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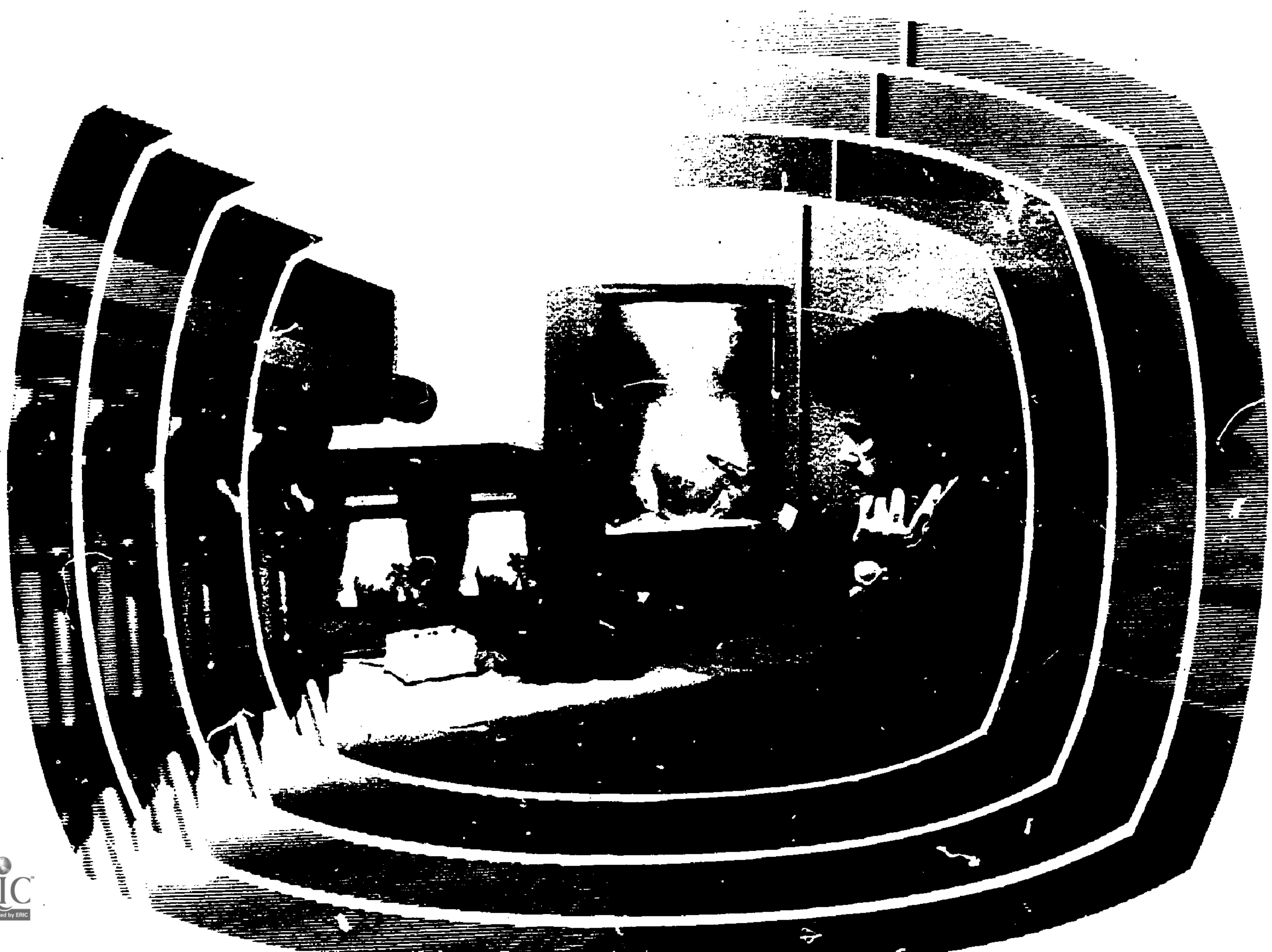
ABSTRACT

Emphasizing primary care, this handbook focuses on the application of specific types of telecommunications technology to the process of information exchange within a rural health care system. Its purpose is to provide guidance to health care planners who want to consider the potential of telecommunications technology for improving quality, accessibility, and efficiency of care. Taking a functional, applications-oriented approach, it integrates the issues and recommends a decision-making process. The range of technologies discussed includes not only the expensive and exotic but also the rather inexpensive, everyday technologies that should be available in many parts of the country. Content includes background material on health care and information exchange; the concept of a network and the distinction between telecommunications links and end-instruments; functional applications of telehealth systems (patient care management, administration, education): technical components of telehealth--transmission (narrowband, telephone, radio, broadband, networks), end-instruments (audio, telemetry, data/record, video, slow-scan television, patient-viewing video devices); process for assessing feasibility of telehealth in a specific setting; paying for telehealth. More than 50 current and planned telehealth projects and references for additional information are briefly described. (RS)

TELEHEALTH HANDBOOK

a guide to telecommunications technology for rural health care

US DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE • Public Health Service • National Center for Health Services Research



ABSTRACT

Telehealth is a term applied to the use of telecommunications technology to facilitate the delivery of health care and services among remotely located, geographically dispersed, or physically confined persons. A telehealth system appears to be a potentially valuable resource for improving access to quality health care in rural areas. Telehealth systems can enhance the information exchange that is vital to providing quality health care and help reduce the professional isolation of rural providers. With an emphasis on primary care, this Handbook focuses on the role of telecommunications technology in the exchange of patient, educational, and administrative information within a dispersed health care system. Although the emphasis is on planning for rural communities, where there is a severe shortage of health services, the resources, concepts, and issues are applicable to urban areas also. The intent is to provide preliminary guidance to health care planners who are considering telehealth among the many alternatives available for improving the quality, accessibility, and efficiency of care.

TELEHEALTH HANDBOOK

a guide to telecommunications technology for rural health care

prepared for the
National Center
for Health Services Research
by the METREK Division
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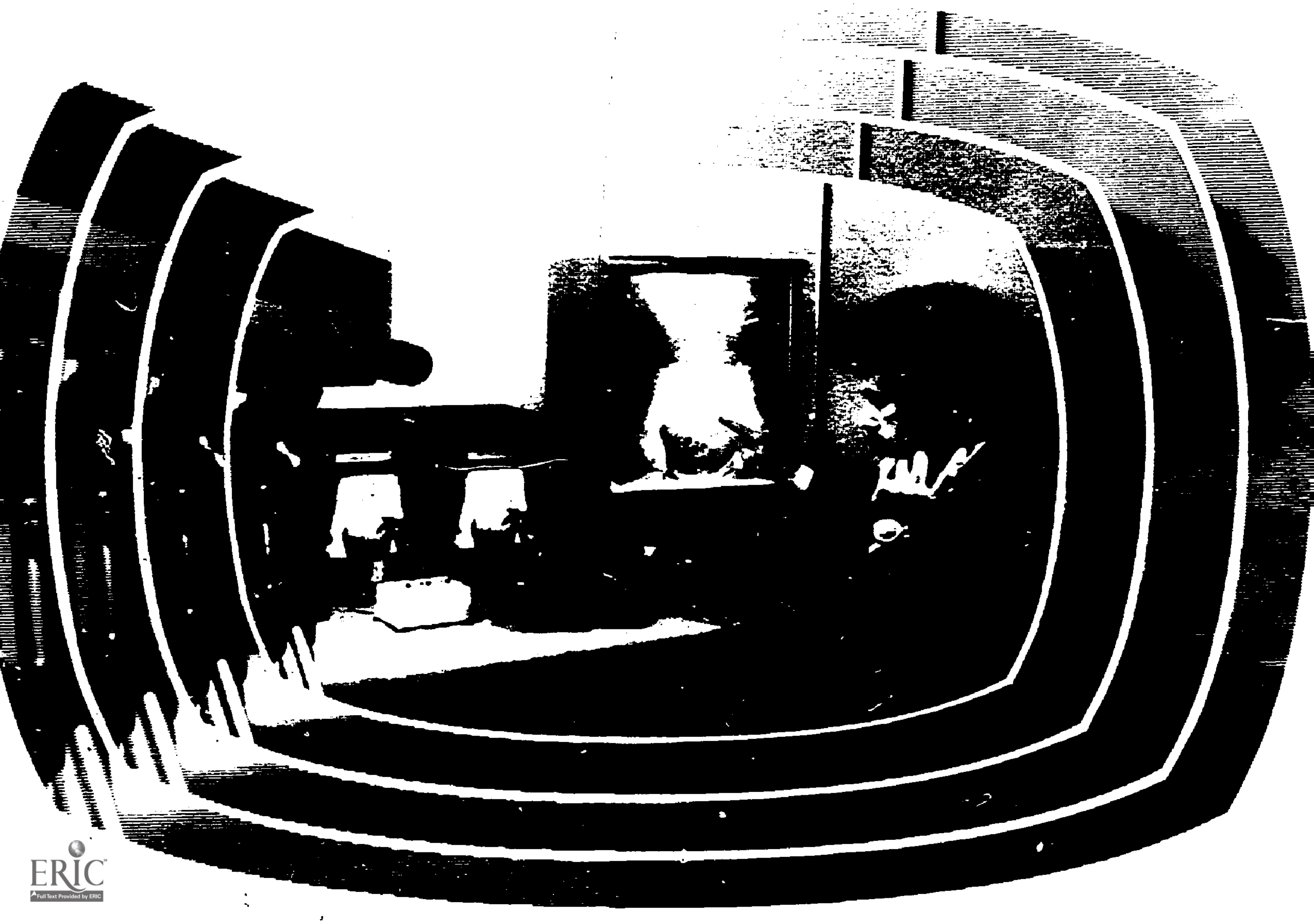

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Dr. Maxine Rockoff, of the National Center for Health Services Research, guided the development of the Handbook from a concept to completion.

Additional copies of NCHSR publications are available on request from the NCHSR Publications and Information Branch, 3700 East-West Highway, room 7-44, Hyattsville, MD 20782 (tel.: 301/436-8970).

FOREWORD

This Handbook for potential users of telecommunications technology in health services delivery is a marked departure from traditional National Center for Health Services Research publications. The Handbook is not a summary of research results in the usual sense, but rather a gathering of the collective know-how of those who have been experimenting with and thinking about health care applications of this technology.

NCHSR began a vigorous telehealth research program in 1971 with seven exploratory two-way visual telecommunications projects. These were intended[3] to: (1) gain "clinical impressions" of the utility of this technology in a wide variety of health care settings and applications; (2) develop methods for assessing the utility of the technology; and (3) develop a framework for further research on the logistics of health care delivery.

Major analytical difficulties are inherent in telehealth research because the technology may significantly alter the organizational structure of the health care system in which it is placed. Moreover, there are many variations in the kinds of technology available and in the functional applications to which these technologies may be addressed. These difficulties surfaced in NCHSR's exploratory projects and we decided to focus additional research on overcoming them.

The kinds of questions we tried to answer included: Could one develop analytical tools that would help narrow the range of research and demonstration projects and field trials that should be funded? Could one predict, prospectively, what the impact of technology would be? Could one use such predictions both to select promising candidate technology/site combinations for demonstration and to evaluate the demonstrations?

This Handbook is part of our progress in developing "yes" answers to these questions. The Mitre Corporation has been under contract to NCHSR since 1972, studying the telecommunications technology that would be appropriate to support the delivery of health care services in rural areas. A series of reports resulted[4,8,10,26,30,31,32,33,34,35,36] on both the analytical work and on the prospective assessment of various manpower/technology combinations that would be likely to have favorable benefit-to-cost ratios. The next logical step would be to initiate projects that appear favorable, prospectively, based on analysis of site-specific needs and technology options available. This Handbook has been developed to provide initial information and guidance to potential users of telecommunications technology who might be interested in undertaking a telehealth project.

One of the most important conclusions of the Mitre research was that telephone-based technologies should be exploited much more vigorously than had been the case in past government-funded research. Hence, this Handbook discusses a range of technologies including not only expensive, exotic, technologies but also rather inexpensive, everyday, technologies that should be readily available in many parts of the country.

Our purpose is well served if this Handbook alerts the health community to the exciting possibilities that telehealth offers to increase access to affordable, high quality health care services, at the same time encouraging the adoption of only those technological approaches that are appropriate and sound.

Gerald Rosenthal, Ph.D.
Director
National Center for Health Services Research

May 1978

PREFACE

With an emphasis on primary care, this Handbook focuses on the application of specific types of telecommunications technology to the process of information exchange within a rural health care system. Although rural communities provide the basis for discussion, the resources, concepts, and issues are generally applicable to urban areas as well. The intent of the Handbook is to provide guidance to health care planners who want to consider the potential of telecommunications technology for improving the quality, accessibility, and efficiency of care. A functional, applications-oriented approach has been taken and an attempt has been made to integrate the issues and recommend a decision making process to those who are investigating telehealth's feasibility.

The authors have not attempted to provide an exhaustive technical coverage of telecommunications or an encyclopedic treatment of telehealth. This publication should be used as a practical guide to aid the reader in deciding *whether* to implement some form of telecommunications to support patient care, educational, or administrative activities and *how to approach* the design process. It provides information to assist the reader in answering questions such as:

- Would a telehealth system improve the delivery of health services in my community?
- Is it economically, socially, and politically feasible to establish such a system in my community?
- How does one begin to design such a system? What are the design alternatives and tradeoffs, and what equipment should be considered?

Section 2 of the Handbook introduces some ideas that are basic to telehealth--the concept of a network and the distinction between telecommunications links and end-instruments. Section 3 focuses on the functional applications of telehealth systems--patient care management, education, and administration. Sections 4 and 5 describe the technical components of telehealth, and section 6 discusses a process for assessing the feasibility of telehealth in a specific setting.

If one has had experience with telehealth systems, the Handbook may be used to explore particular issues. If telehealth is new to the reader, he may wish to skip some of the detailed technical material in sections 4 and 5. The Handbook should be regarded as a source of information and a guide to the consideration of telehealth for specific purposes, rather than as a "cookbook" which dictates explicit solutions. The application of telehealth systems is an expanding field; the Handbook is aimed at facilitating its appropriate and effective expansion.

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1 INTRODUCTION

The problems associated with providing adequate health care in rural areas include a shortage of providers, sparsely distributed populations that frequently are poorer and older than in non-rural areas, geographic barriers, poor roads, climatic extremes, sub-standard housing, and poor nutrition. During the past decade, many approaches have been implemented to ease the problems of medically underserved areas. New educational programs have been designed to increase the number of primary care physicians in rural areas; organizational innovations have been encouraged that emphasize the regionalization and coordination of services and facilities; and, increased reliance on satellite health clinics and non-physician providers has been advocated.

In conjunction with these innovative programmatic and organizational approaches is a growing interest in the use of telecommunications technology to support health care. Improved communication systems can enhance the effectiveness of both existing and new health care delivery approaches and extend the accessibility of health care services to rural populations. These capabilities have resulted in the emergence of "telehealth"* - the application of telecommunications-based technology in the delivery of health care and related services. Telehealth systems show considerable promise for enhancing linkages among elements of a health care system by making remote services available locally and improving the flow of educational and administrative information. These linkages, in turn, should:

*The term "telehealth", rather than "telemedicine", is used in this Handbook because it implies a broader range of health-related activities, including patient and provider education and administration, as well as patient care.

- reduce patient travel and inconvenience,
- improve the continuity of care,
- enhance the quality and timeliness of care,
- improve the financial status of rural health systems, and
- reduce providers' feelings of isolation.

Background

Telehealth began in the mid 1960's with systems using off-the-shelf electronic equipment to facilitate physician-to-physician consultation, emergency medical services, and administrative activities. Concurrently, the National Aeronautic and Space Administration's medical telemetry work in the manned spaceflight program led to the development and application of new technologies to health care delivery problems.

An increasing number and variety of telehealth projects representing a broad range of technologies are being applied in rural, urban, and academic settings. The historical development of telehealth, as well as discussion of alternative applications, implementation and evaluation issues can be found in Park's An Introduction To Telemedicine,[1] and Bashsur, Telemedicine: Explorations in the Use of Telecommunications in Health Care.[2] Technical implications and considerations are discussed in an IEEE Transactions on Communications article by Dr. Maxine L. Rockoff of the National Center for Health Services Research, "An Overview of Some Technological Health Care System Implications of Seven Exploratory Broadband Communication Experiments."[3]

Since the inception of telehealth, experience has shown that it *is* technically feasible to provide remote communications support to rural health professionals. Telephone communication augmented by instrumentation will permit the encoding and decoding of clinical, administrative, and educational information in a variety of forms, as successfully demonstrated in a number of programs.[2] Telephone technology, as opposed to the considerably more expensive and complex alternative of television transmission, is currently the most cost-effective form of telehealth. However, many operational questions and untried alternatives remain to be explored. These alternatives concern the utilization of various levels of technology by different types of providers, cost and revenue implications of different telehealth approaches, training requirements for acquiring skill in the use of telehealth equipment, and the range of services that can be effectively augmented through the use of telecommunications.

Health Care and Information Exchange

Health care is a communications-intensive process. Information is constantly being exchanged among providers and between patients and providers relative to problem diagnoses and treatment plans. Administrative activities depend heavily on the exchange of information in a rapid, efficient manner and education is inherently an information exchange process, whether it be patient- or provider-oriented.

A telehealth system does not create new or more precise information. Rather, it provides the capability to exchange information more efficiently and more broadly to improve decision-making and the delivery of health services.

Telehealth systems have been used to facilitate clinical activities by the transmission of heart and breathing sounds, patient images, bacteria and tissue slides, x-rays, and electrocardiograms. Computerized patient records have been implemented in several telehealth systems* and a few comprehensive health information systems are being developed. Elaborate educational networks based on telecommunications technology have been established to facilitate continuing medical education on a regional basis.

The role of telehealth is simply illustrated in Figure 1 in the context of the hierarchical organization that defines most health care systems. Typically, a telehealth system links multiple levels of health care. For example, a secondary care facility may be connected by means of a communication link to one or more physician-staffed primary care sites and to other hospitals; primary care clinics, in turn can be linked to satellite primary care sites staffed by non-physician providers. Telecommunications linkages between these sites can be used to provide consultation, education, and other support services to patients and providers.

*See Appendix. This Appendix contains brief descriptions of more than 50 current and planned telehealth projects as well as contact persons for most projects and references that may be consulted for additional information.

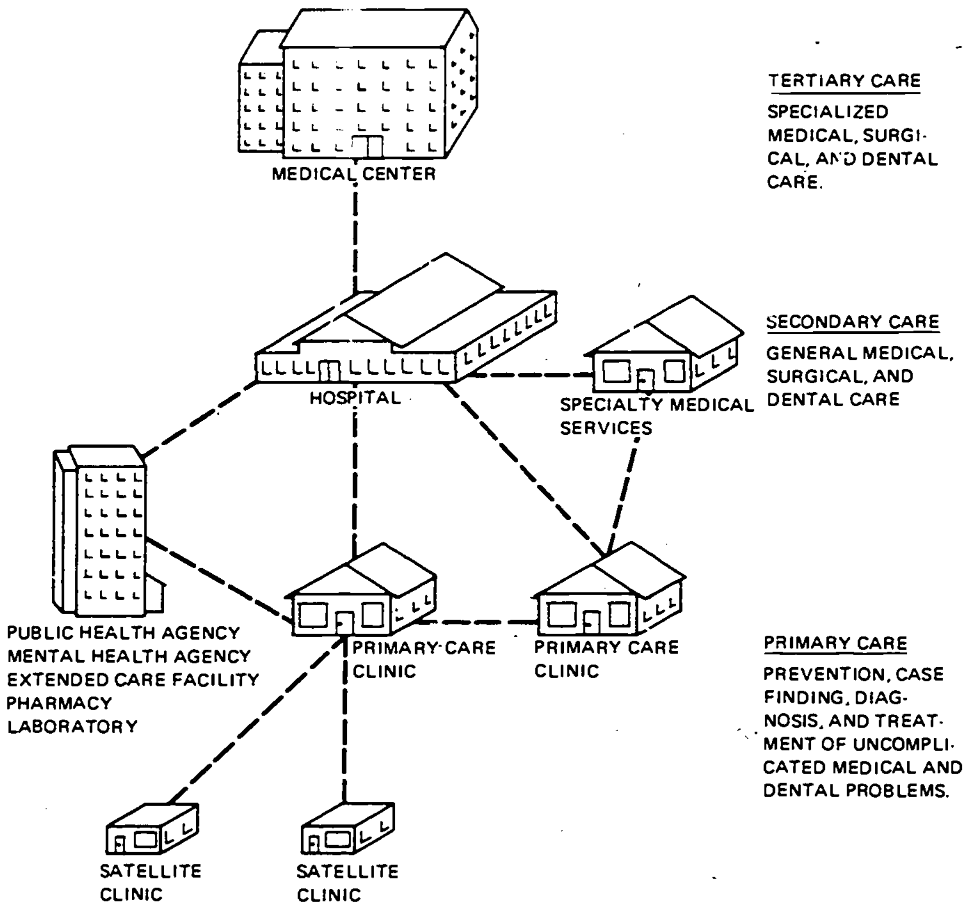

Figure 1
A Hierarchical Model of a Health Care System

2 THE TELEHEALTH SYSTEM CONCEPT

Telehealth systems involve the use of telecommunications-based technology to facilitate the delivery of health care and other related services among geographically dispersed persons. This section identifies and describes the components that could be used to develop a telehealth system. Familiarity with these components, capabilities, and specific characteristics is the first step in considering whether a telehealth approach is appropriate for a particular health care delivery situation.

