been drinking 3-5 cups/day.
Smoking habits: Has never smoked.
Drinking habits: Drinks once a month or only a couple of drinks at any one time. Usu or rum.



SMI Profile 320 Console displaying the Health Rater question

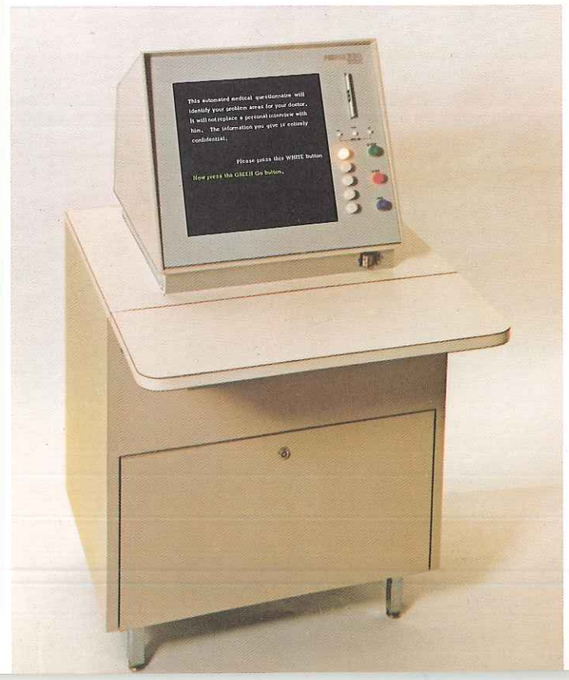
Medical history . . . with the SMI Profile 320 History Taker

The Profile 320 History Taker is an on-line input/output terminal which allows the patient to provide his medical history through a comprehensive and fascinating dialogue with the 320 Data Processor. The Profile 320 utilizes a rear-view specially-designed, tri-shutter optical-projection system. The console is easy to operate with a few simple controls that permit operation by almost any patient with a minimum of instruction.

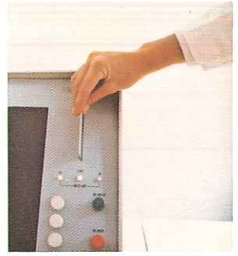
The profile 320 History Taker presents the patient with multiple choice and yes/no questions projected on a television-like screen. It has the capability of storing 320 optical displays; however, many are multiple-use questions, repeated over and over again at appropriate points in the progress of the questionnaire, giving the system a capability of displaying over 600 questions.

History is usually the first station in the typical SMI AMHT system. Working with the Profile 320 introduces the patient to the concept of computer interaction and prepares him psychologically for the battery of computer-based medical tests that follow.

The patient is identified to the computer by means of his coded Patient Access ID Card which, when inserted into the card reader, turns the unit on.



SMI Profile 320 History Taker



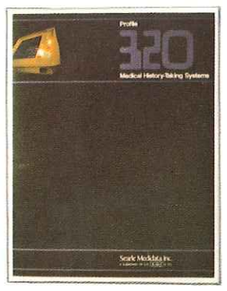
Inserting Patient Access ID Card into card reader of Profile 320

The first displays are instructional to teach the patient the use of the buttons. Experience has shown that the patient can easily be taught this simple operation and has little or no problem in administering the questionnaire to himself.

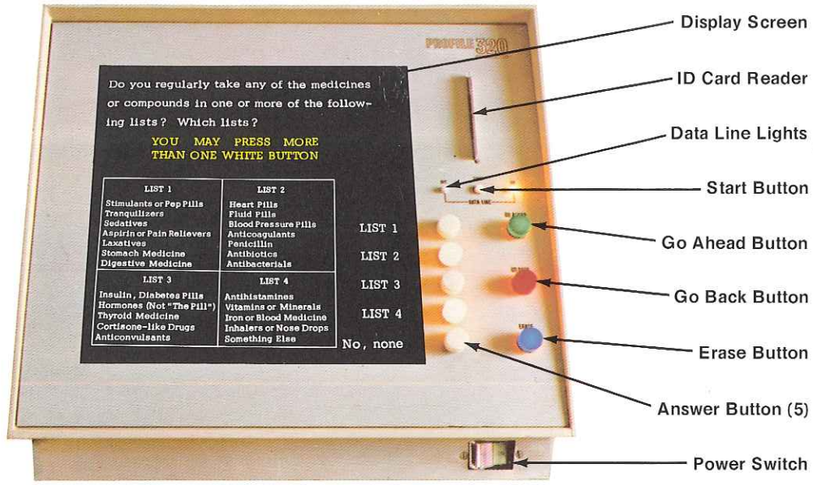
Below each of the medical history questions, there may be as many as five possible answers, each of which is aligned with a white "Answer" button on the console directly to the right of the question.

The patient selects his answer(s) by pressing the appropriate white button(s), causing them to illuminate. If the patient wishes to change an answer, he may erase the lighted "Answer" button by pressing the blue "Erase" button and another answer can then be selected. The green "Go Ahead" button must be pressed to record the answer in computer memory, and simultaneously projects the next question onto the screen. If the patient wishes to return to a prior question, he may do so by pressing the red "Go Back" button. When operational errors are made, the computer displays an appropriate message on the screen, telling the patient of his error and instructing him how to correct it.

Four different categories of histories are currently available with others under development. Those available are: a) the ORNSAH Series of Adult Histories, described in detail on the following two pages; b)



Full-color Profile 320 brochure



DESCRIPTION OF CONTROLS ON PROFILE 320 CONSOLE

Spanish

German

Polish

Swedish

Optical Display of History Question in Foreign Languages

the Pediatric History; c) the Psychiatric History; and d) the Blood Bank History. All four categories of history programs can be simultaneously available utilizing a single 320 Data Processor. When the first display naming the specific history category comes on the screen, the attendant presses the appropriate "Answer" button, which operates as a software switch to chose the corresponding computer program stored in the 320 Data Processor.

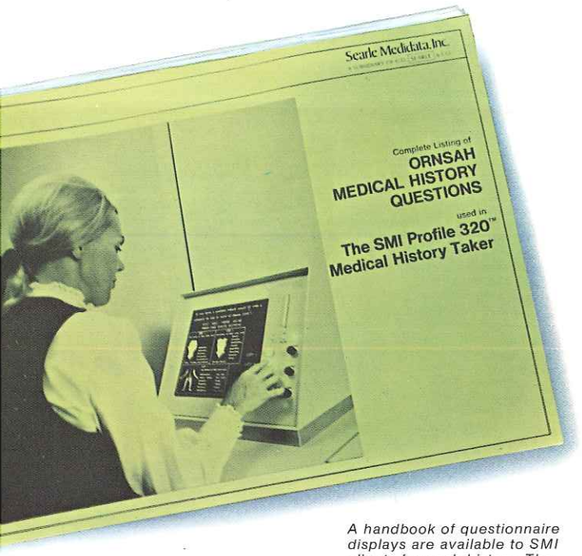
Each program requires its own set of optical displays. When a medical history different from the last one administered is requested from the computer, the attendant need only to insert the appropriate tray of optical displays in the console prior to selecting the associated history program. The ability to simply and immediately change the optical displays permits use of the same console not only for different histories, but also to present any of the histories in any language.

The Profile 320 History Taker is used in each of SMI's different system configurations. Several may be used in a local system, hard-wired directly to the on-site computer. One or more may be used in a local Carrel system, also hard-wired to the on-site computer. One or more Profile 320's may be linked to a remotely-located Multitest System's computer via dial-up acoustic-coupler/data-phone utilizing any telephone. The console is often mounted on casters for mobile use in hospital wards, remotely linked with the computer by data phone. The Profile 320 History Taker is also used in MED/STAT systems, linked to the remotely-located computer via leased telephone lines.

SMI's optical display design principle offers many advantages over other types of history-taking terminals. Optical projection "remembers" the text of the history questions locally, in contrast to a cathode-ray tube terminal which must go to a very large computer memory to extract the text of each question. Use of the Profile 320 as a translating device, with the capability of presenting questions in a foreign language, represents a major service to many physicians. The optical-display design principle permits the economical use of color, and of graphics, e.g., the ORNSAH history. Rear-screen optical-projection presents the questions in a large, sharp, and bright physical form which is easily read by the patient.

Each of the Searle Medidata medical histories has been extensively researched and validated by actual use in critical medical environments. Many thousand patients have taken an SMI medical history questionnaire on the Profile 320. The overwhelming majority of them found it "interesting," "fun," and "preferable" to the manual ask-and-write method of history taking. ■

Changing tray of optical displays in Profile 320.



A handbook of questionnaire displays are available to SMI clients for each history. The ORNSAH booklet is illustrated above.

ORNSAH: Ordinally Ranked, Nested, Self-Administered History

The histories currently available for the SMI Profile 320 History Taker have evolved over the past four years. They have been frequently refined and rewritten on the basis of experience gained in physicians' offices, group practices, hospitals, and AMHT centers.

HIERARCHICAL RATING

From the beginning, patients were generally enthusiastic. The major critique voiced by physicians was that they were unable to determine from the printout how important a given problem was to the patient without extensive further interviewing. In response, SMI developed an innovative hierarchical rating scheme. Each time a patient gives a positive response to a question about a symptom or problem, he is asked to indicate how important it is to him. This is done by the repeated use of the "Health Rater," optical display, a single question asking, "In terms of your total health picture, would you say this problem is: the main reason I came to the doctor; an important problem; a moderate problem; hardly a problem; no longer a problem at all."

With this program, not only is the physician presented with a printout of the patient's complaints and medical problems, but these are ranked in the perspective of their importance to the patient, by the patient himself.

ORNSAH HISTORY SERIES

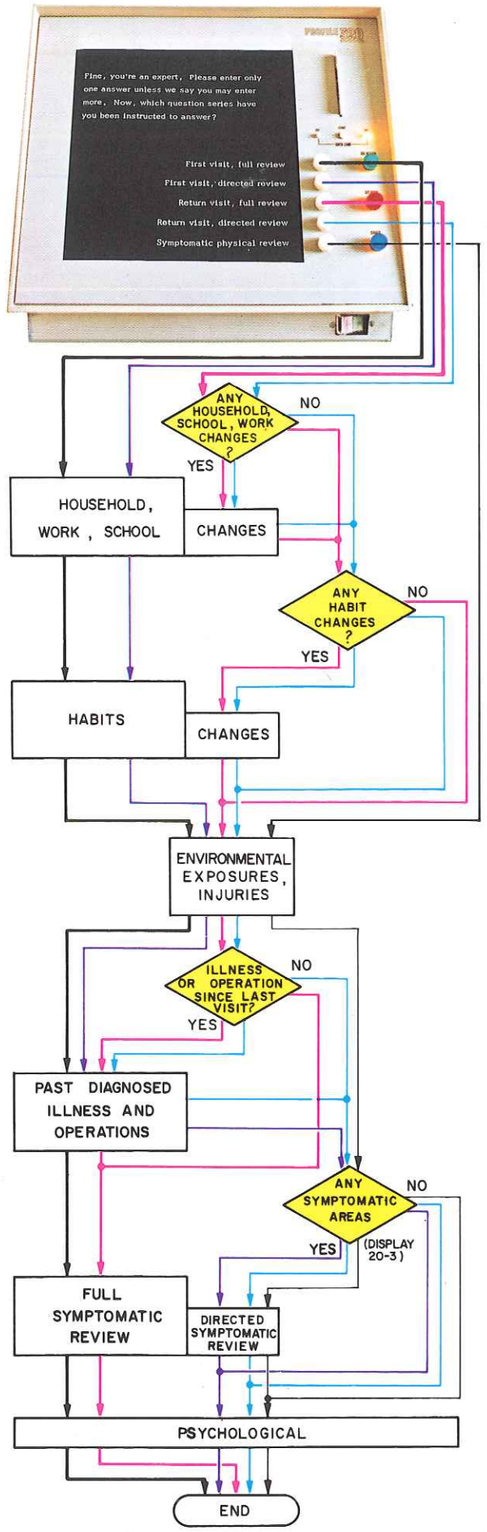
The desire to tailor the appropriateness of the full question series for a wide variety of patient mix, and the desire to ask repeat patients questions about changes since their last visit, led to the development of the most recent SMI Adult General Medical History, the SMI ORNSAH series of histories.