However, descriptions of telehealth system components would be relatively meaningless without some consideration of the health care functions supported by these components. Therefore, in the next few sections both the nature and capabilities of system components and their potential functional roles in a telehealth system are discussed.

<u>Defining the Telehealth System</u>

A telehealth system is essentially a support system. "Telehealth" refers to a telecommunication-based system that supports those functions which have long been established as part of the process of providing health care services. The nature of the support provided is simple in concept, but vital to the health care process. *Telehealth systems support the health care process by providing the means for more effective and more efficient information exchange.* Therefore, one can consider any collection of health care locations that exchange information as a telehealth system. As such, informal telehealth systems are extremely common in many present methods of health care delivery. For example, informal telephone consultations occur frequently between physicians. Administrative details related to arranging medical conference agenda, patient bills or records, and inventory matters often are handled through telephone conversations. Surgical operations are shown on closed circuit television systems for medical education.

Telehealth System Structure

Figure 2 presents a telehealth system as a network with various locations represented by nodes (points) connected by links (lines). This network of points and lines is the most general form in which the structure of any telehealth system can be represented. It identifies the participants (locations) and, through the lines connecting them (links), indicates which participants are engaged in information exchange. From this network point of view, the simplest form of a telehealth system consists of only two points interconnected by a line, i.e., two locations exchanging information over some form of telecommunications linkage.

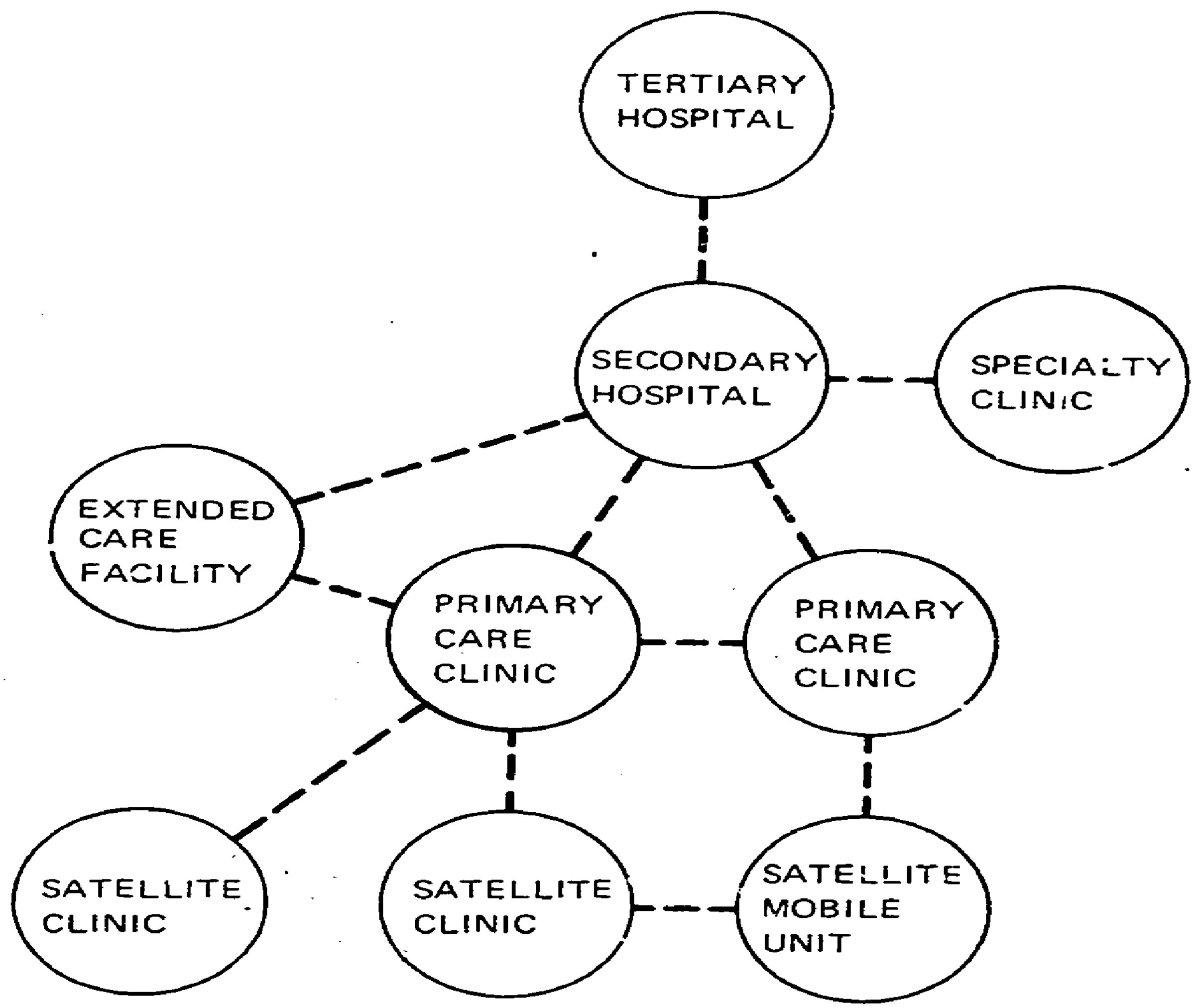

Figure 2
A Network Representation of the Telehealth System

Typical end-instruments include telephone instruments that convert speech into electrical signals and reconvert these electrical signals into sound waves at the receiving end, electronic stethoscopes that convert heart sounds into electrical signals for transmission purposes, and television cameras that convert visual information into electrical signals.

Telecommunication Links. The second basic component in a telehealth system is the telecommunications link. Telecommunications links belong to one of two classes--narrowband or broadband. Narrowband systems are typically represented by a telephone line. They are suitable for relatively slow rates of information transfer, including audio (speech) communications, low-speed data communications (teletype-like), facsimile* reproduction, and telemetry (physiological information translated to electrical signals).

Broadband systems are those that can transmit information at a relatively high rate, e.g., closed circuit or commercial television systems that transmit a continuous picture, including the necessary accompanying audio material. Broadcast television, cable television systems, some microwave radio systems, and some satellite communications systems are examples of broadband transmission systems.

Communication link capabilities, therefore, range from those that can carry only speech information to those that can carry video information.

Basic Telehealth System. The simplest telehealth system consists of (1) an end-instrument that translates physical phenomena into electrical signals which then are transmitted over (2) a narrowband or broadband communication link and (3) an end-instrument at the receiving point that converts the received electrical signal into a form suitable for the particular health care function being performed.

The nature of the end-instruments is related to the specific health care function being performed. For example, different types of end-instruments would probably be required for medical diagnosis and administrative coordination. The nature of the telecommunications link, however, is not

*Facsimile is the transmission of printed or visual material from a hard-copy (paper) input to a hard-copy output at the other end of the communication link.

Within this simple configuration, end-instruments and a communications link form the two basic technical components, or system elements, within a telehealth system. Figure 3 illustrates these two basic elements.

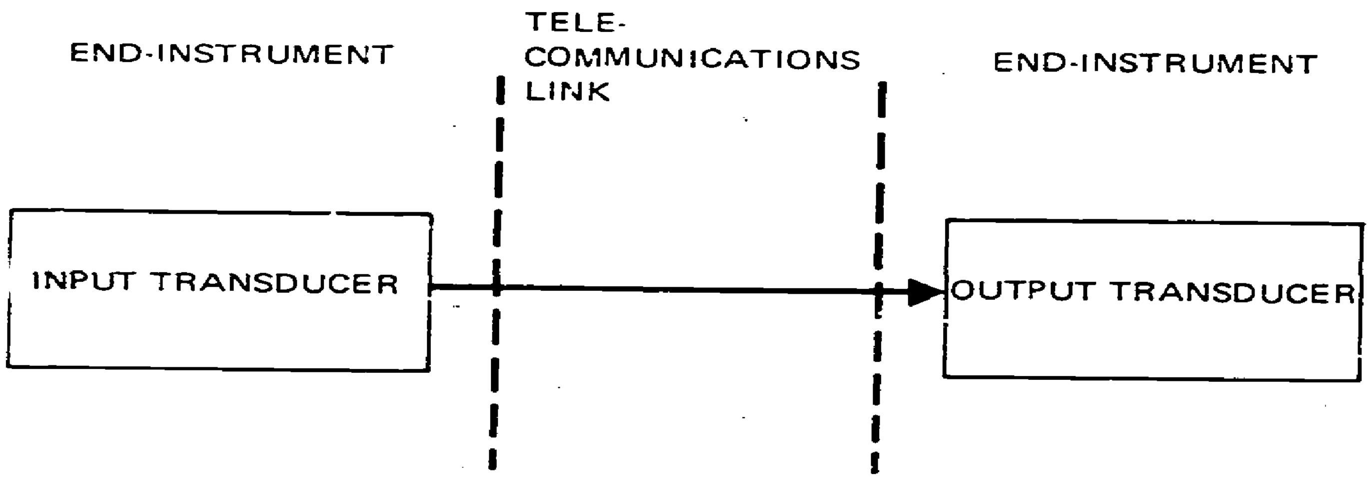

Figure 3
Basic Telehealth System Elements

<u>End-Instruments</u>. End-instruments are the transducers that interface between human participants and the link of the communication system. The input transducer converts a physical phenomenon, such as speech, into an electrical signal; the telecommunications link transmits the signal some distance; and the output transducer converts the received electrical signal into a representation of the input phenomenon.

specifically related to the function being performed. Rather, the telecommunications link must be suitable to the type of electrical signal which is generated by the end-instrument and which must be transmitted over the telecommunications line. In that sense, the telecommunications link is "transparent" to the type of information being sent. However, there are significant cost differences between narrowb- d and broadband telecommunications links and these may cc rain the type of link that can be used. The end-inst should be selected to do the most effective job withi straints.

3 FUNCTIONAL APPLICATIONS OF TELEHEALTH SYSTEMS

A telehealth system is specifically aimed at facilitating timely information exchanges among patients and professionals, especially where the users are separated by great distances. These exchanges of information have been categorized into three functional applications of telehealth systems:

- Patient care/management
- Administration
- Education

Patient Care/Management Applications

Patient care/management covers the broad scope of information exchanges related to the care of individual patients. Although the scope of these information exchanges may vary over the entire range of patient-related services, three types of information exchanges characterize patient care activity in a telehealth system. These are designated as (1) diagnosis, (2) consultation, and (3) instruction.

Diagnostic Information Exchanges. Diagnostic exchanges are those in which information flows mainly from the patient level to the provider level. Diagnostic exchanges may involve the transmission of patient history information, vital signs, test results, telemetry, or visual images of the patient. The important factor in this type of exchange is the orientation of the telehealth system to provide maximum information flow from the location of the patient to the location of the consulting provider. This type of flow is generally referred to as "upline", since it is typically associated with information flowing from primary or secondary care levels to higher care levels.

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Consultative Information Exchanges. In contrast to diagnostic information exchanges, consultative exchanges are more interactive in nature. They can be characterized as information exchanges in which significant amounts of information may be flowing both from the patient location to the consultant and in the reverse direction. Consultative exchanges may involve discussion of patient-related data, development of treatment plans, and similar types of cooperative activities in which information flow in one direction is likely to elicit information flow in the return direction. Note that the kind of information that flows in one direction may be quite different from that in the opposite direction. For example, patient test data flowing upline may result in verbal questions or possible interpretations flowing downline. Telehealth consultation support may also flow "at the same level". For example, hospital-to-hospital exchanges may occur when the consulting specialist is located in a hospital.

Instructional Information Exchanges. Instructional information exchanges represent information flows that are heavily oriented in the downline direction. An example is the passing of "instructions" from the consulting provider to the patient location. These may be instructions to a patient on the management of his problem, technical instructions to a non-physician provider or emergency medical technician on particular therapeutic actions to be taken, or even the transmission of prescription orders. Instructional information may involve speech, data, and visual communication.

The potential benefits accruing from the use of telehealth in patient care management derive primarily from the isolation of rural health delivery systems. Rural health care needs often go unmet because of the lack of local health care resources and the severe cost and time penalties associated with travel to sources of health care. In rural situations where no physicians are available, telehealth may provide faster resolution of difficult rural health problems by permitting local non-physician providers to resolve these cases without referring the patient to a distant source of expertise. For example, in an analytic study of non-physician staffed primary care clinics, MITRE found that the local capability to provide care may be extended significantly by use of telehealth technology.[4] Based on data from nearly 300,000 Navajo Indian encounters in 1974, application of the full range of telehealth technology, including the telephone, could have reduced referral-rates by approximately 50 percent.

In addition, for rural emergencies, telehealth systems may permit more rapid and authoritative determination of appropriate stabilization activities and the need for patient transfer.

In rural situations where physicians are available, the need for specialist consultation is still significant. Telehealth systems can not only assist in the subjective reduction of professional isolation, but can also provide consultation by specialists for the remote physician primary care provider. Such consultative services help to improve the continuity of care available to rural patients and serve to expand the available range of information and experience.

In some cases, telehealth systems may provide the only practical way for a patient to receive needed specialty care. Some rural patients may be unable or unwilling to make the necessary trips to obtain face-to-face specialist assistance. The extent of the hardship involved in physical referral in rural areas is often not recognized. For example, in the northeastern area of Kentucky's Appalachian Demonstration Region, half of the residents do not have automobiles or telephones.[5] The problems of specialty referrals and even of return visits to the local clinic are evident under such conditions. Thus, a primary care physician may particularly appreciate having the capability to offer a specialist's input for the care of a patient who is not able to travel for referral and may not return for a follow-up visit.

Major benefits of telehealth systems as related to patient care are of two types. The first is aimed at bringing greater expertise to bear on patient problems. This has direct impact on the quality of care that can be provided as well as on the accessibility of that care to rural patients.

The second benefit is to help reduce professional isolation--improving the skills of rural providers by linking them with other providers at all levels and making rural providers part of a larger health care system.

Administrative Applications

Potential applications of telehealth systems to administrative rural health care activities span a very wide range. These activities include generation and updating of patient records and bills, maintaining inventory and supply records, exchanging information with third party insurers, recording laboratory test results, and scheduling patient appointments. These examples largely involve the generation, transmission, recording, and processing of data.

Other types of administrative applications involve interpersonal communications, including communications among health care system providers, administrative personnel, and health care auxiliaries. They may involve such topics as scheduling, vacations, new practice policies, forms development, and personnel problems.

Telehealth systems can be particularly effective in both the data and the interpersonal forms of administrative applications. In those applications related to data, particularly where computer systems may be involved, telecommunications already are established as a valuable and effective tool. The key to successful rural application of these well-established techniques is to design economical and efficient telecommunication and computer systems tailored to small practices and rural hospitals.

Administrative applications involving interpersonal communications are normally conducted using the telephone. In rural situations such applications frequently are more complicated and costly because of significant distances and the consequent need for long distance telephone calls.

In addition to purely voice communications, visual communications can play an effective part in such administrative activities. A body of research[6] exists which indicates the benefits of visual communication in certain types of interpersonal information exchange. One telehealth project claims that two-way television capability between rural satellite clinics and their main group practice has greatly enhanced a sense of "practice coherence". This has been attained through numerous and regular video teleconferences involving the staff at each of the clinics for the resolution of a wide range of administrative and medical problems.

Educational Applications

Educational applications of telehealth can be classified conveniently into those that are provider-oriented, directed toward physicians and non-physicians, and those that are patient-oriented.

Physician Education. Typical physician education applications include the remote attendance of physicians at various types of medical lectures or conference presentations, remote participation in grand rounds, and a variety of continuing medical education courses.

Remote attendance situations can be accomplished by means of television or radio broadcasts, either live or taped.

These represent the "one-to-many" type of educational transmissions where the information flow is generally downline. An example of this type of activity is the scheduled lecture and discussion programs held over the Ohio Valley Medical Microwave Network.[1] Lectures on scheduled topics of interest to local physicians are held at designated locations and the lecture material is broadcast to dispersed locations by television. Questions and comments are transmitted to the lecturers by telephone.

Continuing medical education is a generic term which can include lectures, classroom interaction, or computer-based instruction. The most obvious telehealth application is that of computer-based or computer-assisted instruction. A significant number of courses in health sciences, diagnosis, and treatment have been developed for computer delivery. In a typical course, the computer asks the student questions based on computer-presented or text-developed materials. The student replies, and answers are checked by the computer. In other courses computers are used to simulate a patient's condition or a laboratory finding which varies with time. The student may be asked to provide patient treatment by recommending actions to the computer. The computer records the results of the treatment suggestions and changes, or simulates, the status of the patient accordingly.

For physicians located in relatively isolated rural areas, the ability to attend medical educational activities is severely restricted. Frequently this is the result of the distances involved and the lack of adequate practice coverage when the physician is absent. Telehealth systems can assist in bridging distances and in providing opportunities for increased involvement in a variety of medical educational activities.

<u>Non-Physician Education</u>. Education for non-physician providers is similar to those for physicians. They differ primarily in level and degree of detail and in the opportunity for regular sessions with preceptor physicians for protocol administration and development, training, and the audit of non-physician provider medical activities. A rural medical practice in Maine[7], for example, has utilized its two-way television system to communicate among providers located at different sites for purposes of protocol development, record review, and protocol audit.

Significant cost savings can be achieved through the use of telehealth systems when providers do not have to travel to participate in educational or professional development activities. Where telehealth system technology is not available, *the educational opportunities are often foregone* because of the significant travel burden.

Patient Education. Patient education may be classified in terms of its intent, which is usually prevention or disease management. Preventive patient education activities include dental health, personal hygiene, prenatal care, and breast self-examination. Such educational programs have been conducted over commercial television, public television, radio, and similar forms of broadcast communications. This form of telehealth system utilization is a substitute for people meeting to receive direct instruction.

Disease management education takes a form similar to that of prevention. Topics might include diabetes, obesity, hypertension, and other chronic care problems. Education for prevention differs from education for disease management in that disease management requires more personalized patient instruction and, therefore, more interactive forms of telecommunications.

The benefits of telehealth systems in the education area are of two general types. First, telehealth systems may substitute communication for more costly travel. Second, telehealth systems may provide the means for educational activities which would otherwise not be available.

4 TELECOMMUNICATIONS SYSTEMS— THE TECHNOLOGY OF TRANSMISSION

The two major types of telecommunications linkages - narrowband and broadband - have been described briefly. This section discusses in more detail the major forms of these linkages, their operating capabilities, their limitations, and their special relationship to the functional applications of telehealth systems. Those readers who wish to skip more technical aspects of the discussion of telehealth systems may prefer to omit this section, and section 5 which describes and classifies typical end-instruments used in a telehealth system.