ORNSAH stands for Ordinally Ranked, Nested, Self-Administered History. It contains approximately the same material as the earlier clinically tested adult history, but the patient can take a wide variety of paths through the question series.

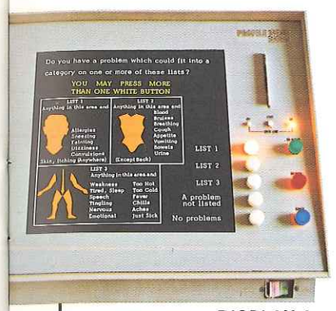
The term "Ordinally Ranked" reflects the patient's ranking of the importance of his health problem by use of the health rater question and the hierarchical rating system previously described.

The term "Nested" refers to the way in which the fundamental components of five versions of the adult history are nested together in a single branched program. They are: 1) FIRST VISIT FULL REVIEW, which covers basic social and family history, past illnesses, full symptomatic review of all body parts or physiologic sys-

ORNSAH PATHWAY OPTIONS

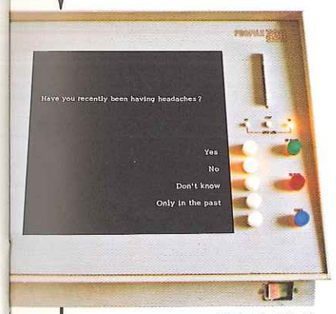


ORNSAH BRANCHING

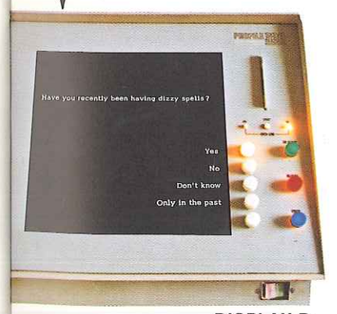


DISPLAY A

DISPLAY B



DISPLAY C



DISPLAY D

tem, and psychologic review. 2) FIRST VISIT DIRECTED REVIEW, which covers basic social and family history, past illnesses, directed symptomatic review, and psychologic review. 3) RETURN VISIT FULL REVIEW, which covers recent changes in social and family status, past illnesses only if the patient indicates he thinks the physician does not know about them, full symptomatic review, and psychologic review. 4) RETURN VISIT DIRECTED REVIEW, is the same as the Return Visit Full Review except it includes the directed symptomatic review and the psychologic review. 5) SYMPTOMATIC PHYSICAL REVIEW, which covers only general health, environmental exposure, symptomatic and psychologic reviews omitting the entire family, social and past illness sections.

The time each patient spends at the Profile 320 History Taker varies with the particular version of ORNSAH he is taking. The shortest history, Symptomatic Physical Review can be covered by the patient in a period as short as twelve minutes. For the longest history, First Visit Full Review, the average patient will spend about thirty minutes at the console.

BRANCHING

There are two different types of branching used in the ORNSAH program. The first major branching concerns itself with broad categories and takes the patient to one or another general area within the history. This block branching is diagrammed by the accompanying flow diagram. The top display illustrates the first crucial branch point at which the five broad options are presented. The response to this initial display, as illustrated in the flow diagram, determines the broad pathway which the patient will take through the question series. The attendant supervising the history-taking terminal normally will press the history path option button.

The second type of branching gathers detailed information whenever the patient gives a positive response to a question initiating a followup branch of inquiry. All the patient's answers, positive or negative, on such a branch will be printed on the report. However, should the patient give a negative answer to a particular line of inquiry, branching does not occur. In this case, the patient would not see any of the detailed questions of the subsequent branch. ORNSAH is programmed to printout only *pertinent negatives,* denials which the patient has actually made. If the patient has not seen a question, it is not printed-out on his history report.

ORNSAH is programmed with non-contradictory logic. If the patient indicates an impossible or contradictory answer, the computer will detect it and display an error message asking the patient to review the question and his choice of answers.

The series of Profile 320 displays illustrate a typical detail branching sequence. Patients who take the First Visit Full Review, or the Return Visit Full Review do not see the top display, since they will go through the entire history including all the options shown on this Directed Review display. However, it, and the List Choice display which follows it, constitute the crucial branch point for the patients taking any one of the three *directed* histories.

Display A asks the patient which of 15 body parts, or physiologic areas are bothering him. In the example illustrated at left, the patient has selected "List 1."

Display B, which the patient will see next, asks him to narrow his concern to five choices. In our example, the patient has pressed button number two which selects the area of "Headaches, Dizziness, Fainting, Convulsions."

Display C, is the next display, it asks, "Have you recently been having headaches?". Had the patient pressed the first button, "Yes", he would have then seen a series of questions pursuing the headache problem. However, to further illustrate a subbranch, we elected to have the patient answer, "No." The computer logic now skips over the series of questions probing headaches and proceeds to the second subject on the list selected by the patient, "Dizziness."

Display D, here we have chosen the patient answer "Yes" to the question of dizziness. He would next see the entire series of dimensional questions covering "Dizziness."

Upon the conclusion of the "Dizziness" questions, the patient would then see the last two remaining areas on the subject list of Display B, "Fainting" and "Convulsions."

TRIGGERING QUESTIONS

For those patients chosing any of the directed pathway options, answers to certain questions trigger other questions to insure that the patient is asked about related pertinent body parts or physiologic systems.

For instance, positive answers to questions about environmental exposure, heavy smoking, and heavy drinking will lead to questions about the lung, the liver, and other appropriate physiologic systems. In addition, positive responses to certain questions throughout the history will question the patient about areas he has not indicated as being a problem. ■

VISION:

	far (2
acuity	
both eyes	20/20
right eye	20/20
left eye	20/20
color vision	normal
stereopsis	88.5%

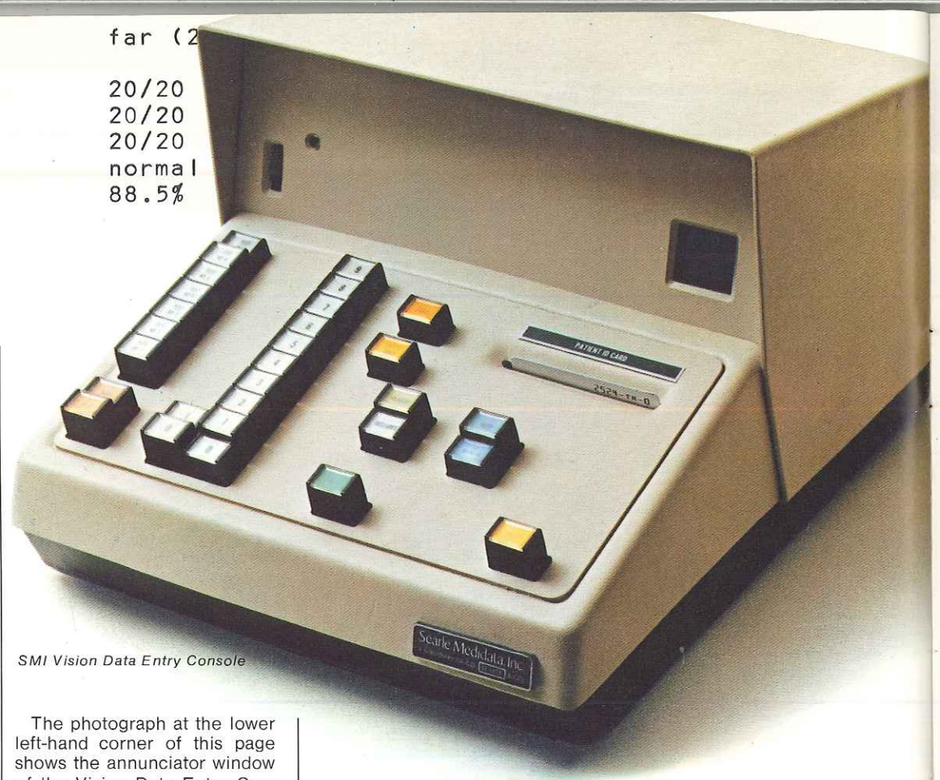
Vision measurements

In Linear Sequential Systems, the logic of scheduling tests, in the interest of smooth patient flow, indicates that all dressed procedures should be accomplished first, followed then by all undressed procedures. When the patient has finished the medical history station, which is ordinarily the first station to which each patient goes, two remaining dressed procedures typically follow, testing vision and hearing. The Traffic Control Console may be utilized to indicate which station is available.

The vision station utilizes entry of test scores through the Vision Data Entry Console, which is on-line, in real-time and interactive with the computer.

The patient's identification card is first inserted into the console's reader, identifying the patient to the computer. The attendant then uses a table-top vision tester, such as the B&L Master Ortho-Rater. The Ortho-Rater shows slides to the patient to test near-and-far visual acuity, phoria, depth perception and color vision. The on-line computer determines which slide is being shown, but the patient's statement about what he sees must be entered by the attendant via the data entry console's keyboard. The computer reads each entry, checks it for validity, and stores it in the patient's record.

Annunciator window of Vision Data Entry Console displays a caution message

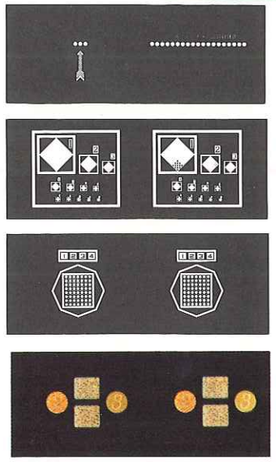


SMI Vision Data Entry Console

The photograph at the lower left-hand corner of this page shows the annunciator window of the Vision Data Entry Console. Every Data Entry Console in all SMI systems has this feature which provides a computer-generated series of text messages relative to the quality control disposition of both the input data and overall system status. Some specialized consoles, such as the Laboratory Data Interpretation Entry Console, have, in addition, dual digital displays permitting the computer to read back the digital input data which the attendant has keyed into the respective console.

Even though a particular test result might indicate a valid physiological abnormality, the on-line capability to immediately acknowledge the deviation from programmed normal limits allows for immediate verification while the patient is still present. This type of quality control check eliminates the possibility of including in the patient's record test data that has been affected by patient artifact, technician error, or equipment failure.

On-line, real-time system design allows for this type of quality control to be handled more efficiently than other computer approaches. Not only does it enhance the physician's confidence in the resultant patient printout report, but it also provides a cost-effective impact on his usage of the system by eliminating the need to duplicate various tests and measurements in his office.



B & L Orthorater slides for testing phoria, acuity, stereopsis and color discrimination (top to bottom order)

Typical operational instructions are: "Insert ID Card" . . . "Ready" . . . "Entry Accepted" . . . "Wait" . . . and "Series Complete". Typical warnings are: "Special Patient" (the test about to be performed has been contraindicated for this particular patient) . . . "Accepted Result Low" or "Accepted Result High" (both require that the data be verified by the attendant for accuracy) . . . "Illegal Data" (data is impossible for that particular test) . . . and "Equipment Failure". ■

Bausch and Lomb Orthorater

In the illustration (left), the Vision Data Entry Console's annunciator window is displaying the legend "Accepted Result Low". Each display *caution* is accompanied by an audible warning signal . . . A variety of messages, not always warnings, routinely appear in the window of all Data Entry Consoles as a result of the quality control surveillance exercised by the SMI computer.

HEARING:

	low		/ middle		/	high		
Hz	250	500	1000	2000	3000	4000	6000	8000
left	10	11	10	15	10	12	10	12
right	12	13	10	11	15	10	12	13

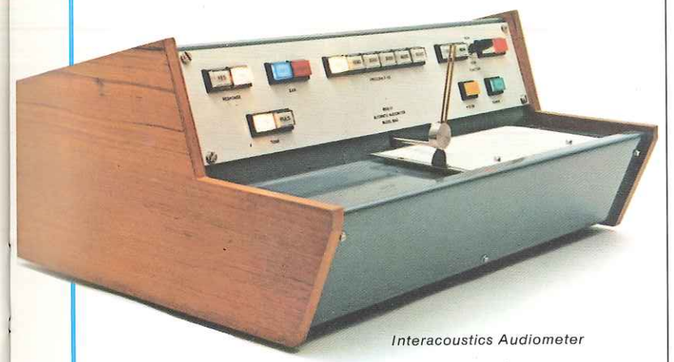
Hearing measurements

The keyboard of the Hearing Data Entry Console reflects the operational simplicity of on-line, system-automated instrumentation. There are only three console controls: "Start", "Enter", and "Test Omit".

System-automation not only assures the exact transmission of data from the instrument to the computer but obviously saves time.

Two types of instruments are usually found in the audio acuity station: a self-administered and an attendant-administered audiometer. Devices like the Interacoustics Audiometer and Rudmose Audiometer are fully automated and patient self-administered instruments. The patient is seated in a quiet area, preferably in an enclosed acoustic booth. The self-administered audiometer automatically records the patient's pure-tone air-conduction thresholds. The attendant initiates the sequence by merely pressing the "Start" button on the Hearing Data Entry Console. The patient responds to the test by pressing a hand-switch button during the period of time she can hear the pure-tone signal. She releases the button during the time she cannot hear the signal.

After one ear has been tested, the test-tone signals are presented in the same sequence to the other ear. Six different frequencies from 500 to 6000 Hz(cps) are the test ranges covered for both ears. The SMI interfaced self-administered audiometer is directly on-line, in real-time with the computer, and the patient's responses are automatically recorded by the computer whenever the hand-switch is pressed or released. The computer will print out the patient's threshold level for each frequency on the medical report. The results are also recorded on the audiogram strip chart which can be filed as part of the patient's permanent record.

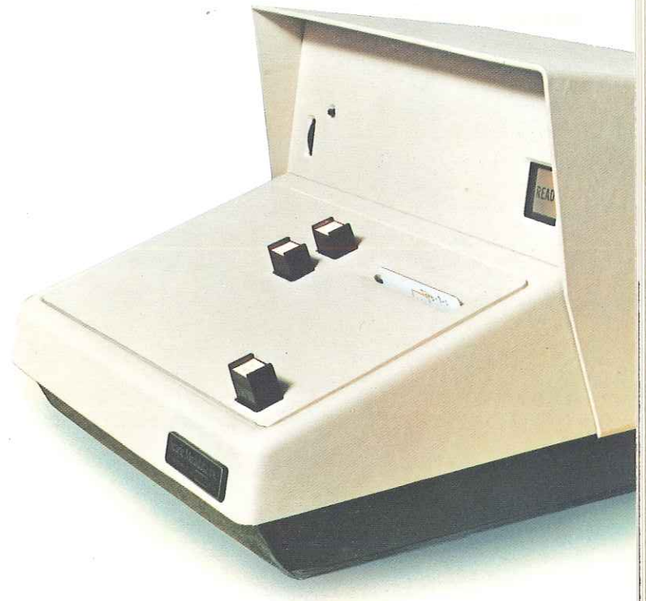


Interacoustics Audiometer

An attendant-administered audiometer is frequently used in place of the self-administered instruments. Experience has shown that an attendant administered hearing test is usually required for children, older adults, and some middle-age adults, who are unable to operate the self-administered test properly.

SMI has modified the Maico Audiometer for semi-automated operation. The Maico is a limited range audiometer for pure-tone testing. It can be used to test for pure-tone threshold level, or to screen for normal hearing at a predetermined threshold level. Each test-tone is presented to the patient by the operator and the patient responds by raising her hand when she hears the tone and lowering her hand when she loses the tone.

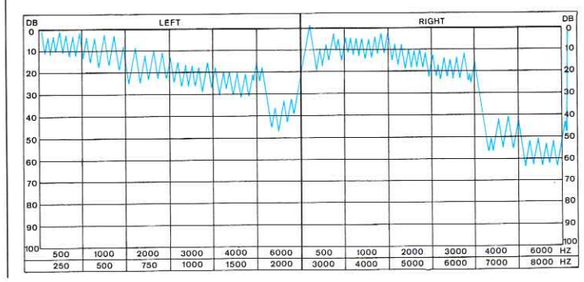
To enter a Maico reading, the attendant need only press the "Enter" key on the Hearing Data Entry Console; the computer will directly read the hearing threshold level and the frequencies. Each ear is tested at eight frequencies covering the range from 250 to 8000 Hz. ■



SMI Hearing Data Entry Console

Maico Audiometer

Typical audiogram tracing



ANTHROPOMETRIC MEASUREMENTS:
height 72.0 inches
weight 185.0 pounds
subscapular skinfold 20.0 mm (average thickness)
triceps skinfold 22.0 mm (average thickness)
body kinfold)

SMI Anthropometry Data Entry Console

Anthropometric measurements

The tests normally grouped in the anthropometry station are all performed through the use of system-automated medical instruments. They have been interfaced by Searle Medidata for on-line, real-time operation and interaction with the computer. The instruments communicate directly with the computer, without any data entry by the attendant.

The Anthropometry Data Entry Console reads the patient's identification number to the computer, indicates which test is being performed and provides signal analog-to-digital conversion. While there is additional provision on the console for manual numeric entry of results, all data is normally transmitted via the console, from the test instruments themselves, directly to the computer.

All test data entered at this station is echoed by the computer to the indicator lamps on the Anthropometry Data Entry Console's manual entry keyboard. This provides an accurate quantitative readout, verifying data input for a particular test or measurement.

The usual anthropometry station tests include pulmonary function, skinfold thickness, Achilles tendon reflex relaxation time, height and weight.

Although there is a variety of tests done in this one station, the attendant can initiate the testing automatically at each instrument, without having to return to the Anthropometry Data Entry Console to select the next test in the sequence.

Lange Skinfold Caliper

PULMONARY FUNCTION

Instruments such as the Collins Model P-800, 6-liter Spirometer are normally used to measure lung vital capacity. The patient exhales into a spirometer tube, where mechanical displacement is converted to voltage by a potentiometer. The voltage is converted to a digital number for direct entry into the computer. The computer program performs all necessary peak reading, averaging, and conversion to conventional units. The vital capacity in milliliters is then stored in the patient's record.

There is no need for the attendant to read dials and copy the results onto a card or keyboard. The computer returns a display of the measured value so that the operator may verify correct entry. In addition, results which are outside the programmed acceptable limits, set by the center's medical staff, are indicated by visible and audible alarms. Attendants are instructed to repeat and verify measurements which the computer considers questionable.

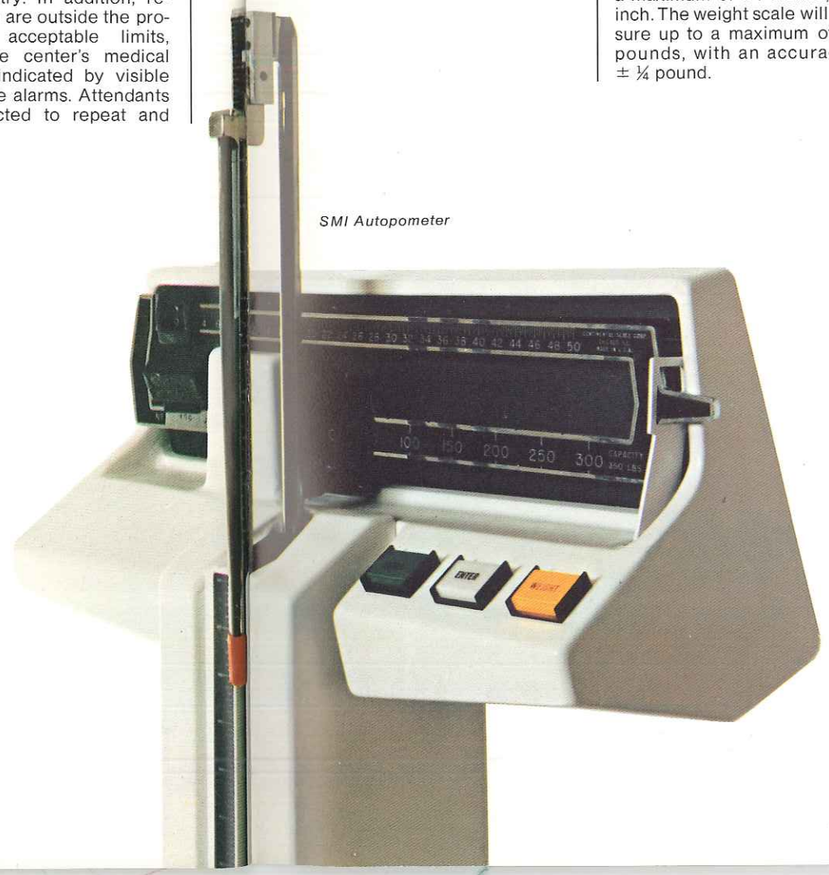
The computer records both the total expired volume, and volume at one-second. On the record printout, total forced vital capacity is expressed in milliliters, and as a percent of predicted normal relative to the patient's age, sex and height.

The one-second vital capacity is presented as the volume reached within this time frame and also as a percent of the total capacity. All computations are performed by the computer.

SKINFOLD THICKNESS

An SMI modified Lange Skinfold Caliper makes a simple, accurate measurement of the thickness of the subcutaneous fat layer. It incorporates the recommended principles for standardized usage in nutrition, fat distribution, child growth and anthropometric studies. After the caliper is applied to the skinfold, the "Enter" button is pressed on the caliper. This total is read directly and automatically on-line and in real-time by the computer. Four measurements are taken, the computer calculating and recording the average skinfold thickness in millimeters. The computer then applies these measurements, along with the patient's height and weight, to calculate total-body-fat as a percent of total-body-weight. Normal values for this measurement, established by the medical staff of the AMHT center, are dependent upon the patient's sex and age. Off-normals are flagged on the printout.

SMI Autopometer



SMI AUTOPOMETER

The SMI Autopometer automatically transmits a patient's height and weight on-line to the computer. A built-in height/weight voltage control circuit connects to the analog-to-digital converter in the Anthropometry Data Entry Console, providing the data pathway to the computer. A telescoping measuring rod will accurately measure the height of patients from a minimum of 38 inches to a maximum of 84 inches, ± ¼ inch. The weight scale will measure up to a maximum of 350 pounds, with an accuracy of ± ¼ pound.