Narrowband Telecommunication Systems

Narrowband systems provide the capability of transmitting up to 3,000 cycles of information per second. This bandwidth is sufficient for the types of communication listed in Table 1.

Table 1
Narrowband Communication

- Audio or Speech Communication
  - Telephone, radiotelephone
- Telemetry
  - EKG, electronic stethoscope
- Data/Record Communication
  - Low-speed data communications at 10 to 30 words per minute rate
- Still Image Transmission
  - Facsimile
  - Slow-scan television

Two basic forms of communication used for implementing narrowband transmission are wireline systems and radio systems. The most important wireline system for purposes of telehealth is the telephone system. The most common form of radio system used in health care delivery is mobile radio which is used extensively in support of emergency medical services.

The Telephone System

The telephone system has become such an integral part of our society that it usually is not thought of as a formal communication system--it simply is there. The telephone's ubiquity, coupled with its high degree of performance, reliability and operational familiarity, makes it an extremely valuable resource for telehealth applications. The telephone value is further enhanced by the fact that any telephone instrument can be interconnected with any other instrument in the country through the switching network. The distinction between point-to-point and switched networks is illustrated in Figure 4.

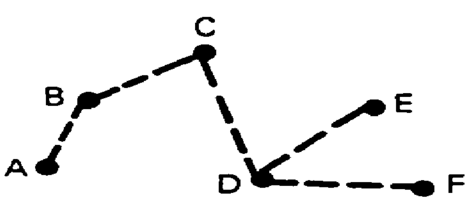

Figure 4a
Point-to-Point Network

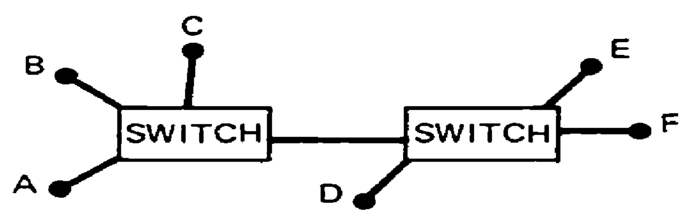

Figure 4b
Switched Network

Figure 4
Point-to-Point and Switched Networks

Structure of the Telephone System. Figure 4a shows a simple communication network in which a message from A to E must go through B, C, and D. Similarly, a message from B to D must also go through C preventing their simultaneous use of the network. A switched network, which is represented by our present telephone system, is shown in simplified form in Figure 4b. This type of system allows simultaneous utilization by a number of parties. A can go through the switches to E while B and C, as well as D and F, are connected simultaneously. Many paths are available between switches.

Because the telephone system is so widespread geographically, numerous devices have been developed to permit end-instrument interfaces. The most familiar interface device is the acoustic coupler. This permits data communication devices such as teletypes and computer terminals to be connected to the telephone system by placing the telephone receiver in the cradle of the coupler. This, and similar interfacing devices, permits the telephone system to be used with a large number of end-instruments without direct wiring of the devices to the telephone line. These interfaces enable the telephone network to be used for the transfer of voice data, facsimile, slow-scan video, or telemetry information. It should be noted, however, that the signals of other than voice devices must take turns transmitting in a two-way, two-wire system. This is known as "half-duplex" transmission.

Telephone System Economics. There are significant economic benefits in using the telephone system. Since the system already exists, no significant capital investment is required for telecommunications links. Further, the system is provided as a service and thus requires no user maintenance or overhead activity. Telephone system service generally is paid for on a per-call basis and is added to a basic monthly connection charge. Often single-call charges are made for local calls while "time-and-distance" charges are generally made for long-distance calls.

Although the quality of the telephone system linkage is good, upon occasion the switched system may generate routings of individual calls which result in poor transmission. Where the circuit quality is of crucial importance to the user, full-time leasing of a "dedicated" line may be obtained. This type of service provides a fixed routing which, for a fixed monthly cost of about five dollars per mile, is always available to the user.

In a rural telehealth system, telephone users typically are at locations regulated by long-distance rate tariffs. To minimize communications costs, telephone lines must be used as efficiently and as quickly as possible. Long-distance telephone use is not limited to a time-of-use basis. WATS (Wide Area Telephone Service) which is characterized by package billing for long distance calls made within a specific time period, is becoming quite extensive. The significant monthly charge for WATS service is economically attractive, however, only if a large volume of calls must be made.

No general guidelines can be given about the typical cost of a telephone-based telehealth system. The cost per month will depend upon a large number of complex factors, including the number of sites that must be interconnected; distances between sites; the volume of calls between the various sites; the length of individual calls; when calls are made; and which sites in the network are located within the same local, state, or WATS calling regions.

Selection of service alternatives and estimates of operating costs are complicated by the fact that although interstate long-distance rates are set on a national basis, intrastate long-distance rates are governed by state utility commissions and differ from state to state. Thus, tradeoff analyses for selecting the best network configuration to use in a telephone-based telehealth system for one rural location will not necessarily apply in another location.

An example of a hypothetical system illustrates some of the factors. Fixed telephone costs for two telephone numbers on separate lines are $60.00 per month. Variable costs for intrastate long-distance charges during the day and occasionally at night (30 calls per month at $1.00 per call) are $30.00 per month. Thus, the basic telecommunications costs are $90.00 per month for telephone-only telehealth support. Telephone systems are not likely to be more costly than alternative approaches to telehealth. On the contrary, despite the long-distance charges, a telephone-based system is likely to be the least expensive approach for telehealth systems.

<u>Specialized Telephone Devices and Services</u>. Another major factor in the attractiveness of the telephone system is the availability of many specialized devices and services which increase its flexibility. These devices and services may be grouped as follows:

1. Additional local capability
    - hands-free telephone operation (Speakerphone)
    - call-waiting
    - call-forwarding
    - conference bridging
    - automatic answering

2. Cost improvement of service
    - WATS service

3. Quality improvement of service
    - dedicated and conditioned lines

4. Radio extension of telephone service
   - pager
   - pager plus voice
   - mobile radio telephone

Additional Local Capability. This category includes a number of capabilities that can be obtained from a local telephone company or by the addition of hardware at the subscriber's terminal. One is a hands-free capability that allows one or more persons to have telephone conversations without the need to hold the telephone. The equipment consists of hardware which allows the user to push a switch, hang up the handset, and continue the conversation, generally from anywhere in a room. This type of device, although simple and familiar, can be an extremely useful adjunct for medical consultation during a patient encounter. The same hardware also can be used effectively for administrative or educational purposes with group participation at a single telephone location and all parties equally involved in the conversation.

Call-waiting is a service that provides a person using the telephone with a signal indicating that an incoming call is ringing. The subscriber may put his present call on "hold" and answer the incoming call. The second call may also be put on "hold". Such a service is useful in emergency situations.

Several additional advantages accrue from such a service. First, it may not be necessary to have an additional telephone number with its associated fixed monthly charge; second, potential patients may not call again if they receive repeated busy signals. The call-waiting service is available only from telephone companies and only in selected locations.

Call-forwarding enables the automatic relaying of an incoming telephone call to a different number than the one originally dialed. The simplest form of such a capability is the service that can be obtained from some telephone companies for approximately $1.50 per month. It permits the user to designate a single number to which incoming calls will be transferred automatically whenever a switch is thrown on the telephone instrument. Customer-purchased call-forwarding hardware may be attached to a standard telephone instrument, permitting the user to enter the additional number to which incoming calls may be forwarded.

The use of call-forwarding equipment is attractive for a number of rural health situations. For facilities that are staffed only part-time, call-forwarding services could automatically redirect inquiries to a location where a provider is available on a 24-hour basis. The use of call-forwarding to provide back-up service for rural sites staffed by non-physician providers was investigated in a recent feasibility study.[8] This study demonstrated that use of call-forwarding in combination with direct-distance dialing would permit a group of five nurse practitioner-staffed clinics to rotate their after-hours back-up services. These clinics, separated by as much as 200 miles, could have their after-hours calls handled by one of the five practitioners on a rotating basis. If the caller required personal assistance, the back-up nurse practitioner would notify the local nurse practitioner. Alternatively, after-hours calls could be routed automatically to a distant hospital emergency room which would assess the need for direct local assistance. This kind of technology would be very helpful in communities that are too small to support more than one nurse practitioner.

Conference bridging permits several locations to be interconnected for a group conversation. Conference calls are particularly attractive for consultations involving multiple locations. For example, a non-physician provider may be discussing a case with a distant preceptor who wants to consult a specialist remote from both of them. Conference calls are also useful for administrative and educational applications. However, the rate structure for conference calls, which would generally involve operator-assisted, long-distance calls,* may be excessive for frequent and lengthy educational activities.

Answering services, a common telephone system feature, allows incoming calls to be diverted to an individual who takes messages for persons not available to answer their own telephones. However, there has been a great increase recently in the use of automatic telephone-answering devices. These devices play a taped message to incoming callers and usually permit the caller to leave a recorded message for later playback. Automatic answering can be used in rural health applications in lieu of call-forwarding. For example, the recorded message played to the caller could indicate a number for the caller to dial if immediate help were needed. If the condition were not considered urgent by the caller, a message could be recorded asking for an appointment or requesting a call from the provider during regular clinic hours.

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*Telephone systems with Electronic Switching Service can provide 3-party conference bridging without operator assistance.

Cost Improvement Services. Telephone companies offer many special cost reduction services. The Wide Area Telephone Service (WATS) is the most prominent and the most applicable of these services for telehealth systems. Outbound WATS permits an unlimited number of calls to be made from a single number within limited geographical regions for a fixed monthly charge. Some restrictions, such as in the number of hours of use, may exist. Inbound WATS permits an unlimited number of incoming calls to a single number from outside the local calling area without the caller incurring long-distance charges. This is the familiar toll-free 800 area number used extensively by business organizations. WATS may be obtained for intrastate as well as interstate services.

Quality Improvement Services. There are occasions when the quality of telephone service is inadequate. This may be due to switching problems (disconnects, false busy signals, or large noise transients that destroy information, poor line quality such as cross-talk from other phone conversations, or low signal levels). These problems are particularly prevalent in rural lines* and central offices. Although the inherent redundancy of speech often permits conversations in spite of such problems, interruptions are very distracting. In image transmission, poor quality can render the system useless.

An improvement in service quality can be obtained by the leasing of dedicated lines. Leased lines are between specific points, they are always connected, and they are not switched. Lines also may be selected to provide lower levels of interference and conditioned to minimize other transmission problems. Such conditioned lines are especially useful for the transmission of digital (computer) data and slow-scan images. Costs of leased and conditioned lines vary widely, ranging from $.50 to $8.00 per mile per month, depending upon locally or federally set tariffs.

Radio Extension of Telephone Service. Two types of radio extension services are used frequently in health-related communications to link the telephone system to mobile users. These services involve the use of pagers or mobile radio-telephones. Most physicians are familiar with paging services. Their simplest form relies on the familiar "beeper" which is activated upon receipt of a coded radio transmission. The pager emits a tone to alert the person being paged to initiate a return call through the normal telephone system.

*There are more than 1600 independent telephone companies in the United States, many of which serve rural areas.

Paging systems are available which interconnect directly with the telephone system. In this type of system the person initiating the page can dial an additional series of digits to initiate the automatic paging transmission. These services may be used to alert health care providers or to facilitate administrative activity.

Paging services need not be limited to a simple "beeper". There are systems which permit a ten-second message to be broadcast to the receiver indicating, for example, what number one should call or to what location one should proceed. Only the designated recipient hears the message. This service does not permit the person being paged to return any messages via the radio link.

The mobile radiotelephone involves the coupling of radio transmission to the wireline telephone system, thus establishing a link between a moving vehicle and a fixed telephone station. In some instances these services are completed in a semi-automatic fashion, requiring a telephone call to a special mobile phone operator for completing the connection. In most cases the system operates automatically, with the dialing of the mobile number automatically initiating the interconnection to the radio link. Such services are used frequently in health applications to reach mobile providers or administrators with whom interaction is necessary or who must be alerted to the need for specific action.

Summary of Telephone Systems. The foregoing paragraphs have described a number of the services and capabilities of the telephone network and have indicated the advantages of the telephone system; namely its ubiquity, switching capabilities, low cost per individual use, lack of capital investment for transmission links, ease of access, and reliability of service. In addition, several specific add-on capabilities have been cited for their potential usefulness in relation to health care activities. Disadvantages in the use of the wireline telephone system include the limited information rate of speech communications, the possibility of lower telephone service reliability and quality in isolated rural areas, and the costs of long-distance calls which are likely to be more significant in rural areas.

Currently, no specific statement may be made about the quality of rural telephone systems or the ability of these systems to support all the services described. The telephone companies involved in each potential application should be consulted with respect to their capability for supporting potential telehealth configurations.

Radio Systems

Narrowband radio transmission systems are of two general types -- broadcast and point-to-point. Broadcast communication is typified by commercial AM and FM radio stations. Broadcast stations transmit at established frequencies in a generally omnidirectional fashion. Inexpensive receivers are available that can tune to these frequencies for programming that may be scheduled well in advance, and for which programming information can be made widely available.

Broadcast systems, because of the one-way, one-to-many nature of their transmission, are effective largely for general public interest announcements or specialized educational programming. In many areas radio systems are being used for educational programming and special educational programs of interest to physicians are being sponsored regularly. In some instances special programs, received only by specially modified receivers, are broadcast along with the normal programming of FM radio stations. This service, known as SCA, is available for a charge and on a limited basis because most areas have only a few FM broadcast stations.

Point-to-point radio links may be established between fixed points or between a fixed point and several moving points. Such radio links provide a half-duplex*, voice-grade circuit and usually are implemented using high-power base stations operating at frequencies and bandwidths designated by the Federal Communication Commission (FCC). In most mobile operations, the high-powered base station is utilized in conjunction with lower powered transceivers** in the mobile units. Since there is only one channel, many users must take turns sharing it. Sometimes this causes "traffic congestion", and users must severely limit their transmission time. To obtain privacy, voice scramblers are used. Health applications generally utilize the emergency bands for emergency services such as ambulances, and the business band for administrative services. For rural applications, long distances and hilly terrain often require the use of repeater stations in addition to the base-station and mobile terminals.

Radio links offer flexibility in mobile applications and may be substituted for the telephone system where it is not available. However, difficulties may be associated with the

*Two-way communication limited to one direction at a time.
**A transceiver is a combination transmitter/receiver.

use of radio links. Distance, terrain, station location, or electrical noise may impair communication quality and reliability. Also, the availability of radio channels is limited in many areas because of the large number of users. The radio frequency spectrum is a limited resource and it has been allocated largely on a first-come, first-served basis.

Long-range communication is also possible via high frequency (HF) radio or by satellite communications. For very remote areas these methods may be the only ones feasible. HF radio has been used by the Navy in the ship-to-shore operation of an experimental narrowband telemedicine link.[9] Narrowband satellite communications links have been used in a similar fashion, both for military and non-military applications. High frequency radio is generally a less desirable transmission means than satellite communication because of its greater susceptibility to noise*, the possibility that the communications path may be interrupted by fading**, and by the limited number of channels. However, HF radio costs are low. Because of the expense of building transmitting and receiving facilities, narrowband satellite links generally have been established only when other mechanisms are not available. The cost of such facilities has dropped rapidly and time-of-use charges are going down. Most of these links are being integrated into the telephone network, rather than being available as separate commercial services.

Education is the most common application of radio broadcast systems within health applications. For point-to-point radio communications, frequent applications include mobile emergency communications and mobile administrative support. The use of point-to-point radio links between fixed locations appears to be effective and efficient only when telephone service is unavailable. For example, the National Center for Health Services Research sponsored the installation of a radio link between a non-physician provider and his preceptor physician in rural Idaho where telephone communications were inadequate; the frequency of their contacts increased appreciably.

*"Noise" is a term used to describe various type of interference, such as static.
**"Fading" is a term used to describe the loss of radio signal strength.

Broadband Telecommunication Systems

A broadband system is one that is capable of carrying real-time video information of quality comparable to standard broadcast television. The capacity of such a channel is approximately 2,000 times as great as that of a narrowband channel. Information bandwidths are available between narrowband and wideband. They are used primarily for data transmission.

A broadband channel typically will carry a full-color video signal and an associated audio channel signal and will have the necessary "guard" bands to prevent interference between signals. Alternatively, this same broadband channel can carry 1,200 narrowband channels simultaneously using the process of signal multiplexing. Private microwave systems are allowed to combine multiple narrowband channels with the video channel on one broadband transmission line. Thus, several voice channels, a data channel, a telemetry channel, and a facsimile or slow-scan channel can be carried simultaneously with the video signal.

Transmission Means. The means for broadband transmission typically are limited to radio or cable.* Radio transmission may be either broadcast or point-to-point. Commercial and educational television are broadcast signals radiated in a relatively uniform geographical pattern (i.e., omnidirectionally) to all in the area who have receivers, such as television sets. Transmitters of this type are expensive to build and operate, and it is very difficult to obtain a broadcast license because of the limited number of available channels. A group of special channels, called Instructional Television Fixed Service (ITFS), is available exclusively for educational purposes. These systems operate omnidirectionally in the broadcast mode and the radiated signal usually has a range of no more than ten miles.

Satellite communication systems are being used commercially to relay broadcast television signals and to interconnect local cable television systems. Satellite systems are feasible for the delivery of health-related educational programming to communities having cable television systems with satellite receivers or to hospitals that wish to invest in a receiving system. Minimum capital costs for a broadband transmitting system are $50,000 at this time. Receive-only station costs

*The term "cable" refers to coaxial cable which has the capability of carrying many channels of broadband information simultaneously.

are less than $5,000 per terminal. Operating costs for a broadband satellite channel range from $300 to $1,000 per hour.

Microwave Radio. Fixed point-to-point communication having a broad bandwidth is usually called "microwave radio", although there are other types of transmission, such as radar and satellite, in the microwave region. As its name implies, fixed point-to-point communication depends upon a series of two-station connections. Depending upon the line of sight between two locations, they may be separated by three to fifty miles, with a parabolic antenna at each end focusing the radio signal into a narrow beam aimed at the receiving antenna. High buildings or hilly terrain affects system routing, distances between and locations of terminals, and costs. Each transmitter-receiver pair makes up a "hop".

Because a large number of broadband channels require a large amount of spectrum, new microwave radio assignments have steadily been moving up in frequency. At present, most microwave users in education, industry, and business must use frequencies in the 12 to 13 GHz band. The allotted bandwidth in this band is 20 MHz which can easily accommodate one video and many narrowband channels simultaneously. Early common carrier (telephone company) assignments were at 2 GHz, a range where radio equipment is easier and less expensive to manufacture.

Broadband Cable. Cable is used for short distances (e.g., from studio, office, or control room to transmitter/antenna) and in areas where radio licenses are not available. Cable may be a cost-effective alternative to microwave radio for distances up to one or two miles, depending upon circumstances such as the availability of space to lay cables and the probability of the cable being damaged.

From a technological point-of-view, cable television systems could be used for the entire range of health care communication needs. However, since locations wishing to communicate often are not in the same community, and since cable television systems are franchised on the basis of political jurisdictions, it is not likely that a cable television system would connect all the points of a rural health system. Cable systems in different communities could be used if they could be interconnected by other broadband transmission means and thereby made part of the same network.

Networks

Transmission systems can be interconnected in various configurations. Radio and wireline networks are discussed in the following paragraphs.

Radio. An example of a linear microwave radio network is shown in Figure 5. This one-way (Simplex) network has three transmitters and three receivers. If it is to be made two-way, three additional transmitters and three additional receivers pointing in the opposite direction must be added. The same antennas and towers may be used for two-way operations.

In networks more complicated than the simple linear one, the switching and the transmitter frequency determinations operate with many practical restraints upon frequency selection.