Collins Vitalometer

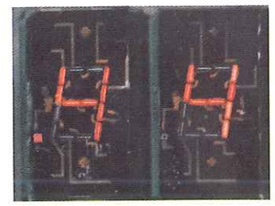
ACHILLES TENDON REFLEX

The use of the SMI Reflexometer in the determination of thyroid dysfunction is an optional test. The entire procedure takes only a few minutes.

The SMI Reflexometer consists of the Burdick Photomotograph detector and an SMI modified timing recorder. The photomotograph employs a photoelectric technique to measure displacement of the foot. With the patient kneeling on a chair, the unit is positioned so that the light beam is partially intercepted by the plantar arch of the foot. A tap on the Achilles tendon with a percussion hammer causes the foot to move in the light beam and this movement is converted to an electrical signal which is amplified and recorded on chart paper. The record produced gives a time plot of reflex action. The time elapsing between the stimulus of the tap on the tendon and one-half the relaxation phase is simultaneously and quantitatively displayed on a digital display readout on the chart recorder unit.

A number of tests are made and the strip chart is examined for correct characteristic wave form along with a consistent digital display pattern of reflex times. When the attendant determines she has a valid recording, she pushes the "Enter" button on the recorder module. This automatically enters the time of the last reflex into the computer.

Other optional tests and measurements, in addition to the Achilles tendon reflex procedure, may be performed using the Anthropometry Data Entry Console. These might include temperature, head circumference, chest circumference, additional skinfold measurements and the like. The identical data terminal is also used when a system-automated tonometric measurement, utilizing a Mackay-Marg applanation-type device, is the preferred method for measuring intraocular pressure of the eye. ■



SMI Reflexometer incorporating the Burdick Photomotograph Detector and a specialized timing recorder. Inset at left shows the nixie readout

ECG normal

CARDIOVASCULAR:
blood pressure
pulse rate

Cardiovascular measurements

Three tests are normally conducted in the cardiovascular station: electrocardiograph, arterial blood pressure, and pulse rate.

The Cardiovascular Data Entry Console functions as an on-line input-output terminal, and provides for numeric entry of up to as many as eight different test results into the patient's record. Depending upon the medical instrumentation employed, the attendant either enters data using the appropriate push buttons on the console's keyboard, or allows the data from system-automated instruments to be fed directly into the computer.

THE ELECTROCARDIOGRAPHS

Searle Medidata normally furnishes ECG instrumentation such as the Marquette C-205 or the Hewlett-Packard 1513 Electrocardiograph. Both instruments provide automatic 3-channel, 12-lead ECG's.

The Marquette C-205 Patientransmitter will produce a three-channel, electronically switched ECG record of the twelve standard scalar leads in continuous, automatic sequence. All electrodes are placed on the patient at once. Leads 1, 11, 111, are then sampled, and if satisfactory, the instrument is switched and automatically produces a strip chart record. Total recording time is normally 10 seconds, 2½ seconds for each group. Since the sequence is continuous, the entire three-channel strip may be used for studies of arrhythmia. XYZ Frank orthogonal leads may also be recorded following V_4, V_5, V_6. Lead identification pulses are automatically produced as part of the sequence.

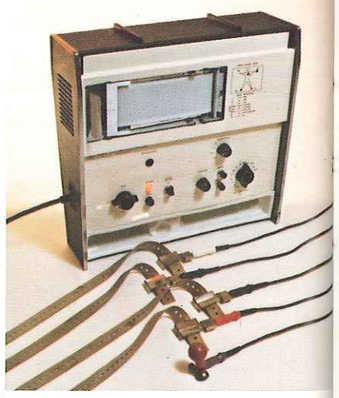
The three-channel Hewlett-Packard 1513A Automatic Cardiograph automatically records all 12 ECG leads in 10 seconds. It saves time, increases accuracy and improves handling efficiency over conventional single-channel units. The output is a one-piece, 12-lead record that fits into an 8½" x 11" plastic mounting envelope—ready for immediate diagnosis. The system completely eliminates the cutting and mounting of individual leads . . . thus greatly reducing labor costs while increasing accuracy.

The various alternative methods for providing the interpretative analysis of the standard 12-lead ECG to be entered into the patient's record are discussed elsewhere in this brochure on page 44 and page 46.

Other less expensive ECG machines, such as the Hewlett-Packard Electrocardiogram Model No. 1500A or Burdick Model No. EK-III provide a manual single-channel recording of either a 1-lead or 12-lead ECG. In the latter instance, the individual lead tracings need to be cut and pasted on specially formatted backing sheets prior to the cardiologist's interpretation.

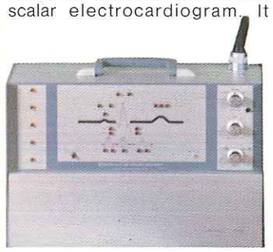
SMI Cardiovascular Data Entry Console

Marquette Patientransmitter


Hewlett-Packard Electrocardiogram

ECG NORMAL/ABNORMAL SCREENING

The Humetrics ElectroCardioAnalyzer (ECA) is a small portable digital-analog device that recognizes and analyzes various (20) parameters of the scalar electrocardiogram. It operates like a conventional ECG, but automatically flags parameters that fall within specified norms utilizing only 5 leads (V_1, V_5, 1, 11, AVF). It is a real-time device, analyzing the electrocardiographic signal immediately. The Humetrics ECA distinguishes between normal and abnormal ECG patterns and calls out abnormals by defining that parameter. When used in conjunction with the Cardiovascular Data Entry Console, SMI provides the necessary computer program which allows the appropriate interpretative statement to be entered on-line, directly into the patient's record.


Humetrics ElectroCardioAnalyzer

SMI believes that the ECA is an optional method conceptionally desirable for screening purposes. The electronic analysis of the wave forms are simply to separate normal tracings from abnormal which permits making additional single-lead tracings only in those few cases yielding an abnormal reading. These single-lead suspect tracings are then analyzed by a cardiologist. Results to date with the ECA indicate that the percentage of false negatives and false positives are within acceptable limits when compared to alternative approaches.

Humetrics also has developed a companion unit, the PhonoCardioScan (PCS), a heart-sound screening aid for detection of heart disease in children. A microphone is placed sequentially on the child's chest and the recorded heart sounds are analyzed. Heart sounds are examined on a beat-by-beat basis for suspect abnormals.

ARTERIAL BLOOD PRESSURE

Various monitoring devices exist today, such as the London Pressurometer Automatic Monitor which take blood pressure measurements — both systolic and diastolic — automatically, over extended periods of time, at preset intervals.

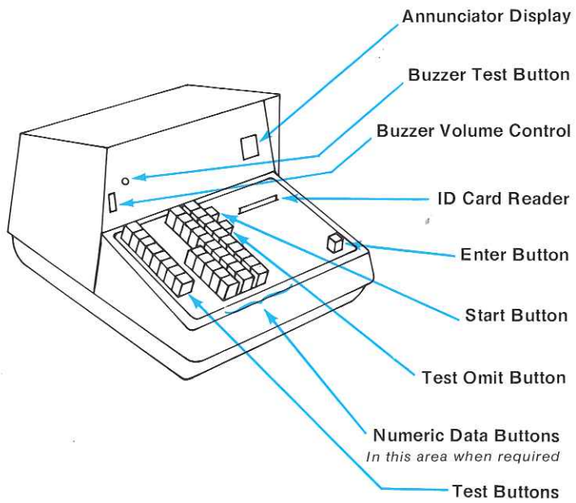
Once the attendant has selected the desired time interval and adjusted the cuff, the instrument automatically inflates the cuff to a preset maximum, bleeds air from the cuff, "hears" every Korotkoff sound, and deflates the cuff entirely, until time for the next reading, when the cycle is repeated. Blood pressure is read, in millimeters of mercury, from large lighted numerals. Both systolic and diastolic pressures appear continuously, until the previous reading is superseded by a new one. By pressing the "Enter" button on the Cardiovascular Data Entry Console the attendant allows the data displayed on the monitor to be fed directly to the computer for entry into the patient's record.

PULSE RATE

Pulse Rate is automatically obtained during the measurement of the arterial blood pressure and entered directly into the computer. If the pulse rate is taken manually, the data is normally entered into the computer via the numeric keyboard on the Cardiovascular Data Entry Console. ■


London Pressurometer


Hewlett-Packard Cardiograph



Specifications common to all SMI data entry consoles

Data Entry Consoles are designed using integrated circuits for high reliability in performance. Patient identification is accomplished by means of the pre-punched plastic Patient Access ID Card which the attendant inserts into a slot on the console face for reading by a photoelectric device.

Each SMI Data Entry Console has an annunciator which displays a series of English text, quality control messages initiated by the data processor.

Various data terminals require a low voltage d.c. power source of 110V at 5A. As many as three such terminals in a system can share a single power supply. Other data terminals will draw power directly from a conventional 110V a.c. outlet, at approximately 2A. Power conversion for 230V, 50 cycles operation is also available.

SMI Carrel Data Entry Console

SMI Carrel Data Entry Console

The basic concept of the Searle Medidata Carrel System has been discussed on pages 12 and 13 of this brochure. The SMI Carrel Data Console is the instrument through which the Carrel System concept is translated into a working system. It combines in one instrument, patient identification, test identification and test result reporting. It combines the individual test consoles and the multiple-test station consoles previously described which are required for a linear sequence patient flow. Unlike certain tests of the Linear Sequential System, e.g., the anthropometry series, none of the medical instruments in the Carrel station are directly on-line with the computer. The SMI Carrel Data Entry Console itself operates in a real-time, on-line interactive mode with the computer.

The SMI Carrel Data Entry Console is used in two principal system configurations, local and remote. It is the data interface in a local system, hard-wired to an on-site computer. The second application of the Carrel Data Entry Console is the data link with the remotely located computer in SMI's MED/STAT configuration. The function of the Carrel is identical in both applications, the only difference being that additional interface equipment is used in the MED/STAT configuration to link the Carrel, through leased telephone lines, with the remotely located time-shared computer. In either multitest system configuration, there may be several Carrel stations where identical or different tests are performed in addition to the admission, history and lab stations.

Like all SMI system elements, the Carrel Data Entry Console is extremely flexible in its application to any particular medical need. The console is programmed to perform any combination and sequence of testing specified by the using medical staff.

Operation is extremely simple. The terminal is self-cycling according to a predetermined programmed testing sequence. The operator need only perform each test as the computer calls for it, using the specified medical instrumentation, and key-in the test result employing only the numeric keyboard.

When the patient enters the Carrel area, the technologist inserts the patient's ID card in the console and presses the "Start" button. The acceptance of a legal patient ID card is signalled by a "Ready" message in the annunciator window, and at the same time the first button in the first column will light, indicating that the first test can be performed. The operator enters the data resulting from the medical instrument test through the ten-digit keyboard. Two groups of digital displays, an annunciator window, and audible alarms are part of the Carrel Data Entry Console's quality control system. Each digit, as it is entered, is confirmed on the computer driven displays. After visual verification of the entry by the operator, she completes the data input by pressing the "Enter" key. The data processor program performs any necessary calculations and the data entered is audited by the computer for validity. If the data entered is legal, it is transmitted automatically by the computer to the patient's record. Acceptance of the data by the computer is indicated by the clearing of the numerical display and an "Entry Accepted" message in the annunciator window.