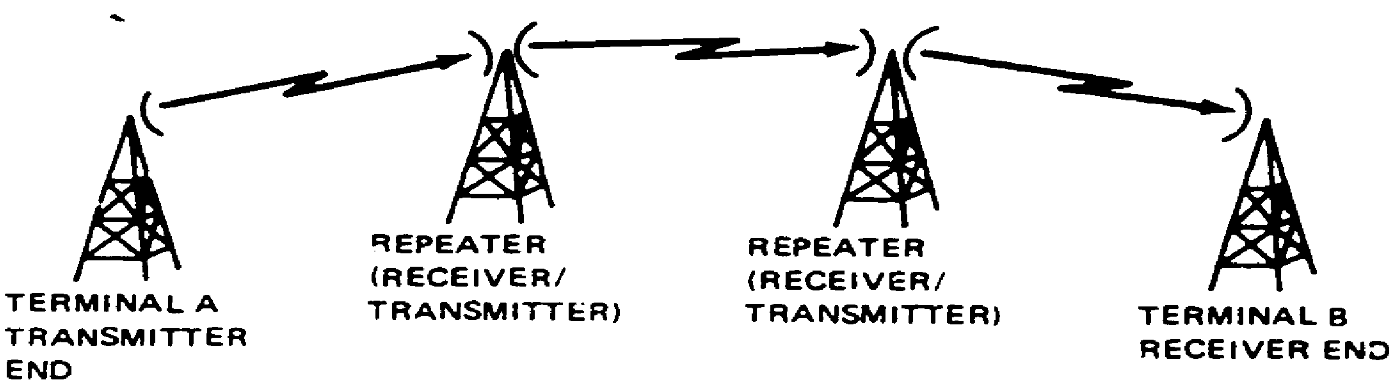

Figure 5
Linear Three-Hop Simplex Microwave Network

Wireline. In the usual narrowband service, the telephone company resolves the technical problems involved in installation and maintenance of lines and switching. All of the engineering is performed for the customer, who purchases only a service. Telephone circuits are full-duplex (simultaneous two-way) and because of the structure of the network, a series of switches will allow a connection between almost any two telephones. A large proportion of the investment of the telephone companies is in switching apparatus.

It is very unlikely that an extensive video (broadband) switched network will come into existence as long as present wire technology is required for local loop distribution (i.e., from the switch to the customer's premises). In the future, a broadband technology based on transmission of signals via lasers and fibre optics is likely to emerge. However, the huge investment required for implementation of this technology assures us that it will be a very long time before videc transmission and switching will be as ubiquitous as the present audio system.

5 TELEHEALTH END-INSTRUMENT SYSTEMS

End-instruments are the transducers that interface between the communications system and the human beings who use it. This section describes the most common telehealth end-instruments in terms of their functional and technical characteristics, suppliers, and costs.[10]

End-Instrument Concepts. Visual communication requires broadband channels, whereas audio communication requires only narrowband channels. Therefore, the only truly broadband end-instruments in a telehealth system are video cameras for input and TV monitors or receivers for output.

An additional and important information system concept is that of storage or memory. A small quantity of information can be stored quite readily and, if necessary, recovered at a rate different from that at which it was stored. Storing large quantities of information requires large and sophisticated storage devices if the information is to be readily and quickly retrieved. Magnetic tape has become a favorite storage medium for data, voice, and video information.

The classification of end-instruments is somewhat arbitrary; however, the following four categories are rather well-established areas of technological end-instrumentation:

- Audio
- Telemetry*
- Data/Record
- Video

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*The term "telemetry" normally encompasses a broad area of physical measurements. However, in this handbook the term is used only to describe instrumentation for physiological measurements. Mechanical and electrical inputs are not included.

The remainder of this section discusses specific types of end-instruments in these four categories. Emphasis is on those instruments which utilize currently available technology, requiring no new development or testing other than what is required for interfacing items of equipment into a single system configuration. Additional discussion is offered on some technological possibilities which show promise for the future, and at the end of the section some sample telehealth system configurations are described. These configurations indicate how end-instrument "building blocks" may be assembled into a functional telehealth application. Table 2 summarizes the end-instruments to be discussed and the following four detailed tables list the types of end-instruments and their functional capabilities, special characteristics, approximate cost, and typical suppliers.

Table 2
Summary of End-Instruments

AUDIO

- Speaker phone
- Call-waiting
- Call-forwarding
- Conferencing
- Automatic answering
- Remote query answering
- Tone paging
- Voice paging
- Mobile radio service
- Mobile radio system

TELEMETRY

- Telephone coupler/modem
- EKG
- Electronic stethoscope
- Miscellaneous telemetry

DATA/RECORD

- Keyboard terminal
- Soft-copy output
- Hard-copy output

VIDEO

- Facsimile, business type
- Special facsimile
- Slow-scan television
    - Low resolution
    - Medium resolution
    - High resolution
- Storage devices
- Stand-alone imaging
- Fibre-optic devices
- Television

Audio Instruments

Earlier the telephone system was described in terms of a switched narrowband transmission system. This section refers to the telephone as a speech transducing instrument--one which on the transmitting end transforms speech into an electrical signal and on the receiving end transforms an electrical signal into speech. Devices and services often used as adjuncts to the telephone instrument are listed in Table 3.

Verbal communication via the telephone is highly interactive and even permits some non-verbal information interchange through tone, phrasing, and voice nuances. The sophistication of the participants and the precision of the medical vocabulary can further enhance the effectiveness of speech communication. Verbal interchanges between providers often can substitute for the transfer of visual information.

Administrative uses of the telephone instrument are frequent and familiar. Placing orders for equipment, making arrangements for management activities, and discussing and clarifying record and billing information are typical examples.

Conference call and "hands-free" augmentations of the telephone have been used effectively in educational activities of many kinds. Speech communications can be augmented further by mailing textual materials or other visual aids prior to formal meetings. Telephone communication also has been used quite effectively as the return link in educational activities involving video communication from an instructor to remotely located students.

Similar capabilities can be attained with radio transmission systems. If the radio link is simultaneous two-way (full-duplex), its use should be equivalent to the normal telephone However, "push-to-talk" is the most common form of point-to-point radio communication. This is a one-speaker-at-a-time

Table 3
Audio (Speech) End-Instruments

NAME	FUNCTION
(1) Speaker phone	Allows hands-free telephone communication and/or several participants at one location
(2) Call-waiting	Signals to talking user that another call is ringing
(3) Call-forwarding	Automatically forwards calls to a pre-selected number; selected number may be changed
(4) Conferencing	Allows users to make 3- or 4-party bridging connections with use of operator
(5) Automatic answering	Answers phone with tape recorded message and records incoming message from caller
(6) Remote query answering	Additional answering capability allows owner to retrieve his messages
(7) Tone paging (beeper)	Provides wearer with signal that he is wanted
(8) Voice paging	Provides wearer with up to 10 second voice message
(9) Mobile radio service	Allows two-way radiotelephone contact with other fixed or mobile sites
(10) Mobile radio system	Same function as (9); in some circumstances owning system is only alternative

* Available through local telephone company
** Available for purchase through many local distributors
*** Service available from local paging operators
**** Service available from local radio common carriers
(See telephone company in yellow pages)

FEATURES/REMARKS
Automatically senses who is speaking and allows only that person to transmit; users take turns speaking
Permits answering and/or holding of incoming call*
May be part of Electronic Switching Services (ESS) package or devices; may be purchased separately for $300-$800**
Part of ESS package
Many variations of this device provide different instructions and different incoming messages
Authorized (coded) inquiry from a remote telephone will play back the recorded incoming messages
Usually wearer calls his office or some other prearranged number for information
Voice pager often allows wearer to take required action without a phone call
Two-way radio may operate with the normal dial-up telephone system
Private mobile radio is usually limited to users of own network

NAME	TYPICAL SUPPLIERS[1]
(1) Speaker phone	Telephone companies lease for approximately $9/month;* purchased device can be attached to any telephone
(2) Call-waiting (3) Call-forwarding (4) Conferencing	Telephone company has special Electronic Switching Services (ESS) exchanges which allow these three services;* may be ordered singly or in combination; not available in all locations
(5) Automatic answering (6) Remote query answering	These are available for purchase from many retail outlets;** see the yellow pages of telephone book
(7) Tone paging (beeper)	Usually purchased as a service;*** hardware suppliers are GE, Lynchburg, VA and Bell & Howell, Waltham, MA
(8) Voice paging	RCA Mobile Communications
(9) Mobile radio service	Service is usually paid for on a monthly basis plus a charge per call****
(10) Mobile radio systems	Private systems available from General Electric, Lynchburg, VA

* Available through local telephone company
** Available for purchase through many local distributors
*** Service available from local paging operators
**** Service available from local radio common carriers (See telephone company in yellow pages)

COST($) PER TERMINAL
$30 to $100 purchased; $9 per month, leased
$5 to $15 per month for various combinations of service
$80 to $200 $250 to $350
$21/month beeper rental $250 purchase
$26/month lease; complete paging system costs $3,000 up
$50/month minimum
$5,000 and up for system plus $1,800 per receiver

[1]NOTE: The listing of typical suppliers is not complete. It does not imply endorsement of any popular product or manufacturers. In general, it is not known whether these suppliers are prepared to give extensive applications descriptions or to engage in detailed discussions with persons attempting to become knowledgeable in their particular field of technology. For further information concerning telehealth technology or suppliers, contact Friend Skinner, The MITRE Corporation, 1820 Dolley Madison Boulevard, McLean, Virginia 22101.

operation that is known as half-duplex. Some operational inconvenience does exist using half-duplex radio channels, because one speaker must wait for the other to finish talking.

The telephone is used in virtually all non-physician-staffed clinics where the non-physician is the primary care provider. Typical instances of this application are in Estancia, New Mexico,[11] and Trenton, Florida,[12] where a nurse practitioner and physician assistant, respectively, provide primary care services and a remote physician provides supervision, consultation, and administrative support via the telephone.

The MIST (Medical Information Services via Telephone) System in Alabama is a highly successful example of telephone usage for providing consultative support to physicians. This telephone service provides physicians anywhere in the state with 24-hour access to specialists at the University Medical Center in Birmingham.[13] Using WATS and CENTREX Service, physicians may discuss specific medical problems with specialists at the Medical Center. The speed and 24-hour availability of the service make it attractive for consultation on an as-needed basis.

The Medical Dial Access Library operated by the University of Wisconsin is an example of the effective use of the telephone for continuing education. This system contains a library of about 500 four- to seven-minute tape recordings on a variety of medical subjects. The service is available to subscriber physicians 24 hours a day, seven days a week. It also is provided by contract to all National Health Service Corps physicians. The user consults a catalog list of the available tapes and their respective numbers, dials the library at the University, and requests a tape. An operator at the University takes the call and selects and plays the requested tape. Usage is divided approximately evenly between general educational and patient-specific concerns. See the Appendix for a description of this project.

Telemetry Instruments

Telemetry, as used herein, refers to the process of transducing physiological signals into a form capable for transmission over a narrow-bandwidth information channel. Any narrowband physiological signal reduced to electrical form may be transmitted to a remote site. For example, fetal and intensive-care monitoring have been conducted remotely with signals relayed from the patient to a remote consultant. Examples of telemetry instruments include an

EKG, EEG, electronic stethoscope, and blood-pressure transducer. All of these have been configured to interface with a telephone line, either by acoustic coupler or direct electrical connection. Table 4 lists typical telemetry devices.

Transmission of EKG signals and remote reading by cardiologists is a relatively common practice. In addition, the use and acceptance of computers for EKG screening and interpretation has increased in recent years. It is estimated that approximately 2,400 sites are using computer-assisted EKG interpretation to process approximately four million EKGs annually. Approximately 60 percent of the requestors are hospitals or clinics and about 40 percent are physicians in private practice.[14]

Telemetry need not involve the real-time interaction of a remote consultant. Remotely received information, such as EKGs, may be stored for later review and the results may be transmitted verbally, through a computer printout, or through mailed reports unless time is considered crucial.

The electronic stethoscope is a telemetry end-instrument of considerable potential interest in rural primary care settings. The device acts as a normal stethoscope, but it amplifies cardiac sounds. An attachment also is available for recording heart sounds on a standard cassette tape recorder. This permits recorded sounds to be submitted to computer analysis with complete power spectrum and phonocardiogram output. Heart sounds may be transmitted over the telephone lines and recorded at a remote site for later review by a consultant. The output from the electronic stethoscope also may be attached to a distribution device that allows simultaneous reception by a group of observers for educational applications.

Other physiological measurement/computer applications that are becoming more common include pulmonary function testing, interpretation of radioisotope scans, and blood gas analysis.

Data/Record Instruments

This category of end-instruments includes Teletype-like (TTY) and facsimile (FAX) machines (see Table 5).

Table 4
Telemetry End-Instruments

NAME	FUNCTION	FEATURES/REMARKS
(1) Telephone coupler/ modem	Allows coupling of telemetry instrumentation to telephone system	Primarily used for operations where a temporary hookup must be made between instrumentation of the telephone system
(2) EKG (ECG)	Transmits electrical heart activity	Often combined with defibrillator in a portable unit; plugs into radio or telephone lines
(3) Electronic Stethoscope	Permits transmission of heart and cavity sounds over telephone lines	Has higher frequency response than conventional stethoscope
(4) Miscellaneous Telemetry (EEG, Pulmonary, etc.)	Transmits any physiological information that exists as an electrical signal	Any physiological signals that have low information rate signals can be sent over narrowband telephone lines

[1] NOTE: The listing of typical suppliers is not complete. It does not imply endorsement of any popular product or manufacturers. In general, it is not known whether these suppliers are prepared to give extensive applications descriptions or to engage in detailed discussions with persons attempting to become knowledgeable in their particular field of technology. For further information concerning telehealth technology or suppliers, contact Friend Skinner, The Mitre Corporation, 1820 Dolley Madison Boulevard, McLean, Virginia 22101.

TYPICAL SUPPLIERS[1]	COST($) PER TERMINAL
EMR, Sarasota, FL is a component supplier for original equipment manufacturers	$200
Datascope, Paramus, NJ Marquette Electronics, Milwaukee, WI	$4,500
Heart Sound Reproductions, Tomball, TX	$150
Hewlett/Packard Medical Electronics, Waltham, MA	Not applicable

Table 5
Data/Record End-Instruments

NAME	FUNCTION	FEATURES/REMARKS
(1) Keyboard terminal	Acts as alphanumeric data input device for a computer or communications system	Usually combined with a display or hard-copy capability
(2) Cathode ray tube (CRT)	Displays alphanumeric data on screen	Many displays are generated by keyboard input; are "smart" or "dumb" depending upon whether they can stand alone or require a host computer; usually are interactive
(3) Printer	Printed paper output for permanent alphanumeric record of transactions	Printers are peripherals that simply record the data; they are often combined with input devices (keyboards) and CRT displays

[1]NOTE: The listing of typical suppliers is not complete. It does not imply endorsement of any popular product or manufacturers. In general, it is not known whether these suppliers are prepared to give extensive applications descriptions or to engage in detailed discussions with persons attempting to become knowledgeable in their particular field of technology. For further information concerning telehealth technology or suppliers, contact the MITRE Corporation, 1820 Dolley Madison Boulevard, McLean, Virginia 22101.

TYPICAL SUPPLIERS[1]	COST($) PER TERMINAL
TeleType, Skokie, IL Texas Instruments, Houston,TX	$500 to $1200; bare keyboard less than $100 in large quantities
Datapoint, San Antonio, TX Infoton, Burlington, MA Perkin-Elmer, Tinton Falls, NJ	$800 to $5,000
Digital Equipment, Maynard, MA Texas Instruments, Houston, TX TeleType, Skokie, IL	$1,000 to $5,000

Teletype (Alphanumeric) Data Transmission. Most teletype machines are no longer the clanking mechanical devices of the past. New keyboard-input, printer-output devices are faster and quieter. The newer devices typically transmit at a selectable 10-, 15-, or 30-words-per-minute rate over a voice-grade, narrowband line. The same machine is used for both transmitting and receiving and also can make a copy of what it is transmitting. Some machines punch a paper tape, some record on magnetic tape for later transmission, and others print. If a printed record is not required, then a TV-like display may be utilized. The text can be viewed on a cathode-ray-tube terminal at both transmitting and receiving ends, and a limited number of lines of text may be stored and retrieved. If a telehealth system is configured to store and search records using a computer, these data communications devices become important end-instruments.

A variety of computer applications are available in the health field. Computers may be used locally or remotely to support patient care as well as administrative functions. Administrative services are widely available through commercial computer time-sharing services, associations or groups of hospitals, and computer facility sharing. Applications include computerized billing and accounting services[15], production of financial reports, and processing and preparation of medical and administrative records for management purposes. Complete computerized medical record systems have been developed for hospital applications and group practices, and are likely to become available shortly on an economically attractive basis[16, 17] even for small practices.

Computer systems may also serve educational purposes in rural areas.[18] Computer-assisted instruction is currently used in training new physicians and in providing continuing education. Data communications are essential for bringing these diverse capabilities to rural health systems which cannot afford stand-alone computer facilities.

Image-Type Data Transmission. Data and records also may be transmitted by means of facsimile (FAX) equipment. These devices transmit pictures from one location to another over narrowband links. Facsimile is versatile and if the traffic (number of individual documents) is fairly low, it can be utilized effectively for the transmission of pictures, written records, signatures, and charts such as EKG tracings. Most systems use the same terminal for transmitting (input) and receiving (output). This type of terminal is called a "transceiver". It requires a narrowband communication line, although some machines are designed for faster or more detailed picture transmission over somewhat greater bandwidth lines.

The photograph or printed document to be transmitted is scanned, line-by-line, in a manner similar to a television scan. Since the bandwidth of the communications channel does not permit the picture elements to be transmitted at a high rate, it takes from 4 to 16 minutes to transmit a single page. A direct relationship usually exists between degree of resolution and transmission time. Moderate resolution can be obtained with six-minute transmission times.

A new type of facsimile has become available recently which will transmit a medium-resolution page of text in 30 seconds. This is accomplished by restricting the image tone to either black or white; no gray scale is possible. With high quality FAX machines, seven gray-levels are discernible and over 90 lines per inch are resolvable. Table 6 provides information regarding facsimile transceivers and other image-type devices.

High-resolution facsimile equipment that utilizes lasers for scanning the material to be transmitted is commercially available. Developmental configurations can provide variable resolution of up to 250 picture elements per inch over .4 inch length and 1,000 picture elements per inch over four inches. Such systems use dry-silver film which is developed on-line to produce ready-to-use output including x-rays of diagnostic quality. Although not yet commercially available, these developmental systems may become competitive in the future, particularly where extremely high resolution is required. These devices have been designed for data transmission at 56,000 bits per second, which is considerably higher than can be transmitted over normal telephone lines, but considerably lower than video transmission rates.

Video Instruments

End-instruments that capture, transmit, and display video information take a wide variety of forms. However, all video instruments involve the use of some type of camera. Facsimile instruments, discussed above, could have been considered as video equipment because they transmit an image which has been taken with a photographic camera. However, this section will stress the transmission of video information in which there is no intermediate stage to produce a hard copy of the video image. Three types of video end-instrument systems will be discussed--"normal" or

Table 6
Video End-Instruments

NAME	FUNCTION
(1) Facsimile (standard)	Transmit/receive hard-copy
(2) Facsimile (hi speed/ hi-resolution)	Transmit/receive hard-copy
(3) Slow-scan television (SSTV) (a) low-resolution	Transmit/receive video image over telephone lines
(b) medium-resolution	Transmit/receive video image over telephone lines
(c) high-resolution	Transmit/receive video image over telephone lines
(4) Stand-alone imaging	Provide soft-copy (display) imaging manipulation and enhancement capability
(5) Storage Devices	Store video images for later retrieval and display
(6) Fibre-optics devices	Gather optical images from otherwise inaccessible places such as body orifices. In conjunction with TV or slow scan transmission
(7) Television	To transmit/receive moving images electronically

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FEATURES/REMARKS
64 or 96 lines per inch resolution; limited gray-scale reproduction; 4 to 6-minute transmission time
Up to 400 lines/inch resolution; gray scale limited only by quality of print material; 30 second to 16 minute/page transmission time
Resolution approximately 128x128 picture elements with 16 gra levels
Resolution 256x512 pixels with 64 or 256 gray levels
Resolution 1024x1024 pixels with 246 to 1024 gray levels
Digital storage and image processing, pseudo color, overlays, cursors, etc.
Instant recall--magnetic disc; delayed recall-magnetic tape
Optical input must be coupled to TV or SSTV system
Requires camera, monitor, controls and coaxial cable or microwave radio transmission (Monochrome or Color TV)

NAME	TYPICAL SUPPLIERS[1]
(1) Facsimile (standard)	Xerox, Rochester, New York 3M, Minneapolis, Minnesota
(2) Facsimile (hi speed/ hi-resolution)	Muirhead, Mountainside, New Jersey Harris Corp., Melbourne, Florida Rapidfax, Fairfield, Connecticut
(3) Slow-scan television (SSTV) (a) low-resolution	Robot Research, San Diego, California
(b) medium-resolution	Colorado Video Inc. Boulder, CO NEC America, Glenview, Illinois
(c) high-resolution	None commercially available
(4) Stand-alone imaging	Comtal, Pasadena, California Ramtek, Sunnyvale, California Grinnell, Santa Clara, California
(5) Storage devices	Arvin/Echo, Mt. View, California Panasonic,* Sony,* JVC*
(6) Fibre-optics devices	Olympus, New Hyde Park, New York Applied Fibreoptics, Southbridge, Massachusetts Fujinon Optical, Scarsdale, New York
(7) Television	System must be custom engineered

*Video tape recorders are available from local distributors. Audio tape recorders can store SSTV images; cost, $100 to $250.

COST($) PER TERMINAL
$1,750 to $3,000
$8,000 to $18,000
$1,500
$15,000 to $17,500
$60,000 and up
$8,000 to $30,000
$2,000 to $10,000 $200 to $10,000
$5,000 to $10,000
$30,000 to $300,000 and up

[1] NOTE: The listing of typical suppliers is not complete. It does not imply endorsement of any popular product or manufacturers. In general, it is not known whether these suppliers are prepared to give extensive applications descriptions or to engage in detailed discussions with persons attempting to become knowledgeable in their particular field of technology. For further information concerning telehealth technology or suppliers, contact Friend Skinner, The MITRE Corporation, 1820 Dolley Madison Boulevard, McLean, Virginia 22101.

"standard NTSC"* television, slow-scan television (SSTV), and special viewing instruments based on fibre-optic techniques. Table 6 lists several video end-instruments.

The Video Camera. A television (video) camera is required for all video systems. It is a complicated device and may be quite expensive. The camera electronically scans an optically-produced image and dissects it, element-by-element and line-by-line. The resulting electrical signal is transmitted and the original optical signal is reproduced on the receiver's picture tube using a moving electron beam which excites a light-producing phosphor spot. The spot is refreshed 30 times a second and the human eye "remembers" each illuminated spot between refresh cycles.

There are several pitfalls for the user of a television camera. Although most modern video cameras automatically adjust themselves for average lighting, lighting remains a major problem in obtaining good images. Use of the proper lenses, including zoom lenses, also is an important consideration. MITRE has expended significant effort in its Telehealth Laboratory in determining how to achieve the highest quality and the most useful video images for telehealth applications.

Monochrome (black-and-white) television is complex, but the addition of color multiplies the technical problems significantly. Balancing of colors is extremely dependent upon lighting, and nonprofessional camera work usually produces an inferior image quality. For medical diagnosis, there are many unanswered questions about the usefulness of color. The limited research experience on the effectiveness of color in remote medical consultation/diagnosis has been in the field of dermatology. These results have indicated that the absence of color does not affect the accuracy of diagnosis, but does increase the time required to make a diagnosis.[19]

*NTSC stands for National Television Standards Committee. The picture frame consists of two interlaced fields having a total of 525 horizontal lines. Of these, 480 lines are visible on the TV screen. The horizontal resolution is approximately the same as the vertical resolution.

Ancillary camera equipment at the input end consists of lights, lenses, mounts, camera controls, and switches. Lighting may be critical for certain views, but most black-and-white cameras operate quite adequately with simple room illumination from fluorescent lights. Auxiliary lighting using table top lamps or a fibreoptics-directed cold light source often is helpful.

In MITRE's experience a small zoom lens with a 6:1 zoom ratio generally has been adequate for enlarging the size of the image to be transmitted. This zoom lens is sometimes used with a set of "close-up" lenses, which allow even closer views and greater magnification (e.g., six inches away and six times real-size images for dermatological or throat examinations). Magnification of a 3-inch by 4-inch portion of an x-ray to full monitor size provides moderately high resolution.

<u>NTSC Standard-Quality Television</u>. The maximum resolution capability of a frame of commercial (NTSC) monochrome television is approximately 370 lines in the vertical direction. Achievable resolution with commercial products is between 325 and 350 lines, but typically it is less than 300 lines. Horizontal resolution is comparable. Camera and monitor resolution in excess of 800 lines per picture is readily available for closed-circuit applications; however, such high resolution pictures cannot be transmitted over a standard television channel. The transmission medium is the limiting factor.

The suitability of video for telehealth applications varies with the resolution and gray-scale requirements of the application, as well as with the requirements for imaging techniques in an operational setting.

Gray-scale capability refers to the number of shades of gray and to the number of gray levels. The number of shades of gray refers to the range, from black to white, which can be represented by a system. The NTSC standard range is divided into 10 shades, the relative increase or decrease from one adjacent shade to another being related logarithmically. The number of gray levels indicates the number of discrete steps within the range of black to white for systems that use digital storage. Analog systems are indicated as having continuous gray levels, distinguishability being limited by system noise.

The gray-scale range of a standard monochrome television image is lower than the range of photographic film and higher than that of a photographic print. In general, however, the gray-scale limitations of NTSC television are not significant in actual use and the average person cannot detect any gray-scale anomalies under normal viewing conditions.

Presently, the most accepted area for video communications is that of education. The resolution and gray-scale capabilities of commercial television are more than adequate for most educational purposes. However, the limitations on educational uses of video communications stem largely from the high costs of video programming and the high cost of transmission systems required by television.

Classroom lecture situations can be handled quite effectively by means of video transmissions. Although such a format may provide a "dull" presentation, no particular operational difficulties generally ensue. When the educational format includes teleconferencing or similar group situations, multiple camera techniques are generally required, and the coordination of natural interactions in the video presentation becomes increasingly difficult. Complex and expensive studio set-ups, program direction, and control staffing may be required.

There are numerous examples of the use of live television for health education purposes. The Dartmouth INTERACT System,[3] the Massachusetts General Hospital System,[1] and the Ohio Medical Microwave Network[1] are three of many successful uses of live television for health education. These systems use point-to-point microwave radio transmission for the television signal.

The NASA ATS-6 satellite was used for a number of experiments in primary care, administrative, and educational applications of television.[20] Notable among these was the WAMI (Washington, Alaska, Montana, Idaho) project, which conducted two-way live broadcasts between Alaska and the University of Washington Medical School. Veterans Administration Hospitals in Appalachia also have utilized the ATS-6 satellite for education and teleconsultation.[21] The forthcoming CTS (Communication Technology Satellite) system will include a number of additional health educational experiments using live television and satellite transmission to link separate sites in a dispersed educational network.[22]

Many medical and educational institutions have established closed circuit television systems to facilitate health education and training. Television also has proved to be an effective medical tool in a wide variety of diagnostic and consultation situations. Notable successes have been demonstrated in dermatology, speech therapy, psychiatry, and nurse-anesthetist supervision. The Handbook Appendix contains descriptions of a large number of television projects.

Slow-Scan Television (SSTV)

The combined factors of consultation needs and technology costs make the end-instrument technology referred to as slow-scan television worthy of consideration for telehealth applications. The single greatest impediment to the use of standard television in rural health systems is the cost of establishing and operating a broadband channel having the capability to transmit continuous video information. Moreover, investigations of the medical use of video information indicate that most information of interest may be obtained by examining several non-sequential frames of video information.[4]

Principles. The concept of slow-scan television (SSTV) comes from a rather simple notion. A single frame of video contains a huge amount of information. Standard, moving television requires a very large amount of bandwidth to transmit each frame's information in a very short period of time (1/30th of a second). However, a single video frame can be transmitted using the very small bandwidth of a telephone channel if a considerably longer period of time (approximately 30 to 90 seconds) is allowed. This concept is embodied in the equipment referred to as slow-scan television. Table 6 contains a listing of slow-scan hardware, costs, and suppliers.

A slow-scan television system consists of the eight major components shown in Figure 6. A video camera is used to capture the view of interest in the same manner as it is used for standard television. The frame of video is rapidly (1/30 second) stored in a video frame storage device. From the frame-storage device, the video is slowly (60 to 90 seconds) read out by the scan converter at a rate that can be transmitted over a telephone channel. The modulator accepts this signal and transmits it over the telephone line to the receiving end.

At the receiver, the demodulator extracts the slowly varying electrical signal and passes it to the video scan converter which assembles the video frame of information for the frame

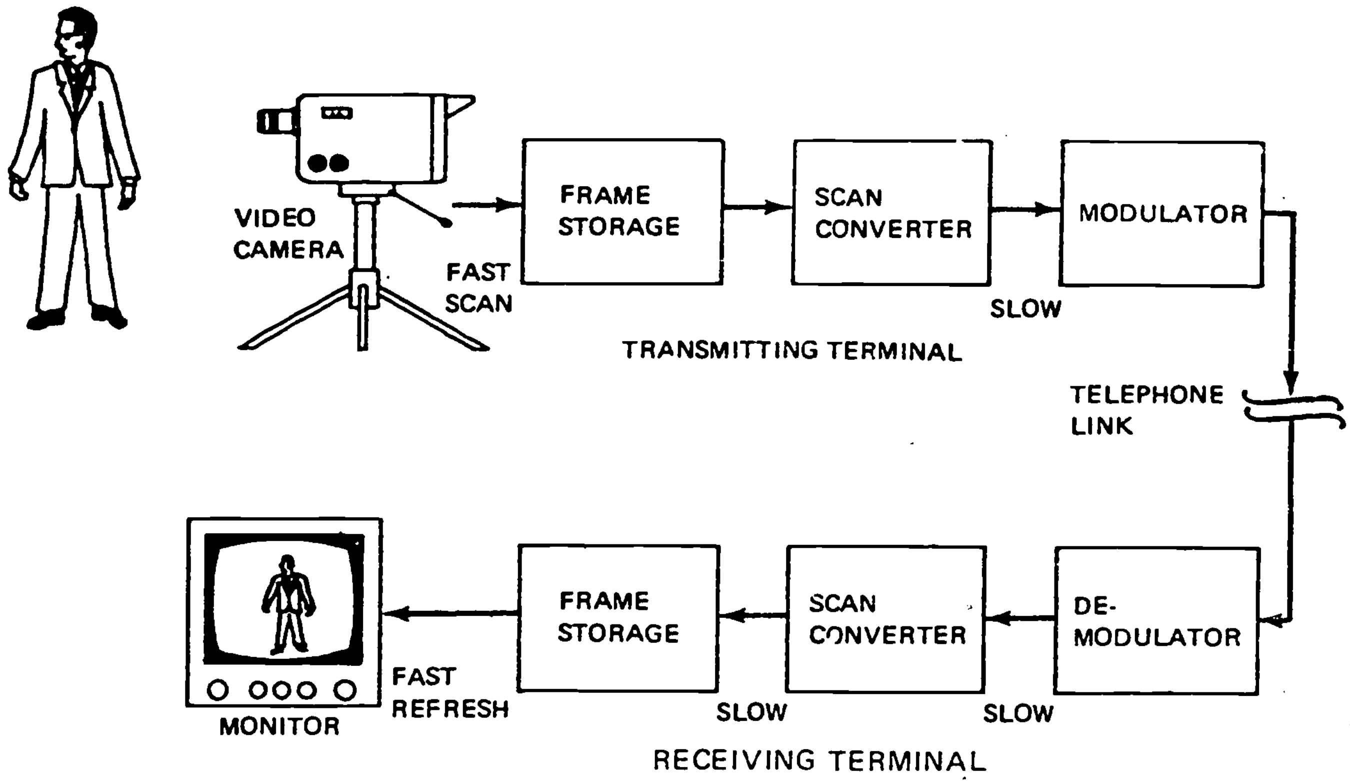

Figure 6
Slow-Scan Television Functional Diagram

storage unit. The full video frame then rapidly (within 1/30 second) and repeatedly refreshes a standard television monitor.

<u>Capabilities</u>. A SSTV system operates on a principle very similar to the facsimile system, using a sequential scanning process to dissect and later assemble an image. However, unlike facsimile, it is not limited to transmission of a hard-copy record. The slow-scan hardware accepts an electronic image from a video camera and stores the frame for the length of time necessary to transmit the electrical signal over the narrowband communications link. Typically, it takes from 30 to 90 seconds to transmit one frame. The exact time depends upon the image resolution and the gray-scale gradations required by the user. If more than one frame is to be stored at either end of the system, additional memory may be incorporated to retain frames for as long as it is desired.

The comparison of presently available SSTV and FAX systems hinges primarily on operating features (soft-copy vs. hard-[illegible]), input and output, resolution (FAX has approximately [illegible] the resolution), gray-scale range (any hard-copy has a much more limited tonal range), and transmission time (SSTV is two to four times faster per image).

Resolution differences between slow-scan and facsimile end-instruments may be somewhat misleading. A zoom lens on [illegible] SSTV video camera can effectively increase the resolutio[illegible] of transmitted information by utilizing the inherent re[illegible]tion of the camera on a smaller area of interest, such as a portion of an x-ray. This approach is not possible with existing facsimile equipment. The gray-scale limitations of facsimile equipment are largely due to the print material used for the hard-copy output. Work has been done using a film medium for the hard-copy and this significantly enhances the gray-scale reproduction capability for x-ray use.

The current cost of a high-quality, medium-resolution slow-scan transceiver terminal is between $15,000 and $19,000. The cost of a standard facsimile transceiver is approximately $3,000. The cost of a high-quality facsimile terminal is $8,000 for a transmitter and up to $18,000 for a receiver. Transmission of very high-quality facsimile could increase the transmission time by a factor of four to six compared to standard facsimile.

The very limited research done to date comparing slow-scan television to live television tends to show no significant difference in the utility of live television with respect to remote diagnosis, if motion is not a significant element in the diagnosis. Furthermore since slow-scan television uses the dial-up telephone system for transmission, it offers greater flexibility than live television which must utilize point-to-point transmission systems. In a system based on compatible slow-scan television transceivers, any terminal can interact with any other terminal, over the telephone, as the need arises.

Some of the capabilities of currently available slow-scan television systems are shown in Table 7. This table indicates the characteristics of various models, including resolution, gray-scale, storage mode, transmission time, and approximate cost.

Applications. In patient-care applications, slow-scan television provides a logical mechanism for transmission of x-rays, pathology slides, and similar fixed-frame visual information, as well as patient views. Present systems use black-and-white transmission, with one exception.* The absence of color provides no limitation on x-ray transmission, but may prove somewhat limiting for pathology applications which are highly dependent upon (artificial) color information from staining. To date, there are indications that color may not be essential even in pathology studies where it has become the standard presentation format. However, no systematic investigation of the effect of color on pathology diagnosis has been attempted.

There have been several applications of slow-scan television for x-ray transmission. A two-year, NCHSR-sponsored program in Nebraska involved the use of developmental slow-scan equipment for the transmission of x-rays from Broken Bow to Omaha in order to obtain radiology consultation services. The results indicated that teleconsultation, even with degraded transmission, was more satisfactory than local interpretation by non-radiologists.[23] A Navy program has successfully utilized a moderate resolution slow-scan television system to assist in medical consultation between non-medical personnel on-board ship and medical personnel on shore.[9]

*A digital, full-color, slow-scan television system has been built by Nippon Electric Company (NEC). It costs approximately $21,500 per terminal for the scan converter and single-image storage memory. This cost does not include the significant expense of color cameras and monitors.

Table 7
Summary of Some Slow-Scan and TV Devices

	STORAGE MODE	PICTURE ELEMENTS VERTICAL x HORIZONTAL (Pixels)
TRANSCEIVERS		
Colorado Video Model 280	Digital (RAM)	256x256 (fast) 256x512 (slow)
NIPPON Electric 754 TVS	Digital (RAM)	262x226
Robot PLTV 530	Digital (RAM)	128x128(4)
RCA Video Voice(5)(6)	Storage tube	480x256 (fast) 480x512 (slow)
Westinghouse Medim II(8)	Disc or digital	480x540
TRANSMITTERS		
Colorado Video 260B(9)	Digital (RAM)	256x256 or 256x512
Robot PLTV 520	Digital (RAM)	128x128
RECEIVERS		
Colorado Video 275	Digital (RAM)	256x256 (fast) 256x512 (slow)
Robot PLTV 510	Digital (RAM)	128x128
FRAME FREEZERS(10)		
Hitachi MS-100 (1 TV field)	Magnetic disc	240x512
Colorado Video MS-200 (1 TV frame)	Magnetic disc	480x512
Hughes 639H	Storage Tube	810x1080
Princeton Electronics PEP-400	Storage Tube	810x1080
Arvin/Echo VDR-IR (200 TV frames)	Magnetic disc	480x540
VAS (100 TV Frames)	Magnetic disc	480x540

(1) Cameras and monitors limit the range of gray from black to white to 8 or 9 shades for all systems
(2) Assumes 300 to 3,000 Hertz bandwidth telephone lines
(3) NEC uses delta or differential gray scale encoding from bit to bit to obtain approximately 8-bit gray scale
(4) Robot systems have a square image format (i.e., 1:1 vertical to horizontal ratio; all other systems have 3:4 vertical to horizontal ratio.)
(5) RCA Video Voice available only as surplus equipment; no longer supported by manufacturer

GRAY SCALE[1] (Black to White Quantization)	TRANSMIT TIME[2] (seconds/frame)	APPROXIMATE COST ($)
64 steps	34 seconds	$16,000
256 steps	78 seconds	
8 bits effective (4 bits[3] data)	30 seconds	$17,500
16 steps (4 bits)	8 seconds	$ 1,695
Continuous (analog)[7] limited only by noise	30 seconds 55 seconds[5]	$ 1,500
10 bits, limited by noise[7]	120 seconds	N/A
64 or 256 steps (6 or 8 bits)	34 or 78 seconds	$ 1,500 (6 bit) $ 2,000 (8 bit)
16 steps (4 bits)	8 seconds	$ 1,545
64 steps (6 bits)	34 seconds	$12,000 (6 bit)
256 steps (8 bits)	78 seconds	$14,000 (8 bit)
16 steps (4 bits	8 seconds	$ 1,395
Continuous (analog) limited only by noise	N/A	Not commercially available
Continuous (analog) limited only by noise	N/A	$ 2,000
Continuous (analog) limited only by noise	N/A	$ 4,500
Continuous (analog) limited only by noise	N/A	$ 4,000
Continuous (analog) limited only by noise	N/A	$10,000
Continuous (analog) limited only by noise	N/A	$ 9,000

(6) Camera subject must be stationary for high-resolution transmission

(7) Continuous or analog signals have electrical "noise" superimposed on the information signal; in an image, noise looks like the "snow" seen on a television set when a weak signal is received; it may vary from the barely perceptible to the extremely obvious

(8) Westinghouse equipment still undergoing development; specification subject to change or modification

(9) CVI 260B must have stationary image or use a frame freezer to stop image movement during transmission

(10) These devices are used for auxiliary storage of video frames; they must be used with a slow-scan transmitter or receiver for telecommunications

In a NASA-sponsored study of the effects of reduced resolution on x-ray diagnostic accuracy, researchers obtained results that are applicable to slow-scan television.[24] These results, although somewhat limited in the number of observers and the lack of gray-scale reproduction capability, indicated that resolutions in the order of 200 to 300 lines were sufficient for consistent diagnostic agreement over a wide range of conditions.

At least one practicing radiologist has incorporated slow-scan television terminals into his regular consulting practice and has placed a terminal in his home.[25] These terminals permit preliminary diagnoses to be made remotely. The actual films are read later for verification. Results to date have been reasonably satisfactory, despite technical limitations of the hardware.