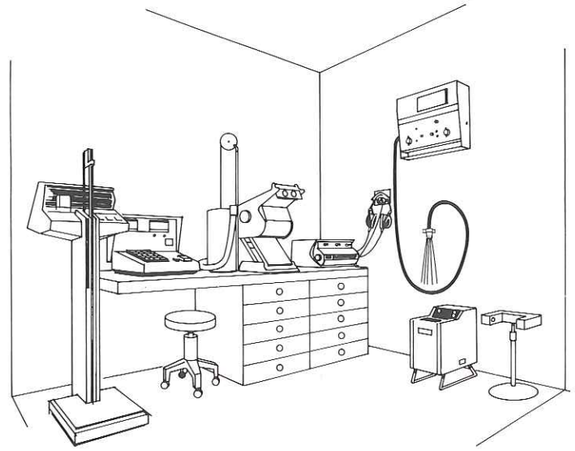
As soon as the first entry is accepted, the computer extinguishes the associated function light and illuminates the second button indicating the next test to be performed in the sequence. When vision and hearing tests are scheduled, two function lights will be on at the same time, i.e., "Hearing Left" and "1000 Hz".

Should the operator make an error in entering the data, it can be cleared from the computer record by pressing the "Clear Field" key which also clears the numerical display. New data may then be entered. Completion of the entire battery of tests will be signalled by an audible signal and a "Series Complete" message in the annunciator window.

The attendant can, should she wish, skip or eliminate certain specific tests from the battery which have been pre-programmed to be administered.

The medical instruments used in the test procedures of the Carrel station may be automatic; they are not system-automated. There is an extremely high degree of automation of the Carrel Console itself, and the automatic computer test sequencing and quality control programs assures a high degree of accuracy and efficiency in the overall patient testing operations. The technician can focus on administration of the medical tests, easily validate her entries and complete the test battery without reliance on memory or written check lists.

An additional optional function of the Carrel Data Entry Console, coincident with its routine use both in a local Carrel or remote MED/STAT System is the capability to provide access to the patient record of the physician's physical examination findings. As many as thirteen of the unused buttons on the console's keyboard can be utilized, in conjunction with a coded work sheet, to allow the physician to enter his positive findings directly into the patient's record. ■



Typical Carrel area

Carrel Data Entry Console used in SMI MED/STAT systems

Technologist enters test data on Carrel Console ten-digit keyboard

OCULAR TENSION: normal range 14 - 20 mm Hg
left eye 1[illegible]

PAP SMEAR:
unsatisfact[illegible]

BREAST EXAMINATION
left breast
right breast

SMI Multitest Data Entry Console

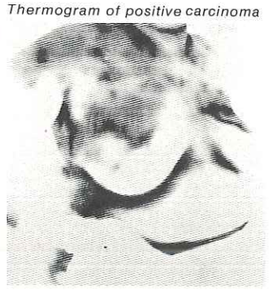
Optional measurements

A large number of optional tests are available for any SMI system. The tests vary from system to system, and utilize instruments with varying degrees of automation, based on the desire of each center's medical staff. Typical optional tests include thermography, mammography, breast palpation, stomach X-ray, fluoroscopy, peripheral vascular measurement, sigmoidoscopy, Pap smear, pelvic examination, weight distribution, tonometry, retinal photography, and dental X-ray.

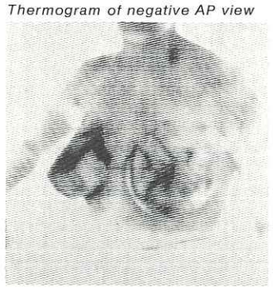
The SMI Multitest Numeric Data Entry Console functions as an on-line input/output terminal for all optional test data. It communicates three basic levels of data to the computer. A "test given" acknowledgment on tests where numeric data is not immediately available, and where additional interpretative data is usually required, e.g., X-ray. The second level reports available digital test data. The third level is descriptive data, e.g., left breast or right breast, right eye or left eye.

Numeric test data may be entered into computer memory either directly from an on-line automated medical instrument, or manually by means of the numeric ten-digit keyboard.

Thermogram of positive carcinoma



Thermogram of negative AP view



Entry of non-digital data is made by pressing special buttons on the console's keyboard which initiate a coded interpretative statement to the computer.

Like other SMI Data Entry Consoles, this type of data terminal has an annunciator which displays a series of English text messages initiated by the data processor. This instantaneous quality control function minimizes data entry error, indicates acceptance and/or verification of input data relative to programmed normal limits and provides specific instruction to the attendant when appropriate.

By providing these computer-interactive functions for all specialized or optional tests, the Multitest Data Entry Console maintains a desired level of operational convenience for the administrative procedures associated with specific tests. In high patient flow systems, utilizing the SMI Traffic Control Consoles, the system interaction of the various Multitest Data Entry Consoles provides supplementary check-point input to a number of important computer program sub-routines primarily involved with on-going system utilization and patient status reporting.

The basic SMI Multitest Data Console is completely flexible in its application and is programmed to suit the particular requirements of the specific test or combination of tests which it serves. ■

Mackay Marg Tonometer

REFRACTION:
O.D. + 2.00 sphere
O.S. - 1.75 -.75 x 120
add + 2.25
Near vision is Jaeger 1

NEAR POINT OF ACCOMODATION:
4.00 diopters
Interpupillary Distance is 64 mm.

Visual measurement laboratory

One of the primary goals of SMI's research and development programs is the expansion of the AMHT concept through Automated Diagnostic Health Testing (ADHT). ADHT provides a second echelon test capability for a broader area of medical applications.

One of the most immediately useful Automated Diagnostic Health Testing modules is Visual Measurement Laboratory (VML), the first of our ADHT subsystems. The VML provides for measurement, data collection, computer calculation, and data reduction for all those portions of an eye examination which do not actually require inspection of the eye by an ophthalmologist.

The appropriate tests of the VML ADHT module can be made available, as options, within the branching structure of the AMHT testing sequence, or as a self-standing service can be used for conducting specialized vision tests as directed by an ophthalmologist. Within the framework of a multitest system, the VML subsystem will be largely an effort to give specialized attention as a second echelon follow-up to screening procedures. In other words, when a patient "fails" a vision screening test within the structure of the AMHT criteria, a computer-generated advice rule would help channel the patient to the more specialized data gathering station where appropriate referral could then be made on the basis of the extensive testing performed in the Visual Measurements Laboratory ADHT module.

The VML subsystem should be under the overall direction of an ophthalmologist who routinely follows up on those patients referred to him as a result of the tests. Because the ophthalmologist establishes the criteria for such referral, he has complete control over the standards by which his patients are handled. Should the VML be implemented as a specific satellite module in a MED/STAT service network, other ophthalmologists utilizing the same VML facility can vary the testing criteria to their needs.

Operation of the VML is normally in the hands of a licensed optometrist. Such individuals, assisted by a receptionist-technologist, can handle about 32 patients per day in an average VML facility of about 300 square feet.

Whether it is part of a MED/STAT system, or an optional test station in an existing SMI AMHT facility, the VML subsystem consists of the following:

a) VML Admissions Data Entry Console, permitting separation of computer programs and patient records from those simultaneously used in the Model 320 Data Processor for multitest operations.

b) Profile 320 History Taker, programmed with a special, short, (5 minutes) ophthalmologic history.

c) IBM Selectric typewriter with control logic, for use during admission and local printout of the VML results.

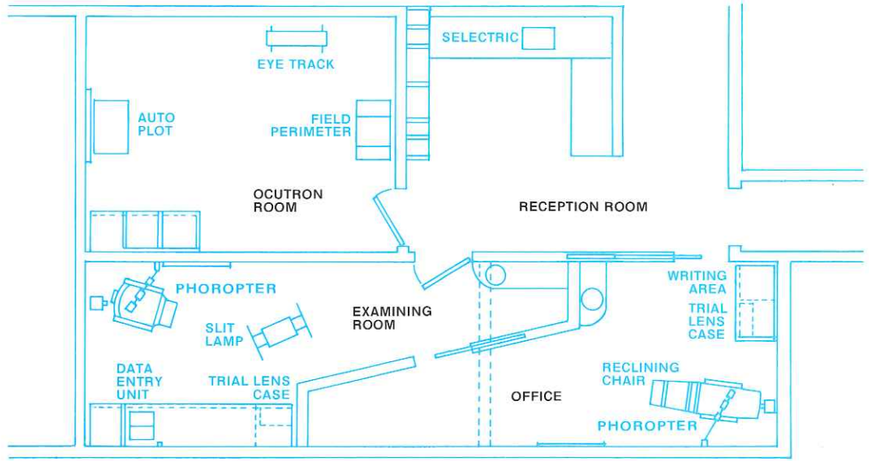
d) VML Data Entry Console (Carrel terminal) for entry into the SMI 320 Data Processor of the results of all tests and measurements.

e) Visual Measuring Equipment, for performing the following examinations: measurement of patient's old glasses (if any), visual acuity of each eye, color vision, phoria, depth perception, visual fields of each eye, refraction (done over the patient's old glasses where relevant), visual acuity through the new refraction, near visual acuity with the bifocal add appropriate for age, intraocular pressure measured by applanation tonometry, optional tests such as reading rates, optokinetic nystagmus, four prism diopter tests, and tonography.

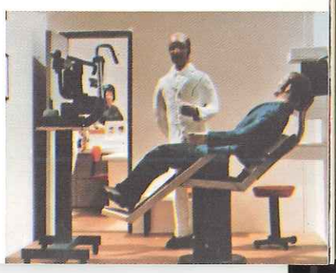
The computer printout derived from these tests includes ophthalmologic history, quantitative data on all eye tests including indication of abnormalities, and eyeglass prescriptions where required. The VML helps to organize the delivery of eye care to conserve the ophthalmologist's time by having the appropriate data available when he sees the patient. In many cases, depending upon the criteria established by the ophthalmologist, no patient visit will be necessary.

The packaged VML ADHT module is a joint creation of SMI and Visual Measurements Laboratories, Inc. The SMI contribution relates to the design of the computing portion of the system to utilize the standard SMI on-line, real-time system for taking patient histories, processing test/measurement data, calculating appropriate indices and printing out the results. Visual Measurement Laboratories' contribution has been the design and selection of the tests and measurements from a professional standpoint, development of appropriate optics, calculations and programs, and the validation of the system from the ophthalmologist's standpoint. As SMI consultants, the ophthalmologists of Visual Measurement Laboratories, Inc. assume medical responsibility for the system and are available to SMI clients in an advisory capacity, both in setting up the system and in assisting in its operation. ■

TYPICAL VISUAL MEASUREMENT LABORATORY FLOOR PLAN



Scale model illustrating typical VML testing procedures



BLOOD CHEMISTRY:

		value		normal range
tot pr	g%	7.0		6.0 - 8.0
alb	g%	6.0	**	3.5 - 5.0
cal	mg%	9.0		8.5 - 10.5
phos	mg%	3.0		2.5 - 4.5
chol	mg%	200		150 - 300
gluc	mg%	70		45 - 150
uric	mg%	5.0		1.5 - 8.0
t bili	mg%	0.5		0.1 - 1.0
alk p	mu/ml	50		30 - 85
ldh	mu/ml	125		90 - 200
creat	mg%	1.0		0.7 - 1.4
sgot	mu/ml	20		10 - 50
a/g	ratio	6.0	**	1.1 - 2.2

SMI Laboratory Data Entry Console

Laboratory data handling

Flexibility in the number and type of laboratory tests and the data handling method for directly transmitting the information to the patient record is characteristic of SMI's approach to tailoring the system to meet individual requirements. The group of laboratory tests to be performed depends upon: a) the breadth of the test panel desired, b) the availability of pre-existing facilities, c) the cost which can be tolerated, d) special considerations, such as research programs, and e) the personal perference of the pathologist or other professionals associated with the multitest facility.