MITRE has investigated the applicability of telecommunications-based technology for supporting non-physician providers in isolated rural areas.[26] Analyses suggest that the use of slow-scan television, for applications including x-ray transmission and patient viewing, has a significant potential to increase the range of primary care problems that can be handled by a non-physician provider without patient referral. Cost-performance analyses of such systems show reduced patient cost and time per episode. Investigations of physician-to-specialist referrals in rural Kentucky indicated that the local physicians believed a high percentage of their referrals also could be avoided using slow-scan television.[5]

MITRE has recently installed slow-scan television systems for two Health Underserved Rural Areas (HURA) projects. One of these applications links a nurse-practitioner-staffed rural clinic at Blue River, Oregon, with a hospital in Eugene.[27] The other connects an osteopath's office at Block Island, Rhode Island, to the Rhode Island Hospital in Providence in order to facilitate consultations for the doctor on Block Island.

The potential applications of slow-scan television systems are not limited to patient care. Sites equipped with slow-scan television terminals can use them for administrative and educational purposes, as well. Remote certification of Medicaid eligibles decreases verification of billing information, and supporting verbal descriptions and directions with diagrams and pictures are instances in which a video capability could enhance administrative activities.

Slow-scan television already has been used successfully for educational purposes. Courses have been given at Northwestern University to demonstrate and develop educational techniques using this medium. Slow-scan television was used like a remote viewgraph or slide projector and thus did not require significant revision or development of educational materials. The approach was also acceptable to students. They regarded slow-scan television as providing the same effective capability as closed-circuit television.[28]

Despite the considerable advantages offered by slow-scan television, operational experience with this type of equipment is relatively limited in the medical field. Resolution and gray-scale limitations will undoubtedly restrict its utility in some applications. However, its demonstrated capabilities; its continually improving cost and quality characteristics, because of new solid-state and digital techniques; and its utilization of the switched telephone network clearly point to slow-scan's importance as a potentially cost/effective telehealth technology.

Patient-viewing Video Devices

"Patient-viewing video device" is a term used to describe an equipment class that permits the viewing of body orifices using fibreoptic techniques. Cold light is supplied for illumination and an image is brought to the camera via a bundle of many flexible optical fibers. Such devices are related to the patient-viewing microscope and similar diagnostic instruments that permit interior body views. The NASA/HEW Papago Program, STARPAHC, uses a patient-viewing microscope coupled to a live video transmission system, in a mobile clinic environment.[1] There are initial indications that such technology could facilitate remote physician consultations to rural clinics employing non-physician providers. This is particularly the case for consultation in conjunction with upper respiratory infections and ear problems.

Standard fibrescopes, which are hand-held viewing systems with flexible fibreoptic probes, can be coupled to a standard endoscope, otoscope, or nasal speculum for a less expensive and less complex body-orifice viewing capability. Since the images developed by such devices are of interest primarily as single frames of information, these devices appear to be highly suited for use with slow-scan television. To date, test results have been less than satisfactory because of image-quality problems. Current cost estimates begin at $6,000 including the necessary video camera coupling.

Examples of End-Instrument Configurations

There are a very large number of potentially viable combinations of equipment and techniques. In this section, selected combinations are illustrated in a very simplified form. These illustrations are intended to show how a more complex information system can be designed from the simple building blocks previously described.

A simple one-way video, two-way audio system is shown in Figure 7. This combination has often been used in telehealth systems.

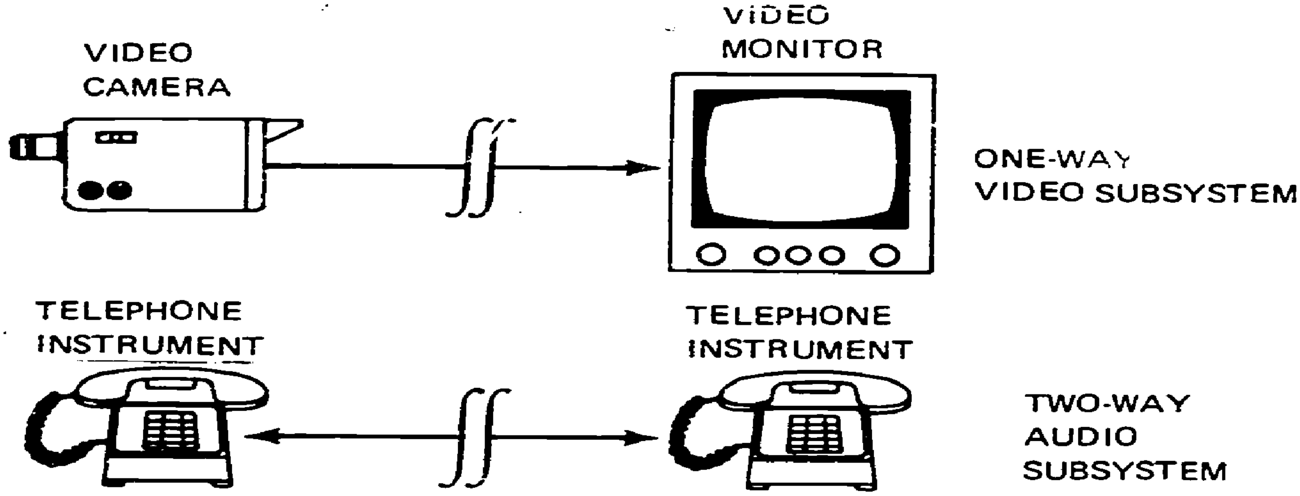

Figure 7
Video and Audio System

The video subsystem consists of an input device (camera), a transmission line (coaxial cable or microwave radio link, illustrated by ∫∫), and a display device such as a video monitor. The audio subsystem may utilize two telephones (speakerphones may be used for hands-free operation); or a microphone and speaker combination (not shown) may be used at each end. Both telephone and microphone speaker audio systems have been used successfully in existing telehealth applications.

A tape recorder, although not shown in Figure 7, may be used as a storage device at either the transmitting or receiving end to record either audio data alone or audio and video data. The extent of recorded information within a telehealth system depends upon the wishes of the users.

Figure 8 illustrates character-oriented (alphanumeric) devices. For record or hard-copy, commonly used devices are an input keyboard and an output printer. Although the figure shows one-way (simplex) devices, it is far more common for each end-instrument to have both a transmit and receive capability. If this is the case, the devices must take turns transmitting and receiving (half-duplex). Data also may be sent and received over narrowband lines from a computer. The output terminal may produce hard-copy or soft-copy such as a CRT display. Data terminals are becoming extremely sophisticated in their storage and computing capabilities, as well as in their processing. The cost of computers and "smart" microprocessor-based terminals is decreasing rapidly. In future publications, MITRE will provide considerably more information concerning computer technology applications in rural health systems.

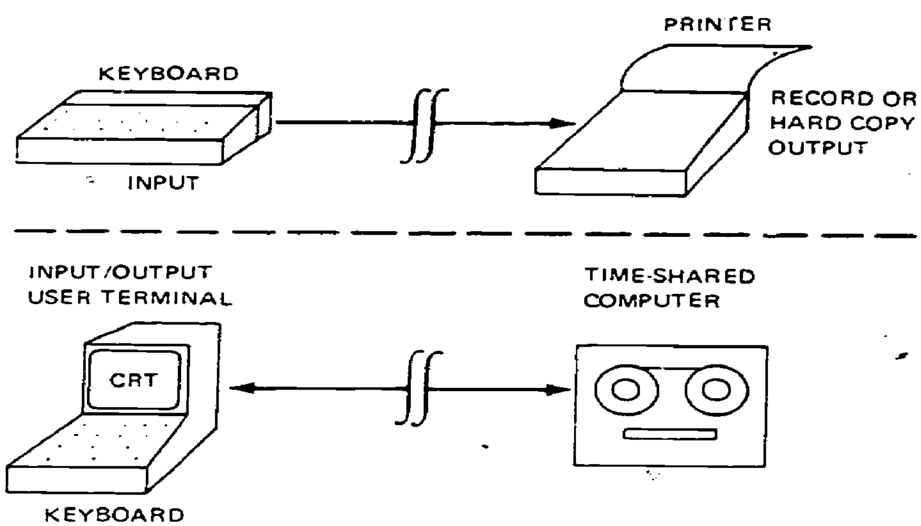

Figure 8
Data-Oriented End-Instruments

The telephone, an audio-end-instrument, is shown in a simplified system form in Figure 9.

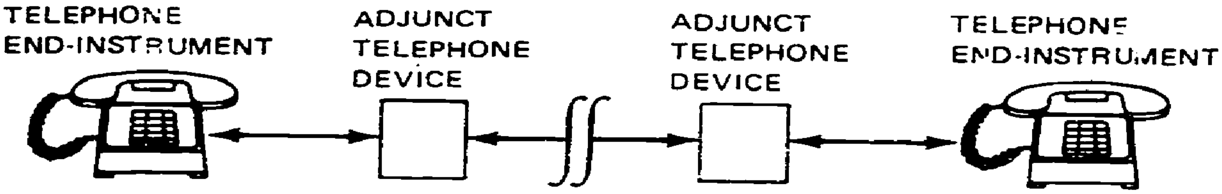

Figure 9
Two-Way Audio System

The telephone instrument may be coupled with a wide variety of adjunctive devices, a number of which are described in Section 4. These devices do not modify the basic speech communication function, but provide for interconnection, switching, storage, and extension of the telephone end-instrument.

The radiotelephone will provide a very similar function, whether it is a private system or a service provided by common carrier. The major exception is that radio communication is one-way-at-a-time, and also some of the telephone adjunct services are not available.

The telephone instrument also may be used as a transmit or receive device for telemetry. In Figure 10 the telephone instruments are used to couple telemetry end-instruments with a narrowband telephone link.

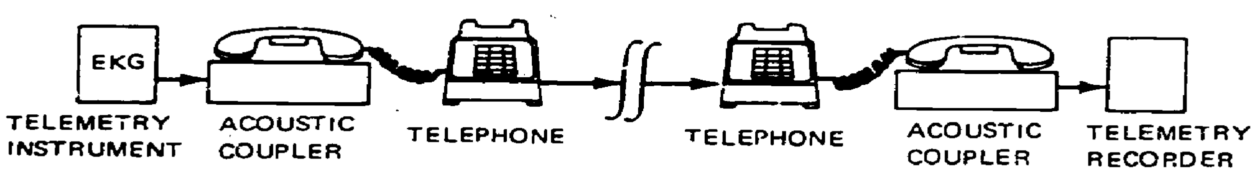

Figure 10
Acoustic-Coupled Telemetry

The system illustrated in Figure 10 shows three end-instruments--the telemetry instrument, the acoustic coupler, and the telephone instrument. Each of these performs a different function, however, and this seemingly roundabout way of transmitting telemetry is really quite cost-effective in terms of simple, reproducible interfacing between pick-up and the communications link.

Figure 11 shows facsimile and slow-scan, two kinds of end-instruments that allow communication of visual information over narrowband transmission lines. Facsimile requires hard-copy input and produces hard-copy output. Most models are combined transmitters and receivers (transceivers). However, new high-speed, high-picture-quality models are either transmitters or receivers, not transceivers. Regardless of the model, facsimile systems operate in a half-duplex (one-way at a time) mode.

A slow-scan system of image transmission may be one-way, as shown in Figure 11 or two-way. If the subject is motionless (e.g., a photograph or an x-ray), storage at the transmitter end is not required. However, there must be storage of the complete picture at the receiving end. The scan-converter at the transmitter end accepts a standard video camera signal as input and produces a narrowband signal as output to the telephone line. The scan-converter at the receiving end functions in exactly the reverse manner.

New technology in the area of picture element storage, by far the most expensive part of the slow-scan system, may bring about a marked reduction in storage costs. Devices are being considered to interface video camera input to a system that provides a facsimile-like hard-copy output. However, such combinations are not yet commercially available.

Figure 12 illustrates three systems that use different medical-specific end-instruments as input to a video camera. The inputs are a trinocular laboratory microscope, a fibreoptic probe (with appropriate speculum attached), and a fibreoptic coupled patient-viewing microscope (PVM). The video output from the camera may be transmitted in real-time on a broadband communication link, or a single frame of the video may be fed into a slow-scan television system and transmitted slowly over a narrowband channel. Normally there would be a two-way audio link associated with each video system. These three systems can transmit images that cannot be readily viewed by the unaided eye. However, their utility has not been investigated outside the laboratory.

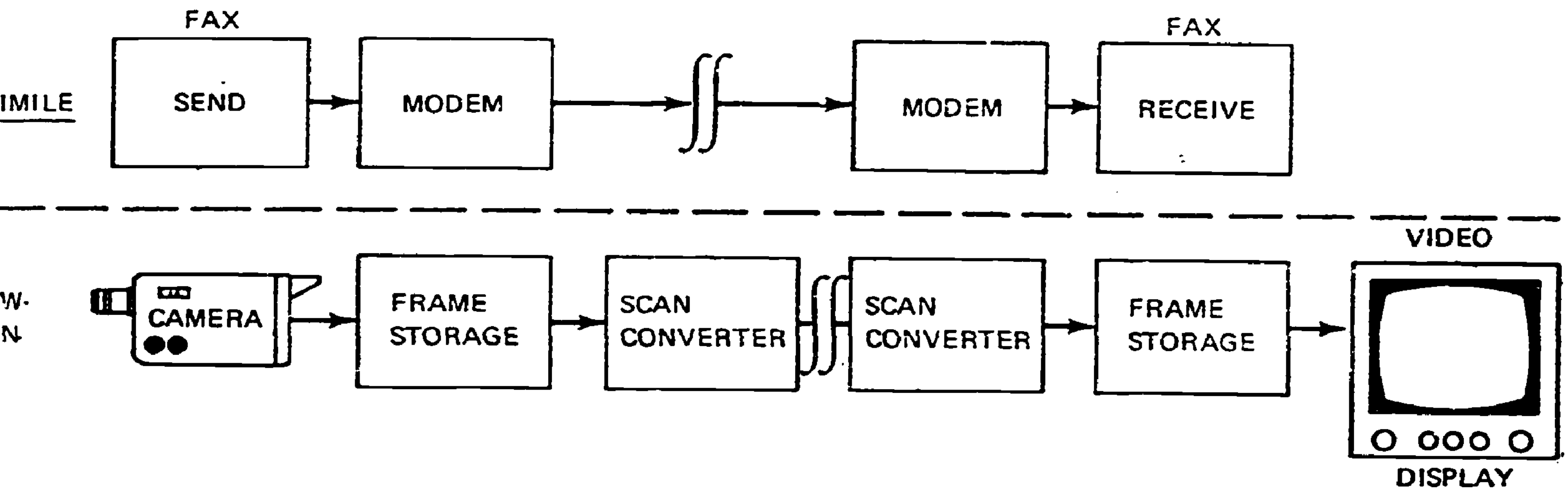

Figure 11
Facsimile and Slow-Scan End-Instruments

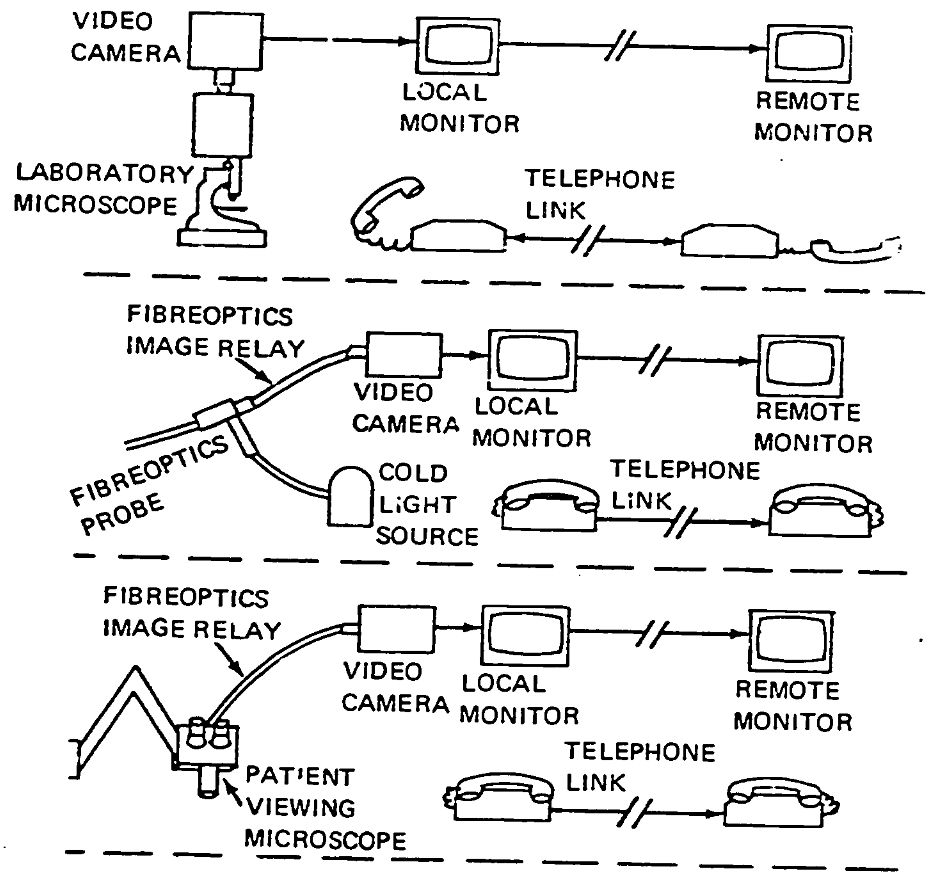

Figure 12
Some Medical-Specific End-Instrument Systems

This section and the previous one have discussed the transmission systems and end-instruments that are the technical components of telehealth systems. Their characteristics, advantages, disadvantages, and potential have been described in relation to the functional application areas of patient care, administration, and education. The following section discusses selecting and assembling a telehealth system from among these components and attempts to provide guidance in determining whether or not a telehealth approach is appropriate or feasible in a particular operational situation.

6 TELEHEALTH SYSTEM IMPLEMENTATION

The previous sections described telehealth technology and its application in patient care, education, and administration. The purpose of these sections was to indicate what *could* be done. The purpose of this section is to deal with what *should* be done -- in other words, deciding whether telehealth approaches would help to strengthen a particular health care system.

In considering the question of telecommunications' advantages in rural health care delivery, telehealth system design factors must be addressed simultaneously. One must first assess the structure, needs, and problems of a health care system and then consider design alternatives in determining whether telehealth appears to be a sufficiently attractive solution compared to conventional approaches.

Ideally, specific telehealth systems would be defined as appropriate for particular health care system models. However, as enticing as "standard" system design might be, they probably will not work in practice. The unique needs of different settings and situations, and the values placed on specific capabilities, make the use of "canned" solutions inappropriate.

Improving health care delivery in isolated, low-density agricultural areas is very different from improving health care delivery in rural vacation areas with great seasonal swings in population. Some health care systems may be concerned with providing basic preventive and acute care services because they do not currently have such services; others may want to focus on the incorporation of specialists' services in areas having only a primary care capability.

This section concentrates on the *process* of formulating telehealth alternatives and assessing their desirability for individual situations.

Defining and Evaluating the Telehealth Alternatives

The process of defining and evaluating telehealth alternatives may be considered in terms of the five-stage process illustrated in Figure 13. This process need not be rigidly adhered to, but each stage should be given conscious consideration. The characteristics of a particular situation may permit simplification of some stages.

Stage I: Determination of System Requirements

The initial stage in determining the desirability of a telehealth system considers what the potential system must be able to do, and how well it has to do it. Three types of requirements must be defined: functional, structural, and performance.

Functional Requirements. Defining functional requirements is a matter of determining what types of clinical, administrative, and educational applications will be performed by a telehealth system. If a physician-based practice wants telehealth support for specialist consultations, then the types of specialists' services (e.g., radiology, cardiology, pathology) should be identified along with the types of specialty cases for which support is desired. This approach is required in order to define what type of information would be transmitted over the communication links.