Technicon SMA 12/60 with T & T Technology SMART ADC

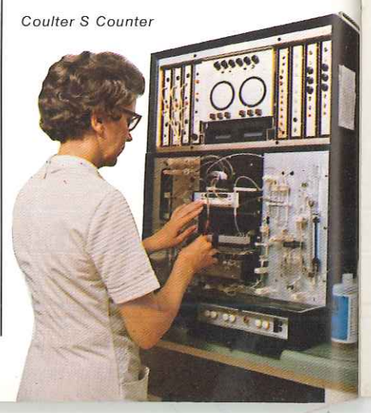
Generally, the laboratory determinations in SMI AMHT Systems cover four broad areas: a) urine analysis, b) hematology, c) blood chemistry, and d) other tests like analysis of Pap smears. Although any method of generating hematology and blood chemistry determinations can be utilized, the principal instruments in the typical SMI multitest center laboratory, are the Coulter S or Coulter Fn and the SMA 12/60 or smaller versions of Technicon equipment.

Laboratory data is made available at each AMHT center in two forms. First, a complete typed record is produced for transmission to the physician along with the examinee's history, physiological measurements and the other information that comprises the comprehensive medical record. Secondly, on command, the data processor will print out a partial report, transmitting a hard copy of those laboratory tests that are then complete. There is no need to interrupt the laboratory operation to retrieve this information since test results automatically enter the patient's record almost as soon as the technician has obtained them and transmitted them to the computer.

DATA ENTRY OPTIONS

Three general methods are available to enter laboratory data into the examinee's AMHT record: a) the SMI Laboratory Data Entry Console, b) the SMART-type Analog-To-Digital Converter, and c) the CliniLab 320 system. The data handling choice largely depends on the degree of automation desired by the laboratory director, primarily based on work load projections.

Coulter S Counter



Digital Equipment Corporation Clinical Lab 12 System

SMI Laboratory Data Entry Console The simplest and most flexible method of data handling in the laboratory is through one or more discrete SMI Laboratory Data Entry Consoles. This is an on-line data terminal which can be tailored and programmed to enter results for any series of lab tests: urine analysis, hematology, blood chemistry. cytology, or others. The procedure for entry of test values is essentially the same regardless of the particular test. However, the labelling of the test key on the console keyboard will differ depending on which test results are being entered.

Laboratory technician examining Pap smear slide

As with all SMI Data Entry Consoles, the lab entry console is on-line in real-time with the computer in an interactive mode. Quality control checks of the input by the console operator are an inherent part of the operation.

The operator can choose to enter a complete set of lab test results for one patient. She simply presses the "Hold ID" button and then keys-in all of the test data for a particular patient without further re-entry of the patient's ID number. Certain test results, e.g., urine analysis and hematology, for that particular patient may be entered using the sequence button. When a sequence button is depressed, the computer automatically calls for the test results by lighting each of the test buttons of a given set in order. Other tests that are not covered by a sequence button, may be selected manually by depressing a specific key on the console for each determination.

A second mode of operation may be selected by the operator, holding a specific test constant and entering a series of patient identification numbers and corresponding test results. A different test button may be pressed at any time and the appropriate sequence repeated.

It is often convenient and desirable to utilize several data entry consoles throughout the laboratory. Frequently, a single console will be devoted to a single test, e.g., the cytology findings on the Pap smear. For some tests, raw data is entered and processed by the computer. For other tests, the technician makes the required calculations keying-in only the finished value. Since functional behavior of most push buttons and displays in the Laboratory Data Entry Console is determined by computer software rather than internal wiring, special purpose consoles for hematology, urine analysis, etc., can easily be provided.

T & T Technology's SMART SMART, the Sequential, Multiple Analysis Reporting Terminal, is a low cost, laboratory-based, digital-output system that converts, compacts and communicates sequential multiple analyzer output quickly, efficiently and at very low cost. The system will handle the high volume of data from the SMA 12/60. The SMART is interfaced to the 320 Data Processor by an SMI software program. This program permits mixing of multitest examinee SMA determinations with those of non-multitest examinees. Only multitest coded determinations are transmitted to the multitest computer for proper insertion in the appropriate examinee's record file.

The SMART processes and formats data from the SMA 12/60 onto punched paper tape. The tape is then fed into the center's data processor and entered into the patient's record for subsequent printout with other information. In addition to the SMART's punched paper tape and printed outputs, the normal SMA 12/60 chart output is also always available to the laboratory. Programs can also be provided to accept data from other devices which put clinical lab data on paper tape. Examples are T & T COURT, Infotronics CRS-75, and Technilogger.

CliniLab 320 The ultimate automation of the laboratory is realized through application of the CliniLab 320. This is the Digital Equipment Corporation's Clinical Lab 12 System which is interfaced by Searle Medidata to the center's multitest computer. Hardware and software for the CliniLab 320 are provided by the Digital Equipment Corporation, and the interfacing of the system to the AMHT computer will be provided by Searle Medidata.

The CliniLab 320 is a powerful laboratory system that yields important benefits to the large scale laboratory where total automation is economically feasible. It has a very flexible report-generation capability. It provides a great number and range of reports that are useful to the pathologist e.g.: Summary Reports, Ward Reports, Billing Reports, Quality Control Statistical Reports, End-of-day Reports, Diagnostic Printouts for Area Decision. ■

Laboratory technician entering data on an SMI Laboratory Data Entry Console

CHEST X-RAY INTERPRETATION (14 x 17):
emphysema, left and right
lung fibrosis, left
consider follow-up P-A and lateral

SMI Interpretation Data Console

SMI Interpretation Data Consoles

A number of the specific tests performed in an SMI AMHT center require interpretation by cardiologists, radiologists and other specialists. Most frequently the interpretations are made after the examinee has left the multitest center.

The instrument output of such tests, be it a strip chart, a sheet of film, or another form of medical data, is forwarded to the appropriate medical specialist for his inspection and interpretation. His finding is subsequently transmitted to the SMI multitest computer for entry to the individual patient's record.

The on-line terminal required to interact with the computer is the SMI Interpretation Data Console. It provides the means by which the medical specialist, regardless of his location and the time lapse, can directly enter interpretations of X-rays, electrocardiograms, and other specialized measurements into the computer's memory for filing in the individual examinee's record.

The data entry procedure is essentially the same for all interpretation consoles. However, the labelling of the descriptive keys differs depending on the specific test being evaluated. In general, the specialist transmits his interpretation by pressing the appropriate labelled keys on the console. The keys transmit a descriptive phrase or combination of phrases. As each interpretative statement is formed, it is transmitted directly to the center's computer which automatically locates the record for each patient on its magnetic tape standby file, updates the file with each result, and leaves the updated record on tape for any remaining additions, or to await printout upon command.

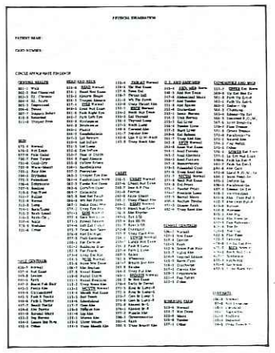
Appropriate phraseology panel layouts are employed for data interpretation consoles reporting a wide variety of interpretative tests such as ECG, Retinal Photo, Dental X-Ray, thermography, radiology, etc.

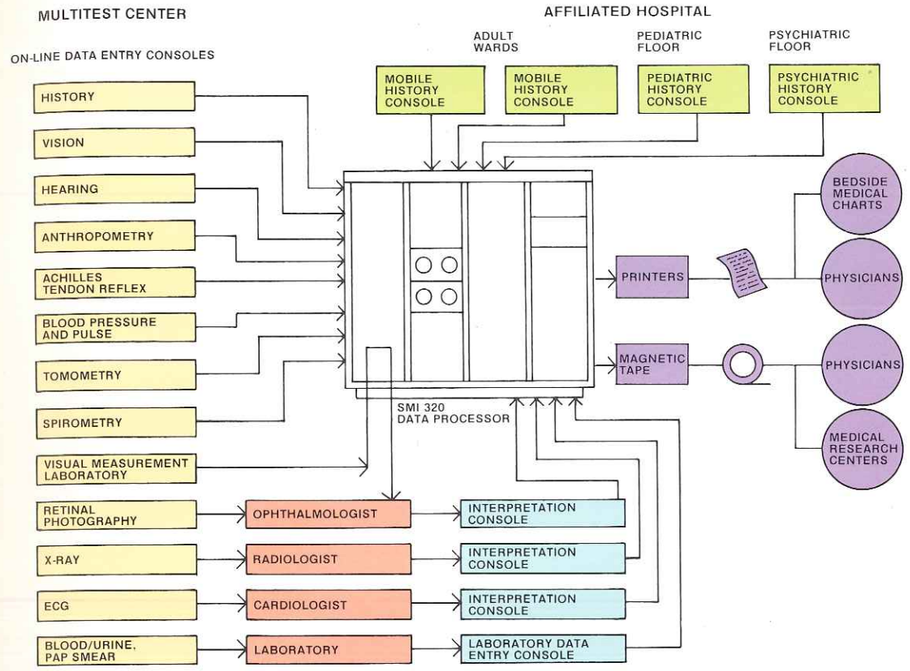
PHYSICAL EXAMINATION DATA

Many AMHT systems, by definition of their application end use (such as new patient clinic work-up, hospital admissions, etc.) will include a physician's physical examination immediately subsequent to the completion of the routine tests and measurements. As an alternative interpretative function of the system, SMI can provide a Physical Examination Interpretation Console which, combined with a coded work sheet, allows the physician to enter as many as eighteen positive findings into the patient's record as a result of his physical examination of the patient. When this option is provided in the system, the resultant printout appears on the patient's record immediately following the medical history profile.

Previous mention was made of entering this type of data as an optional use of the SMI Document Reader. This is more apropos in those instances where the physical examination is done at a later time and/or in a physician's office remote from the AMHT facility. Here again, were a remote MED/STAT satellite testing module available, containing a Carrel Data Entry Console on-line, the identical Physical Examination optional interpretation program as described above, would allow the physician to enter as many as thirteen positive findings into the patient's record. ■

Typical physicians examination coded work sheet





TYPICAL AMHT MEDICAL INFORMATION FLOW IN HOSPITAL ENVIRONMENT

AMHT data management

A number of options are available for the management of patient data within the SMI AMHT system. In addition to the hard copy output of the medical report, a machine-readable DECtape is also made for permanent storage. With the increasing use of computers in medical research, every indication points to the fact that eventually this residual medical data base will be considered among the most valuable outputs of an automated health testing system.

PATIENT RECORD STORAGE AND RETRIEVAL

When a patient is discharged from the screening system, his record is transferred from active status on disk to standby status on DECtape. At least two small magnetic tape transports and controller are standard components of the Model 320 Data Processor. This allows storage capacity for 175 patient records. With the addition (option) of a third tape transport, storage capacity is increased to 350 records. Access to the standby file is through a directory containing patient number and a corresponding DECtape location. A copy of the directory is maintained on disk. Record transferral from active to standby status is triggered by the "Discharge" button of the admission console. A record on a standby file is *automatically* updated when a test value is entered on a Laboratory or Interpretation Data Entry Console. After all test results have been entered, the record is returned to standby status on DECtape where it will remain until processed to the archive file, which is also on DECtape.