Structural Requirements. Structural requirements refer to the number and location of participants in the telehealth network. If a non-physician provider-staffed rural clinic is to be linked with a physician's office, the network may consists of two points -- the rural clinic and the physician's office. In a slightly more complex system, the network may consist of a clinic and several physicians offices and/or hospital locations. The network structure must be identified to determine how many links will be needed and what functions (information transfers) are associated with each of the links in the network.

In the case of networks of hospitals, different locations within a hospital should be identified. Situations might arise when consultations are needed from physicians in several departments of a hospital. This would require information transfers to individual departments in one hospital and perhaps to consultants located at another hospital. These structural considerations are important in estimating the costs and operating complexities of a potential telehealth system.

Performance Requirements. Performance requirements usually are stated in terms of accuracy, response time, error rate,

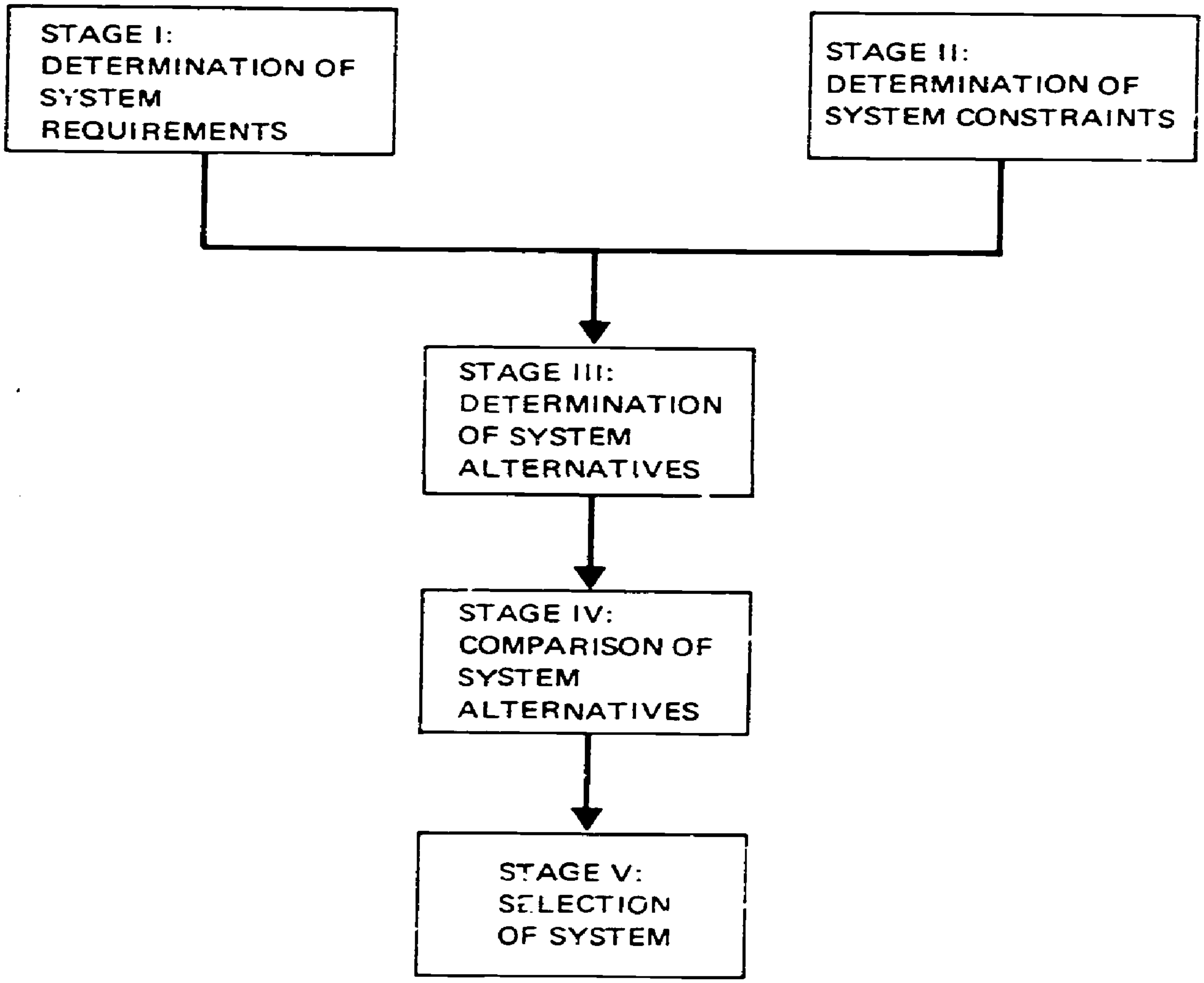

Figure 13
Determining the Desirability of a Telehealth Approach

resolution, and speed of image transmission. The minimum capability requirements for each link and end-instrument in the potential telehealth network must be defined. Also, the capabilities of the persons using the telehealth system play an important role in defining performance requirements. For example, the performance required of a telehealth link connecting physician specialists to a family practice physician might be different than if that link were connected to a nurse practitioner or emergency medical technician. The observation and processing capabilities of the people should be considered in defining performance requirements of a telehealth link.

Data Collection for Determining Requirements. The best approach for determining functional, structural, and performance requirements for a telehealth system is to collect data concerning the needs of the current health system. These data should be based on actual activities within the current system and may include a log kept by the health care providers concerning additional linkages or support that would have been useful.

Table 8 contains a fairly comprehensive set of data that might be collected by a health care system in order to determine its requirements for telehealth support. The data indicated in the table range from simple identification and summaries of the types of cases and patients seen to logs of consultation support obtained or desired.

If the information listed in Table 8 is complete and representative, telehealth requirements can be developed which accurately reflect the realities of the specific health care setting.

Stage II: Identification of System Constraints

The essence of this step is the recognition of inherent limitations on a potential system. These might include legal, attitudinal, and economic constraints. The most obvious types of constraints are those that may be imposed externally. For example, a state's laws regarding the use of non-physician providers may preclude certain telehealth approaches for isolated rural clinics. A related constraint might be telehealth's effect on malpractice insurance premiums. However, information inquiries to four operating telehealth systems by MITRE did not reveal rate increases as a result of patient care-related telehealth activities.

The attitudes of the community members and medical practitioners involved in a telehealth application could be a powerful constraint. Negative attitudes may gradually

Table 8
Detailed Site Data Collection

DATA ITEM	SOURCE	TELEHEALTH DESIGN RELATIONSHIP
1. Number of acute patient visits (by type of problem/diagnosis) a. Initial b. Follow-up – Scheduled – Unscheduled	EF*	Potential frequency of system use
2. Number of other visits (by type of service provided)	EF	Telehealth charge structure: potential system impact
3. Visit distribution by day of week, hours	EF	Communications need; impact on information storage
4. Number of referrals to other physicians or institutions (by type of physician or institution); type of health problem (diagnosis); home location of patient	EF/MR**	Identification of applicable technology; location and frequency of activity; additional patient expense
5. Number of telephone consultations by type of consultant, consultant location, health problem (diagnosis), and time of day; number and type of consultations associated with referrals	SL***	Potential application of technology; telecommunications link requirements; frequency distribution of interactions
6. Provider estimates of additional information transfers/exchanges (e.g., views of lesions, x-rays, heat sounds) that would facilitate/improve consultations in item 5 above; identify consultations associated with referrals	SL	Technology applicability and impact estimation
7. Provider estimates of information transfer capabilities (e.g., views of lesions, x-rays, heart sounds) that wou[illegible] referrals in item 4 above	SL	Technology applicability and impact estimation
8. Provider estimates of consultations that would have been attempted if specific information transfer capabilities (e.g., views of lesions, x-rays, heart sounds) had existed. Identify associated patient visits by diagnosis and time of day; provider locations and types; patient home locations	SL	Technology applicability and potential impact; telecommunication requirements

*EF = Encounter Form
**MR = Medical Record
***SL = Special Log

change through education and experience, but the development of a telehealth approach may be severely impeded until such barriers are overcome.

Most telehealth approaches are constrained to some extent by economics. This would include limitations on capital investment or operating funds. However, such constraints may be absolute or relative, as in the case of operating cost being offset by increased revenues or savings in other areas after the establishment of the telehealth system. This would be the case if the introduction of telehealth linkages brought new patients to a rural clinic.

Third-party reimbursement policies concerning non-physician providers and teleconsultations are probably the most critical economic/legal constraint on the telehealth field. The states' Medicaid policies vary, but generally they do not provide for reimbursement for services rendered by nurse practitioners and physician assistants, or for certain types of consultations.* Although some of these limitations are likely to change through legislative action in the near future, any relevant economic/legal constraints must be addressed carefully in considering the desirability of a telehealth system.

Stage III: Definition of Telehealth System Alternatives.

The first two stages in the process of defining and evaluating telehealth alternatives identify needs that should be met by the telehealth network and constraints on the manner in which these needs may be met. The third stage involves the definition of alternative technology approaches to satisfying the health system's needs. This requires information provided in earlier Handbook sections concerning communications systems and end-instruments, as well as the data collected in the process of determining telehealth system requirements.

For example, alternatives might be developed involving broadband and narrowband approaches for providing consultation/diagnostic support. Further, within each of the functional applications (patient care, education, and administration), different levels of capability might be identified. Consideration could be given to a capability for (1) voice communication only, (2) voice plus data/telemetry, (3) voice plus data/telemetry plus video, or (4) voice plus data/telemetry plus video plus body orifice viewing. The level chosen affects the type and degree of consultation/diagnostic assistance that can be provided as well as system costs.

*Teleconsultations suc as remote EKG interpretation are currently reimburse .

Non-telehealth alternatives also should be identified and included in all analyses of the relative advantages and disadvantages of telehealth approaches. For example, the alternative to telecommunication-based linkages between a rural clinic and a remote source of specialist assistance might be the provision of a mini-bus service to transport patients. Another alternative might be the periodic importation of such specialists for the operation of scheduled specialty clinics. Each of these alternatives has different operational characteristics, costs, and abilities to satisfy needs of a problem situation. The purpose of the next stage in the process is the comparison of such alternatives.

Stage IV: Comparison of System Alternatives

Once a set of alternative approaches has been assembled, the next step is to compare the capabilities of these alternatives as a prelude to the selection of a specific solution. The alternative systems should be compared along a number of dimensions. The first dimension of comparison is that of functional performance. The term "functional" is emphasized to distinguish it from "technical" performance.

Functional Performance Capability. Functional performance refers to the capability of a particular configuration to satisfy the application needs of the system, whereas, technical performance refers to such characteristics as resolution, gray-scale, and transmission rates. It is not necessarily the absolute technical capability of the configuration that is most important in comparing telehealth systems. Rather, it is the capability of the entire configuration and how it is used operationally to satisfy functional needs that should be the primary factor in selection of a configuration.

Therefore, two telehealth configurations may be compared which utilize different video transmission systems, one of which has a higher resolution and gray-scale range than the other. However, if both of these video transmission systems provide sufficient resolution and gray-scale range for the intended need (e.g., x-ray viewing, dermatology examinations, and EKG transmission), their functional performance capabilities are equivalent with respect to the needs of the system. A greater technical performance capability of one of the systems would be relevant to an extension of the system's use into new application areas. Therefore, this factor should be taken into consideration under the heading of "flexibility" or "future expansion capability" of the configuration but it is not relevant to current functional requirements.

A similar situation exists in comparing the capability of two interactive broadband television systems for continuing education purposes when one is a color system and the other is black and white. One should examine whether the absence of color restricts the types of educational programs that can be conducted. This is the functional performance capability that is important for comparing the two systems.

In comparing functional and technical performance capabilities of alternative configurations, the *performance of the entire configuration* that is being compared, not simply the capabilities of specific components within the configurations. For instance, suppose two configurations are compared which utilize video transmission for the transmission of x-rays. A zoom lens may provide enough enhancement in effective functional performance to make a lower resolution system as effective as a more expensive system with higher resolution. This presumes that there is some level of visual quality of the transmitted image that is sufficient for the diagnostic purpose, and that any increases in visual quality beyond that level are diagnostically unnecessary even though they may be emotionally appealing.

The human component of the telehealth system can have a notable effect in modifying the functional performance capability of the system. For example, the use of medical or skilled nursing personnel to describe color characteristics of dermatologic conditions, or shading of microscope slides, may largely preclude the need for color transmission of certain types of images and thereby significantly reducing the cost of the required video system. In fact, viewing the telehealth system as a means of supporting and augmenting the verbal information provided by trained medical personnel may be the most realistic manner of assessing the place of a telecommunications system in the consultation/diagnostic process.

Since a telehealth system provides for enriched information flow between users, the time required to accomplish that information flow may be significant. Therefore, the *total time* required by each alternative telehealth configuration to meet the functional needs of the system must be considered. If two telehealth configurations are being compared, one which utilizes slow-scan television with an 8-second picture transmission time, and the other which utilizes a slow-scan television system with a 78-second transmission time, this difference must be noted and its significance considered as part of the determination of functional performance capability. Depending on the functional requirements, a lower quality picture may be sufficient if it can be delivered quickly.

An excellent example of this type of situation occurs in the teleconsultation services provided by Marine Medical Services to the tuna fleet on the West Coast.[29] Communication with the tuna vessels is maintained by HF radio circuits which share communication channels among many users. Those channels are subject to frequent interruption and poor quality due to signal fading and interference and video transmission of a minute or more could not be adequately maintained. Teleconsultation via slow-scan television provides diagnostic services to these vessels by means of equipment requiring only 8 seconds for a single picture transmission. Even though the picture quality (resolution) of this equipment is inferior to that provided over other (slower) types of slow-scan systems, time is the relevant criteria in meeting the functional needs of the user.

In some cases, difference in transmission time between different configurations, may be of no importance. For example, assume that two alternative telehealth configurations used for administrative functions are being compared. One configuration can transmit the data at high rates; the other must use a much lower data rate. Assuming the major goal of the data communication system is to complete a transfer of medical record information, the time difference involved might not be significant. A dedicated line exchanging the data may be used to transmit at the end of the working day directly into a central computerized record system. In such an application, the cost associated with the two transmissions [illegible] not be different, and since machine-to-machine communication is involved, there is no time penalty such as a user delay in acquiring information.

Finally, *total* time must be considered in making time comparisons. If significant set-up times are associated with one telehealth alternative, this distinction must be included in time comparisons. One example of this situation is the use of real-time television in a hospital setting where a single location must be maintained for all system users. In such a situation, when a call comes in for a teleconsultation, the consultant may require considerable time to get t the television room. This delay in access time, and its disruptive consequences, should be considered in comparing the time response of alternative configurations. In contrast, if terminals can be placed in several locations, it may be possible to reduce or eliminate such delays.

Financial considerations constitute another dimension for comparing alternate telehealth configurations. This includes both cost and revenue-generation factors. The first cost concern is that of capital investment. Different configurations will, of course, require different capital investments. The second cost component is that of operating costs. Again, different configurations will generate different operating costs.

Capital investment costs include the costs of end-instrument equipment, communications equipment, and facility construction or modification. Initial assessment of the first two capital investment categories can be obtained from material contained in this volume. The last category is dependent upon specific local conditions.

Since capital investment requirements preclude initiation of the project, consideration should be given to lease versus purchase approaches to the acquisition of capital equipment, or to financing arrangements which might lower the initial outlay. Where such arrangements are utilized, the amortization and debt payments associated with the purchase of the capital equipment may be handled as part of the operating cost comparisons.

Operating Costs. Costs generally include the categories of transmission, equipment maintenance, personnel, facilities, and utilities. The last three categories are only indirectly related to implementation of a telehealth system, and it is important to point out that in estimating operating costs associated with the technology system, only the charges that are directly attributable to the system should be included in cost comparisons of alternative configurations.

Transmission costs are uniquely associated with telehealth information exchanges. These costs include such items as the telephone charges associated with the establishment of a narrowband telehealth network. Maintenance costs may be estimated as a percentage of the cost of capital equipment, when more specific information relative to the cost of a maintenance contract for a specific configuration is not available. Current technology, which involves largely solid-state techniques, should yield average annual maintenance costs somewhat less than five percent of equipment cost. This may differ significantly if equipment is mobile or subjected to severe environmental extremes.

In economic terms, the proper way to compare the costs of alternatives would be to compare the present values of the future cost streams associated with each alternative. This would take into account, in terms of current dollar values, the capital, operating, maintenance, and replacement costs of the equipment associated with the configurations. This permits comparison of configurations having different replacement cycles as well as different initial and recurring costs. Such a detailed comparison probably is not warranted in the initial consideration of a telehealth application, but it should be undertaken if major network investments are being considered. Such comparisons can also include tax aspects of the capital investment and recurring costs.

Comparison of the revenue generating capability of alternative configurations is the other major element in the financial dimension. First, different configurations may facilitate different ranges and volumes of services and thereby generate different total revenues. Second, although not considered as direct income generation, different ranges of capabilities may permit other costs within the system to be deferred. For example, in considering the alternatives of real-time interactive television and slow-scan video, differences in revenue generating capability might exist. The more expensive real-time interactive television could be used for a wide range of continuing medical education purposes in addition to its patient care uses. In contrast, the slow-scan system would be limited to individual fixed images much like a remote slide projector. Similarly, the real-time interactive system might attract other educationl and training services not related to the health function and these could be used to generate income. However, the slow-scan television system might be able to reach a wider potential audience because it can use the telephone distribution network rather than requiring a fixed microwave transmission system.

The same income generating aspects of these two configurations would have different effects on cost deferral. The real-time interactive system, because of its greater range of applications, may result in reductions in travel and non-productive time. However, administrative applications of the same two transmission systems for purposes of transmitting images of documents would involve no cost savings differences, despite the higher information rate involved in the real-time system.

When looking at the cost deferral aspects of alternative configurations it is important not to credit higher capability systems with reductions in costs that would not normally be incurred. For example, if the alternative to education programming over the real-time system would be no investment in that educational function at all, then costs associated with travel to obtain the education are not really "cost savings". Cost savings can be credited to the telehealth configuration only if the educational program would have been undertaken in the absence of the telehealth system.

Other Factors. A number of other capabilities should be considered, although not to the same extent as the preceding ones, in comparing alternative configurations. These include such factors as:

1. Flexibility of Application - What other functions can be performed with a given configuration beyond those included in the list of functional requirements?

2. Reliability - Are any of the configurations likely to be subject to problems of equipment reliability or tranmission link performance?

3. Developmental Risk - Is any of the equipment in the alternative configurations likely to require development activity before they can be installed?

4. Maintainability - Are any of the configurations likely to be subject to significant maintenance problems, e.g., spare parts, or contracting for services, or training of local personnel?

5. Training Requirements - Do any of the configurations represent significantly more difficult requirements in operating skills which might cause training needs or user acceptance to become significant problems?

6. Privacy - Do any of the configurations present significant risks of violation of personal privacy?

7. Growth Potential - Do any of the configurations offer significantly more or less capability for future expansion into other application areas?

The above factors can be reviewed initially by simple consideration of whether gross significant differences occur. At an early stage of comparison, only major distinctions in these factors are worth concern compared to differences in the major dimensions discussed above.

Stage V: Selection of System Approach

Although previous discussions addressed various methods for comparing features of telehealth alternatives, there is still a need to select the "best" alternative approach. This somewhat imprecise word, "approach", indicates, at this preliminary stage, that definitions of alternatives are somewhat unprecise. That is detailed design analyses, specification, and installation cost estimates have not been made to the extent for detailed budgeting, ordering of equipment, and implementation planning. Therefore, to speak about the selection of alternative "approaches" is to remind the reader that small differences between alternatives at this stage are likely to disappear when detailed design and implementation stages are reached.

One of the alternative approaches to be considered is the approach that involves not using telehealth. Even though it may have some attractive features and benefits, in some situations telehealth simply may be too expensive or insufficiently relevant to high-priority needs.

However, a decision not to use telehealth does not necessarily mean doing nothing. Procedural and organizational changes in the health care delivery system may provide significant benefits when they are appropriately used. The frequency of need, the immediacy of consultation problems, the likelihood of patients returning to the local center to participate in specialty clinics, the availability of specialists traveling to remote locations, and similar alternatives should be reviewed in comparing such approaches with telehealth. They must be considered as part of the process of determining whether or not to proceed with telehealth.