The archive file is suitable for producing reports, establishing retrievable medical histories for periodic examinees, providing feedback to screening personnel and for entry into larger data processing systems for information retrieval and analysis.

Periodic off-line updating runs inspect the standby file for completed records and transfer these to the archive file. Optional reports are produced listing patient numbers transferred to the archive file, and patient numbers retained in standby awaiting laboratory and interpretation data for completion. In addition, transfers can be forced or prohibited by option. To facilitate transfer of this data to other computer systems, a program is available to copy an archival file from DECtape to industry-compatible magnetic tape.

ADDITIONAL DATA LINKS

Searle Medidata has now under development and validation a number of new techniques to directly interface additional measuring equipment to the SMI 320 Data Processing system. These will be released as soon as programs are finalized and then validated by the medical community.

An increasing degree of automation is evident in ancillary laboratory systems associated with SMI AMHT centers which require more efficient coupling into the multitest system. Two automated methods currently in use, and discussed on page 43 are Digital Equipment Corporation's Clinical Lab 12 and T&T Technology's SMART. Utilization of either of these two systems provides for considerable saving in operator time and increased accuracy through elimination of manual keying of data. In a large laboratory processing many samples, it is almost a necessity. SMI programs will be developed for other equipment as the requirements become apparent and the equipment becomes available. Other major data processing programs, specifically ECG computer analysis and medical billing service, that help to increase the overall utilization load of the 320 Data Processor are now available from Searle Medidata. These exciting developments are discussed in detail on the following pages.

DATA POOL INFORMATION SYSTEMS

A large body of medical data in computer readable form exists in the archive files of a number of SMI AMHT centers which have been in operation for some time. This information represents a data base which has been previously unobtainable. What use, if any, can be made of it depends upon the nature of the organization operating the multitest system, and its computer capabilities.

An intriguing number of possibilities exist for the use of the patient data in epidemiology, longitudinal studies and delineation of health trends. Medical records, regardless of type, will be made compatible between multitest centers and other institutions through programs which convert and transfer the various data outputs of such centers onto industry-compatible tape for common analysis.

An additional and significant input of AMHT data is evaluation of cost effectiveness and benefits concerning multiphasic screening. Cost effectiveness analyses of AMHT data can establish the value of various tests, differing biomedical instruments and alternative testing procedures in providing a desired result.

AMHT centers that are affiliated with large hospitals can integrate their AMHT system into a master information system through data linkage to the institution's large-scale computer. The SMI 320 Data Processor functions as an input terminal, communicating with the large-scale hospital computer. Multitest information can complete a vital link in a total hospital information system.

SMI provides its users with a program to convert archival data on DECtape to industry-compatible tape for data analyses in large-scale computer systems. We stand ready to consult with Searle Medidata users on utilization of the patient data base collected through their center and other multitest centers throughout the world. ■

4421 QRS .12 , TERMINAL QRS RIGHTWARD AND ANTERIOR — RIGHT BUNDLE BRANCH BLOCK

8321 QRS AXIS RANGE 93 TO 269 — RIGHT AXIS DEVIATION

CONCLUSION: ABNORMAL ECG

Full scale reproduction of portion of ECG short-form record

USPHS Certified ECG Computer Program

Searle Medidata makes available a certified United States Public Health Service ECG Computer Program to its clients. This important program provides the cardiologist with a powerful tool with which to efficiently handle the increasing ECG interpretation load.

Many of the existing USPHS ECG programs employ very large scale multi-purpose computers. The SMI Automated ECG Program utilizes the same SMI 320 Data Processor that is used in SMI's AMHT systems. When the ECG computer analysis program is used on the same 320 Data Processor normally servicing an AMHT system, the complexity and size of the computer programs involved dictate non-simultaneous operation. The SMI ECG analysis program can be loaded quickly (3 minutes), during the off-cycle times when the computer is not being used in the multitest mode. ECG analysis are performed at a rate of 30 seconds maximum/12-lead ECG. The resultant printouts require from 2-8 minutes, depending upon the record format requested. Reloading the 320 Data Processor for AMHT operation is similarly quick, requiring only 3 minutes.

Use of the 320 Data Processor during the time when the center is not processing examinees significantly reduces the cost of the computerized ECG program and makes it economically viable even for smaller centers. It provides a very desirable increased utilization level of the SMI 320 Data Processor.

SMI's ECG Computer Analysis Program, whether it is associated with an AMHT system as an adjunctive interpretation, or as a separate remote medical service to physicians in general, involves three basic phases of operation.

The first phase is simply recording a 12-lead electrocardiogram signal from the patient onto magnetic tape. A variety of well-known ECG machines, including a strip chart recorder plus a built-in tape recorder, are available today. At a scheduled time, the tape containing any number of patient code-identified ECG's is hand carried to the computer.

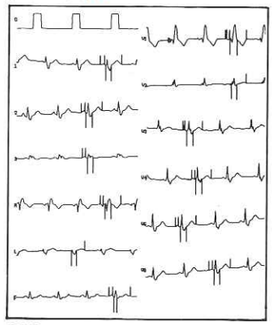
Should the computer be remotely located, the use of these ECG machines along with an acceptable telecommunications interface allows the data to be sent directly to a remote tape unit, usually located at the computer site.

The second phase concerns itself with the actual analysis of the ECG data collected on tape(s) utilizing conventional tape input peripherals to the Model 320 Data Processor.

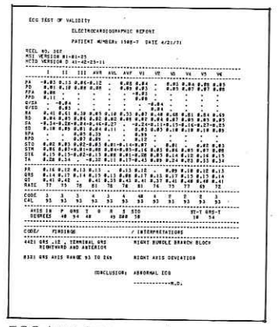
Phase three is the data management of the ECG analysis to produce various record printout formats. Both a short-form and long-form interpretative analysis can be generated on the computer console typewriter as hard copy along with corresponding punched paper tape outputs. These reports can be hand carried, mailed, or sent via conventional teletype lines to any location.

The ECG records are also placed on DECtape and handled in a similar fashion to the multitest archive file program. Not only will this procedure allow listing of records showing patient number and date of analysis tape indexes, DECtape copy onto industry-compatible tape for later generation of data for statistical analysis, but also will permit transfer of the interpretations to the AMHT system's patient records while the multitest system is in operation. The ECG interpretative data can then be included as part of the standard AMHT medical record printout. In all SMI multitest systems, including MED/STAT, printout of the short form version either as part of the multitest record or as a separate hard-copy report can be generated at any print station in the system.

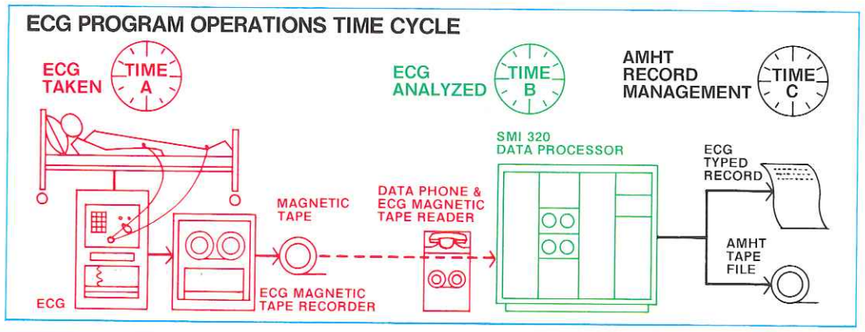
The ECG computer analysis program in itself is viewed as a technical interpretation only, therefore any abnormal report and corresponding ECG wave form is then presented to the cardiologist for his analysis and medical interpretation. The computer generated data includes a table of all the ECG measurements, rates, calculations of the various electrical axes and a suggested interpretative statement. The cardiologist reviews the data, amends the interpretative statement if necessary, and signs the interpretation. ■

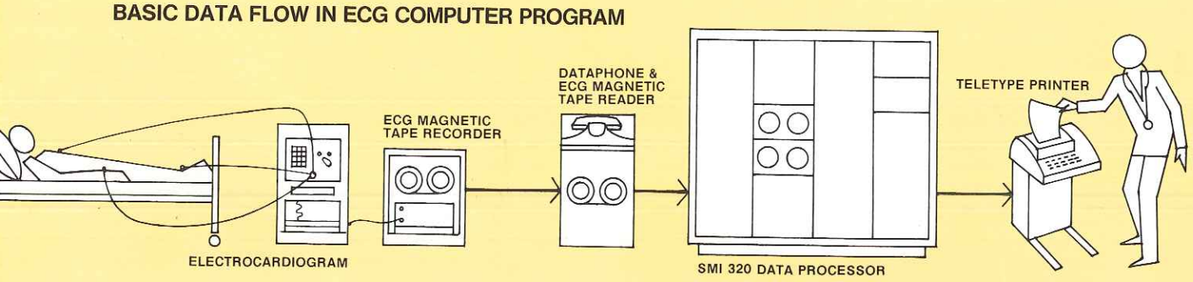


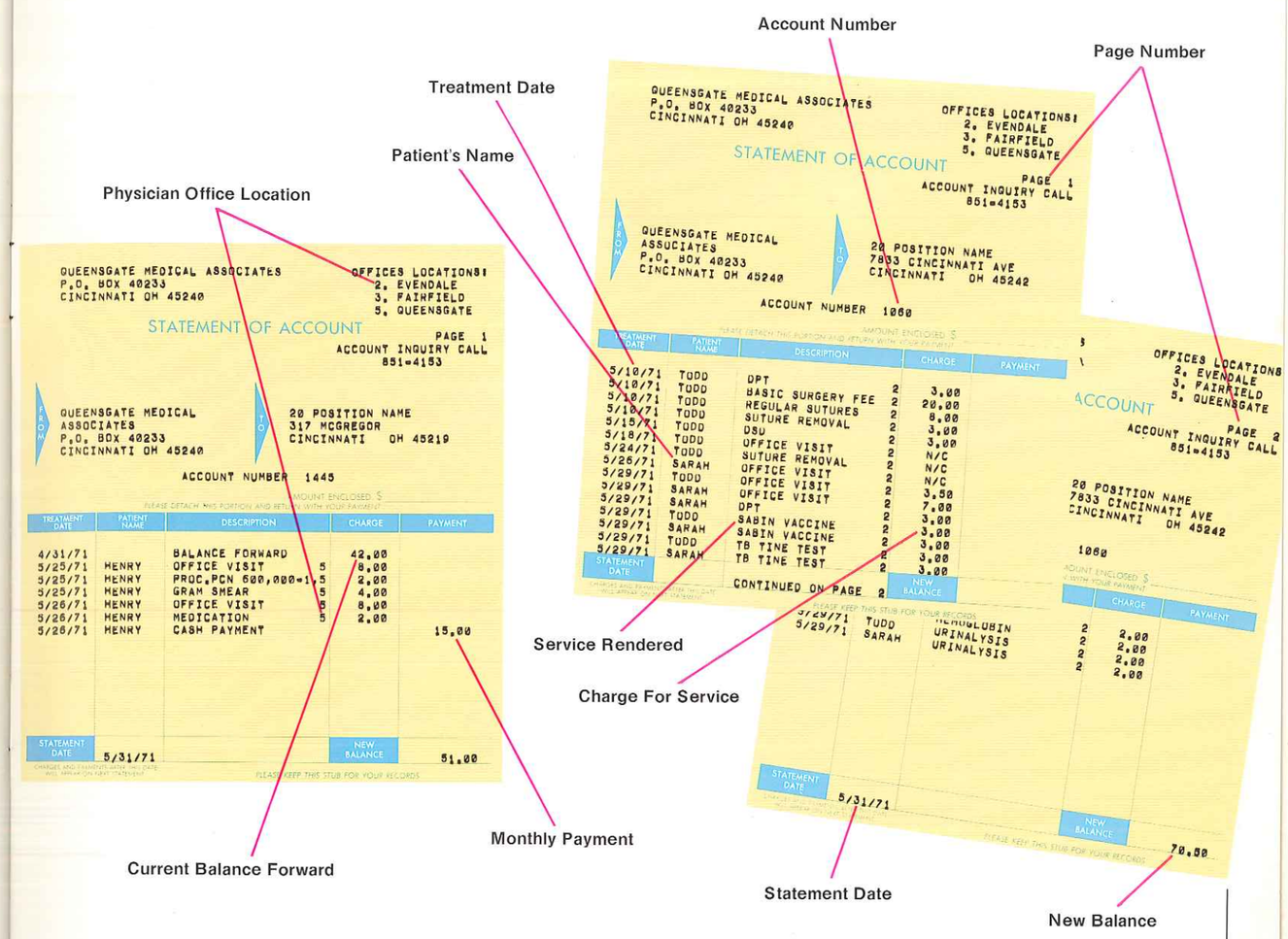
ECG wave-form record



ECG long-form record







SMI Medical Billing Program

Searle Medidata, Inc. in a joint development program with Clinical Computer Corporation, Cincinnati, Ohio, has developed a Medical Billing package that provides additional utilization impact on the overall operational capabilities of the Model 320 Data Processor. This off-line service program, along with minimum additional computer hardware, results in the production of statements, aged accounts receivable, name and address listings, and management reports. The program has the capabilities of functioning in a clinic type environment by keeping track of services provided by doctor or department or a combination of both.

Two master files are maintained. The first is a *name and address file,* while the second is a *description of services master,* which may contain up to 1000 different medical services. The following is a listing of the various reports generated by the system: 1) input listing for balancing purposes, 2) current month's accounts receivable journal with aged balances, 3) summary of services report, 4) statements, 5) report of services by doctor and 6) report of services by location.

The billing system has been designed to take advantage of data processing and electronic computer operation at a reasonable cost. Additional hardware update to the standard SMI Model 320 Data Processor consists of an 80 column line printer (LP-08) and an additional dual magnetic tape unit (TU-56).

The present method for development of the input data combines the use of conventional charge slips in conjunction with the 320 Data Processor's teletypewriter utilizing a conversational technique to guide the operator in entering the correct data. In the near future, SMI will provide the necessary computer programs which will allow for the on-line entry of input data simultaneously with AMHT operations, utilizing the Admissions Data Entry Console and its associated Selectric typewriter. This would allow any SMI AMHT system to be used to enter a medical facility's billing data, new patient accounts, etc. during the day and process all necessary reports on the 320 Data Processor at night on an off-line basis. The two methods can be used interchangeably thus allowing the billing service to be made available to a broad spectrum of medical client subscribers.

In a typical SMI MED/STAT system, any satellite testing module (STM) that utilizes an Admissions Data Entry Console, will be able to enter billing input data to the central remote computer using the same on-line operation techniques. Each satellite user would have his own secured files and the billing cycle cut-off would be dictated by each individual satellite location.

Typical statements are shown above to illustrate the type of reporting information generated by the computer. SMI will make available the necessary programming services for customizing the Medical Billing Program to meet client requirements. ■

SMI client services

The true end product of Searle Medidata is delivery to the physician of an accurate, comprehensive, reliable health-profile record of his patient. To accomplish this, SMI offers an array of services to its clients. The responsibility of Searle Medidata is magnified by both the complexity of the system itself, and the AMHT concept in general. SMI is an active and concerned resource for each of its clients in the successful operation of their AMHT system and its ensuing interaction with the involved health care delivery system and/or application.

MARKETING SPECIALIST

SMI marketing specialists are located throughout the United States and the world. You will find them extremely knowledgeable and helpful. They are prepared to discuss your requirements in terms of physical plant, medical system, community needs and financial restrictions. They will prepare a detailed proposal for a system within the parameters you define. They are always available as an informative general AMHT resource person to the medical community at large.

CONTRACT NEGOTIATIONS

SMI systems may be purchased outright, or leased under a wide variety of plans. Your SMI marketing specialist will be happy to discuss your financial requirements and propose several alternative methods for acquisition of the system you require within the financial resources you have available.

PROGRAM MANAGER

Once a sale or lease contract is signed, a host of SMI services are available to the client. A program manager and his staff is assigned to deal with all the details of your multitest center installation. Your program manager will make on-site visits, learn the wishes of your medical staff, in terms of customizing computer programs, and explain any facet of your AMHT project with other allied medical professionals and specialists that may be involved. He will work with your administrative personnel to ascertain your operational needs. He will aid your people in establishing methods, test normals and operational routines. He is available to cooperate with your architect in planning renovation of an existing facility, or the design and construction of an entirely new facility to house your AMHT system. He has available to him all the technical personnel of the Searle Medidata organization and can call upon any of the resources of the company which he requires to solve any problems. He will be present when the system is delivered and installed . . . stay with your system on location after installation as long as his services are required . . . arrange training sessions for your service and medical personnel. He will be your primary Searle Medidata liaison during the initial period of planning, system installation and start-up.

SMI representatives are always available for training and other assistance

PERSONNEL TRAINING

SMI has a comprehensive, formal training program for your medical personnel and allied technicians. Training your personnel to efficiently operate your SMI AMHT center is an integral and very important part of your sales contract. Initially, your people will receive intensive training in the multitest demonstration center located at our Waltham, Massachusetts headquarters. This training is carried out by staff members of our Medical Sciences Division under the direction of our Medical Director. After your SMI system has been installed, the same group who trained your people in Waltham will conduct additional on-site training of your personnel using the equipment installed in your location under your conditions.

MEDICAL COMMUNICATIONS SERVICES

SMI maintains a continuing research and development program aimed at assisting each client to interact fruitfully with patients, physicians, medical societies, industries and political bodies. This involves first the development of movies, slide shows, brochures, physician's handbooks, report jackets and other aids. A quantity of each are furnished at no charge to our clients at the time of system installation, and arrangements are made to furnish additional quantities at cost. In addition, an SMI Medical Communications Representative is available to orient and train those client personnel who will participate in medical and community relations activities. The Medical Communications Representative will continue to work with the client throughout the life of the lease to assist in the development and planning of medical and public relations activities such as: medical symposia, news conferences, press releases, political action programs, and liaison with professional societies such as the recently formed International Health Evaluation Association.

Typical literature produced for use by various clients and a report jacket for housing and transmitting AMHT data to physicians

MEDICAL AUDIT

A periodic medical audit is conducted by Searle Medidata at every SMI installation. The SMI audit staff checks the procedures used by your technologists in operating the data processor, medical instrumentation and the other system components. They will survey the administrative methods and confer with your medical staff to solve any medically-oriented problems that may arise. They are always pleased to discuss new ideas, new procedures, new tests, and to accommodate your medical staff in making the output of the SMI AMHT center more valuable as a viable medical tool for the delivery of superior health care to your community.

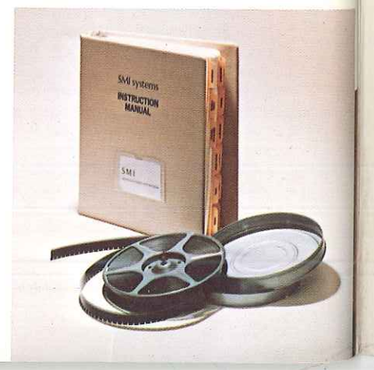
EQUIPMENT MAINTENANCE

A uniquely trained staff of electronic and instrument service people are maintained by our SMI Product Support Group throughout the United States, and by our affiliates in key countries of the world. They have been specifically trained in the maintenance of medical instrumentation, data processing units, and all the interface equipment employed in the Searle Medidata AMHT system. Continuous and efficient operation of your AMHT facility is an ongoing responsibility of Searle Medidata. We have taken the required steps to insure that adequate preventive maintenance and emergency service for a system as complicated as automated multiphasic health testing is available whenever and wherever you require it. Details of maintenance service are routinely covered in your sales/lease contract. Special arrangements can be made for providing a full-time on-site SMI service engineer if you wish. We will train your own service engineer at our Waltham headquarters, if that is your desire.

INTERNATIONAL REPRESENTATIVES

International operations of Searle Medidata are conducted throughout the world by Searle affiliates and other authorized representatives. They maintain the same high caliber of overall service that is available to our clients in the United States. They will be happy to discuss the SMI AMHT system, your particular health care delivery requirements, help you with planning, make a proposal that will meet your operational and financial needs, and deliver on-site technical support for the complete operation of your system. Their understanding of the national medical practices and health care requirements of your country, coupled with their high degree of knowledge about the Searle Medidata AMHT systems enable them to design a system configuration that is precisely suited to your individual needs and those of each medical community throughout the world. ■

SMI provides operating manuals and makes other aids available including three motion picture films each of which is available in three versions, and a number of training programs for audio-visual teaching systems



IDENTIFICATION OF CLIENTS ON THIS COVER

MEDUC, G.m.B.H.
Bruchtorwall 8
33 Braunschweig, West Germany

Automated Services, Inc.
30500 Van Dyke St.
Warren, Mich. 48093

Medical Innovations Corporation
5514 South Western Ave.
Oklahoma City, Okla. 73109

Health Testing Services
6800 France Ave.
Minneapolis, Minn. 55435

Data Medica, S. A.
Paseo de Las Palmas 745
Mexico City, D.F. Mex.

Shepherd Foundation
67 Lynch Crescent
Brighton, Victoria 3186
Australia

Medical Data Acquisition Corp.
3445 Peachtree Rd., N. E.
Atlanta, Ga. 30326

IDENTIFICATION OF CLIENTS ON BACK COVER

BUPA Medical Centre, Ltd.
210 Pentonville Rd.
King's Cross
London N1, England

Clinical Computer Corporation
680 Northland Rd.
Cincinnati, Ohio 45240

Medifacts, Inc.
250 East Liberty St.
Louisville, Ky. 40202

Straub Medical Research Institute
888 South King St.
Honolulu, Hawaii 96813

McHenry Medical Group
330 Terra Cotta Ave.
Crystal Lake, Ill. 60014

Medical Computer Services Association
1116 Summit
Seattle, Wash. 98101

AMHT Systems
MED/STAT — Remote history systems

MEDUC

EARLY DETECTION CENTER
COMPUTA-DIAGNOSIS

data
médica

Medical Innovations Corporation

SHEPHERD FOUNDATION
MULTIPHASIC HEALTH TESTING SYSTEM

HTS
HEALTH TESTING SERVICES LTD.
SOUTHDALE

medaco

SEARLE **Medidata, Inc.**

a Subsidiary of G. D. Searle & Co.

140 Fourth Avenue,
Waltham, Massachusetts 02154
Telephone: 617 890-6940

BUPA Medical Centre

WEBB HOUSE 210, PENTONVILLE ROAD, N. 1.

HAWAII HEALTH APPRAISAL CENTER

C-III
Clinical Computer Corporation
EVENDALE FAMILY HEALTH CENTER

McHENRY MEDICAL GROUP

medifacts

MCS ASSOCIATION

MED-1-411/ PRINTED IN U.S.A.