Initial Questions. First, one must consider whether the capital investment costs associated with the various telehealth approaches are affordable. In other words, is the cost of implementing a telehealth approach for the particular local situation beyond *reasonable* expectations of available capital? If the answer is "yes," this is the time to recognize such a situation and look for other ways of resolving health care delivery problems.

Does telehealth offer the only feasible means of providing essential services? If the services are vital, *some* means must be found to provide them. And if telehealth is the only *feasible* means of providing the services, then the problem becomes one of selecting among alternative telehealth approaches.

Most decision makers probably will find themselves somewhere between these two extremes; that is, some telehealth approaches are affordable and the services to be provided, while not absolutely essential, are highly desirable. Telehealth is probably not the only feasible approach, but it is an attractive one.

Eliminating, for the time being, alternative approaches that fail to satisfy basic performance requirements, it is often sufficient to rank the alternatives for each of the areas of comparison (e.g., functional performance, cost, and flexibility). Quite often a single alternative is a "dominant" solution; that is in most comparison areas it is as good as or better than other alternatives.

Where several alternatives seem attractive but none is dominant, the relative importance of the areas of comparison should be assessed. For example are cost or performance capability of much greater importance than other characteristics? If one of the alternatives is clearly superior in one or both of these areas, that alternative probably should be selected.

if clear-cut decisions cannot be developed in this simple manner, alternatives should be eliminated which are clearly less desirable than others until only two or three options remain. The remaining alternatives should then be subjected to closer scrutiny with the aid of professionals who are skilled in system analysis and cost-effectiveness techniques.

Example of the Selection Process

A simple selection process might occur in the following manner. A small group practice in a rural community requires specialist consultation services to support their ambulatory and hospitalized patients. Their principal needs are in the areas of radiology, cardiology, otolaryngology, and ophtalmology. The distance to the nearest community with specialists in these areas is approximately 80 miles, and transportation is sometimes complicated by severe weather conditions. The current approach of referring all patients requiring such services is unsatisfactory.

A non-telehealth alternative would involve a combination of several approaches referring patients whose treatment or consultation could not be deferred, scheduling periodic clinics in the local community for patients whose conditions permit some delay, and obtaining delayed consultations, by means of x-ray films and EKG records that are mailed to appropriate consultants for review.

One telehealth alternative being considered is the use of a slow-scan television system for consultation and diagnostic support via the telephone network. This system would permit transmission of heart sounds, EKGs, and video information such as x-rays and patient views. The alternative telehealth approach being considered would also utilize transmission of heart sounds and EKGs, but it would employ an interactive, closed-circuit television system using a specially constructed microwave radio system between an urban medical center and the local group practice.

Selecting among these alternative approaches might proceed by judging whether or not the non-telehealth approach would be sufficiently responsive to the time requirements of the local practice, and whether it would result in the loss of local patients whose needs are not met by the local system. Data concerning residents who avoid the local practice or who resist referral to outside specialists, would help in making this judgement.

When the two telehealth approaches are compared, both are found satisfactory with respect to functional performance capability. However, continuous frame (broadband) television system provides a sense of "presence" between the communicators, by providing continuous full-motion video and transmitting changing facial expressions and other forms of "body language". It has some additional capability for specialty consultations such as orthopedics and speech therapy that must show patient motion. Finally, slightly better resolution can be achieved and this results in shorter consultation times than one-frame-at-a-time slow-scan television.

The capital investment requirement for the slow-scan system is between $40,000 and $50,000, since it utilizes the telephone system for transmission and requires no capital investment in a communications network. The broadband system requires an expenditure of between $200,000 and $300,000, primarily to accommodate the construction of a microwave radio link between the urban community and the local practice

Operating costs of the narrowband system, which would include telephone usage charges and a WATS system charge, would be roughly equivalent to the operations and maintenance charges for the broadband communications system. Transmission of video images in the narrowband system would take approximately 80 seconds, compared to instantaneous transmission of video over the broadband system.

With respect to secondary level capabilities of the two approaches, the broadband system permits the transmission of continuous video communication with the local community for purposes of continuing education, administrative conferencing, and other health and social science services. The narrowband system would permit only single-frame video information to be transmitted to the local community. The areas of reliability, development risk maintainability, and training requirements are likely to be similar for both approaches.

Expansion of the narrowband system is simpler and less expensive than expansion of the broadband system because no communications system construction is required to initiate telephone-based activity at additional sites. New locations can participate in the activities of a narrowband telehealth system simply by the installation of end-instruments at each new site.

If the selection problem is addressed in terms of comparing the two approaches only on the basis of whether they satisfy the immediate needs of the rural group practice, then both would be considered acceptable. Both systems meet consultation needs in terms of minimum functional performance capability, although the broadband system would probably be more satisfying to the participants in an individual consultation.

They are "equivalent" in the areas of operations and maintenance costs. In terms of capital investment cost, the narrowband approach is considerably less expensive than the broadband approach.

Considering secondary factors, the two approaches are approximately equivalent in all areas except flexibility of application and growth potential. The broadband system has greater flexibility of application, but the narrowband system is significantly easier to expand.

In summary, both systems will perform the essential functions adequately but they differ significantly with respect to cost. Some secondary factors favor the narrowband system; other secondary factors favor the broadband system. Therefore, if a decision is to be made on the basis of major differences, the least costly alternative approach would be selected. Another line of reasoning would be to recognize the significant cost differential between the two approaches and to determine if the additional advantages of the broadband system could be considered sufficient to make up the significant cost difference. Unless cost is no object or there is a significant value placed on educational applications, the narrowband system is likely to be the preferred alternative.

This extended example is intended to illustrate a simplified selection process that first determines whether or not any particular solution tends to dominate all others. Next, a solution is sought on the basis of a major advantage in either functional performance or cost. And finally, based on specific needs and values of the potential user, any major advantage is balanced against less significant differences to determine whether they outweigh the major advantage.

If neither of these arguments yields an obvious answer, the alternatives are assumed to be relatively the same in performance and cost. In such cases, selections are going to be made on the basis of secondary factors. In the absence of characteristics that would tend to eliminate one alternative or the other, such as significant maintenance or reliability problems, the selection usually should be made on the basis of factors related to flexibility of operation and growth potential. The significance of these factors is influenced by local characteristics and must be determined by the judgement of the potential user. If an initial system capability is part of a larger, expanding system, growth potential might be given the most significant weight in the selection. If physicial expansion of the system is unlikely, then flexibility of application would be the more significant factor.

Obviously the selection process is not likely to be either straight-forward or tot·lly quantitative. Where the characteristics of alternatives do not dictate an obvious choice, the judgement of those who will be using and depending upon the system should be the determining factor.

7 PAYING FOR TELEHEALTH

Regardless of how capital funds for a telehealth system are obtained, provision must be made to amortize system costs, allow for depreciation and replacement, underwrite operational expenses, and pay for any other costs involved in using the system, such as the fees of consulting specialists.

Three fundamental issues arise in the consideration of payment alternatives:

1. Who incurs the costs involved in implementing and operating a telehealth system?

2. Who receives what types of benefits from the operation of a telehealth system?

3. What payment/reimbursement mechanisms seem appropriate and feasible?

Who Incurs Telehealth Costs?

At the present stage in the development of telehealth systems, the initial investment in a telehealth capability is assumed to be made by health care providers, either individual or in some form of joint-venture agreement. The providers may be individual practitioners, group practices, hospitals, nursing homes, community groups, or other organizations that could benefit from participation in a telecommunications-based health care network. Some funds currently are available from the federal government through research and demonstration grant programs investigating new approaches to health care delivery. Other federal and foundation sources may also exist, but such sources will be able to support only a limited number of new initiatives.

Telehealth operating costs depend upon the type of system being used and they may be incurred in several ways. Broadband telehealth systems are likely to involve significant

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capital investment for communications links. Since these links are fixed, the operating costs are likely to be incurred by the same individuals/groups who constructed the system.

In the case of narrowband telehealth systems that utilize the telephone network, operating costs for communications purposes may be incurred either by individuals initiating consultation requests or on a shared network basis, using WATS services. When telephone costs are incurred on a call-by-call basis, the person initiating the call generally will be charged for the cost of the individual communication. In the case of rural health applications, long distance telephone charges are levied on the one who initiates a consultation or administrative call. When a number of sites have jointly developed a narrowband telehealth network, WATS service may be utilized. This involves the sharing of telecommunications costs among network users on a formula basis. Educational application of telehealth may involve more complex cost incurrence for telecommunications because conference call arrangements would have to be utilized in order for all members of the network to be involved simultaneously. In general, however, the call initiator would incur the direct charge from the telephone company.

Costs incurred by patients would be a direct function of the charge structures established by health care providers in order to recoup the cost of establishing and operating the telehealth network.

Who Receives Telehealth System Benefits?

Telehealth benefits can be appropriately considered in terms of three groups -- patients, providers, and the health system.

Patient Benefits. If telehealth fulfills the expectations of its advocates and field experience is consistent with the results of analytic studies, telehealth should provide a number of important benefits to rural residents. If specialist care can be made available at the primary care level, then fewer patients should be referred to specialists. In turn this should mean fewer delayed and avoided consultations, which should result in less severe illnesses and, logically, reduced hospitalization. The ability to treat more complex cases at the local level also would increase the continuity of care provided to rural residents. An improved capability within local level health care systems should reduce the avoidance of assistance because of the expense and inconvenience involved. Most directly, the patient would not have to travel to other communities for the resolution of health care problems; and incur associated expenses such as lost wages and child care.

Provider Benefits. The local primary care provider can bring improved decision-making capability to bear on local health care problems through consultation with distant colleagues. This should reduce the sense of isolation and anxiety faced by many rural providers. In addition, provision for back-up assistance is easier with a telehealth system, and the resulting opportunity for increased leisure and educational activities should enhance providers' satisfaction in rural settings.

Telehealth also may improve the financial basis of the rural practice. The ability to deal with a broader range of health care problems at the local level may reduce the loss of patients to distant communities as well as permit local follow-up rather than continued interaction of local patients with distant providers. Telehealth may permit a rural physician or group practice to increase their "catchment area" through the establishment of satellite facilities staffed by non-physician providers. Also, the capability of telehealth systems may satisfy the requirement for the direct supervision of physician extenders now required by state Medicaid systems and/or licensing agencies. Finally, telehealth systems can provide for increased provider education, through both the process of consultation and the delivery of continuing medical education programs.

Secondary/tertiary care providers also may benefit from telehealth systems through an increased base of referrals and higher productivity because initial workups will be readily available from primary care providers. Further, teleconsultation will tend to reduce unnecessary referrals to secondary/tertiary levels. These factors, assuming availability of reimbursement may also improve the financial status at this level of operation.

Health System Benefits. In the larger sense, the entire health care system may benefit from the broad and appropriate application of telehealth systems. If telehealth systems are successful in permitting a wider range of cases to be handled at local levels, a general reduction should result in the cost per episode of illness. Should the benefits to local health care providers prove to be obtainable, significant improvements may result in the ability to attract and retain providers for rural areas.

What Are Appropriate Telehealth Payment/Reimbursement Mechanisms?

The technical feasibility of telehealth has been demonstrated in a variety of settings and applications. However, such systems will have little impact on the provision of rural health care if appropriate and reasonable payment/reimbursement mechanisms do not accompany the effective application of technology. Benefits can accrue only if telehealth systems are utilized, and utilization on a sufficiently broad basis will occur only if there are appropriate payment/reimbursement mechanisms.

The first and most critical question is whether or not reimbursement will be available from third parties for services provided using telehealth systems. Certain telehealth services are already being reimbursed and others have been indicated as "reimbursable" under current approaches and definitions. Remote reading of EKGs is regularly reimbursed under current third party systems and remote reading of x-rays has been characterized as "probably reimbursable". There is less willingness on the part of third party payors to reimburse for consultation services based on visual images of patients.

A lack of consistency exists in reimbursement policies because of the basic fragmentation of our nation's health care system. On the basis of limited evidence, it appears that the absence of reimbursement for telehealth services does not result primarily from the medical adequacy of the service provided, but from uncertainty as to the effect of teleconsultation reimbursement on the utilization of health care services.

Third party payors are concerned about the effect that teleconsultation might have on the utilization of referral services. Dismissing the possibility of excessive use of teleconsultation if reimbursement is widespread, short-term increases in total health care costs may occur before the potential longer-term benefits of such services are recognized.

Several effects on health care utilization are possible as a result of telehealth networks. Increases might occur in the incidence of consultation among primary, secondary and tertiary providers due to the capabilities provided by the telehealth system and to the availability of reimbursement for the provision of such services. Studies and surveys referenced above have indicated that the need for patient referrals to secondary and tertiary care levels would be reduced because telehealth linkages could be substituted for a substantial proportion of pre-telehealth referrals. However, there is uncertainty concerning whether the presence of telehealth systems might not also result in additional referrals that previously should have been, but were not, made.

At present, adequate information is not available regarding the effect of telehealth systems on utilization of health care services. The Health Underserved Rural Areas Program is sponsoring telehealth research that should provide significant information in the critical areas of utilization and reimbursement.

Assuming the availability of reimbursement, on either a regular or experimental basis, payment mechanisms and charge structures still must be developed. It seems reasonable to expect consultants to be reimbursed for telehealth consultations in the same manner as they would be reimbursed for physical consultation with patients. Charges would have to be established for teleconsultation activities that do not result in an immediate referral. Teleconsultations resulting in immediate referrals should probably be absorbed or included in the fee for a referral visit.

The remaining question is how the costs of the telehealth system should be recovered by the primary care provider. There appear to be basic approaches. First, the primary care provider charges a patient when the system is used in his behalf. This approach would treat the telehealth system in the same fashion as a diagnostic or therapeutic device such as x-ray or diathermy equipment.

The second approach would view the telehealth system as a general resource of the practice, similar to the telephone, sterilization equipment, or the blood-pressure cuff. The cost of the system would therefore be a part of the practice overhead.

The first approach levies charges on a patient from whom the system is used. The second approach includes a small charge in each patient's bill, spreading the cost of the telehealth system across the entire patient population. Both approaches have advantages and disadvantages.

Establishing a charge for the use of the telehealth system has the obvious merit that its use for a specific patient can readily be identified, just as it can be for the use of diagnostic or therapeutic instrumentation. Less obvious is how such a charge should be established and what effect it might have on the introduction and utilization of a potentially important innovation in health care delivery. Without some knowledge of the probable utilization rate for such equipment, it would be difficult to establish a reasonable charge on a per use basis.

Should a flat charge be levied on the basis of the occurrence of a teleconsultation, or should it be based on elapsed time or the number of transmitted images involved in the consultation? Will establishing a per-patient charge for the use of the telehealth system inhibit its use and thus impede its acceptance and the devel ent of creative applications? If the telehealth system is to be employed for administrative and/or educational purposes, what proportion of total costs of the telehealth system should be allocated to these functions and what proportion to patient-related consultation activity? These questions indicate the likelihood of somewhat arbitrary charge structures until additional experience has been gained with the utilization of telehealth s stems.

A telehealth system does not create new information or more precise information. Rather, it provides the capability to exchange information more efficiently and more broadly so that improved decision-making capability can be brought to bear for the benefit of the patient.

The telehealth system is very much like the telephone. It permits the exchange of information between providers of care for the benefit of the patient. Even though we could identify the fact that a particular telephone call was made in relation to a particular case, we do not attempt to charge patients for the use of the telephone. Instead, we include it as an overhead item in the provision of care. At the present stage of development of telehealth systems, rather than risking inappropriate charge structures and the concomitant possibility of impeding the growth of knowledge and skill in the utilization of telehealth, an approach similar to the one for telephone is recommended to cover telehealth costs. This issue may, and certainly should, be reconsidered in the future. However, considerably more experience should be obtained before attempting to develop a charge structure on the basis of individual patient use.

Field experience with operational telehealth systems will increase significantly in the near future, particularly experience with systems that utilize the telephone network for transmission. This handbook presents the current level of understanding of the critical elements and issues. It is a guide for proceeding into the future but it is not a definitive set of answers. Hopefully the promise of telehealth systems can be achieved through intelligent and appropriate applications, and that this volume will be useful in achieving that goal.

APPENDIX
TELEHEALTH PROJECT SUMMARIES

ALABAMA, ANNISTON

TITLE: East Alabama Rural Health Foundation

PERIOD: 1976-1979*

TECHNOLOGY: Computer, Telemetry

APPLICATION: rimary Care, Administration

The East Alabama Rural Health Development program was initiated to help alleviate the severe shortage of health care providers in a number of counties in Eastern Alabama through the establishment of nurse-practitioner staffed-clinics. These clinics are currently in developmental stages. The program proposes the eventual development of a computerized medical records and billing system to link the nurse practitioner-staffed clinics with each physician's office and a group physician practice. Currently, software is being developed and computer equipment has been installed in the group physician practice.

REFERENCE: Anderson, C., and W. Rappaport, <u>Technology Applications in Rural Health Care Systems</u>. MTR-7537 (The Mitre Corporation: McLean, Virginia, May 1977).[27]

CONTACT: Bill D. Stout, M.D.
P.O. Box 2127
1010 Christine Avenue
Anniston, Alabama 36201

*Future date indicates end of funding period.

ALABAMA, BIRMINGHAM

TITLE: MIST--Medical Information Services via Telephone

PERIOD: 1969-Present

TECHNOLOGY: Telephone--WATS, Centrex Tie Line

APPLICATION: Primary Care, Education

MIST is a telephone extension service of the University of Alabama Medical Center at Birmingham which brings the Center's resources to physicians and other health professionals statewide. While used by many health professionals, MIST is aimed at assisting physicians in their day-to-day care of patients. Many of the questions phoned in by physicians pertain to techniques, procedures, equipment, or services. In 1971, DATL (Dial Access Tape Library) was added for physicians and nurses. DATL is widely used by nurses for teaching conferences.

REFERENCE: Klapper, M. S., and I. B. Harper, "MIST--Observations and Trends." Journal of the Medical Association of the State of Alabama (April 1975).(13)

CONTACT: Margaret S. Klapper, M.D.
Director of MIST
Room 111, Mortimer Jordan Hall
University Station
Birmingham, Alabama 35294

ALABAMA, BIRMINGHAM

TITLE: On-Line Medicaid Billing System

PERIOD: 1971-1973

TECHNOLOGY: Telephone Equipped with Card-Dialers, Answer-Back Equipment, Computer

APPLICATION: Administration

The intent of this project was to provide an on-line statewide billing system for physicians' services. The system design provided for point-of-service terminals on-line to a central computer to reduce the costs of submitting claims from physicians' offices and preparing data for the carrier. Data were entered from the physicians' offices on standard Touch Tone[R] telephones equipped with card-dialers. Patient information and eligibility confirmation data were received from the central computer facility via voice answer-back.

REFERENCES: Mesel, E., and D. D. Wirtschafter, "Automation of a Patient Medical Profile from Insurance Claims Data: A Possible First Step in Automating Ambulatory Medical Records on a National Scale." Health and Society. 29-45 (Winter 1976).(38)

Mesel, E., and D. D. Wirtschafter, "Economic Analysis of an Automated Billing System for Physicians' Services." Medical Care. 14:1037-1051 (1976).(39)

CONTACT: David D. Wirtschafter, M.D.
Director of Clinical Information Systems
University of Alabama
809 S. 19th Street
Birmingham, Alabama 35294

ALABAMA, TUSKEGEE

TITLE: Tuskegee Telemedicine System

PERIOD: 1973-Present

TECHNOLOGY: Telephone, 2-Way Audio/Data

APPLICATION: Primary Care

The Tuskegee Telemedicine System provides health care services to a three-county area in southeastern Alabama. A total of seventeen community sites will be serviced by two mobile vans, each staffed by a three-member team including a nurse practitioner, a laboratory technician/driver, and a nutritionist who work with a community-based coordinator. Each van is equipped to transmit EKG tracings via telephone to the main clinic location to be read by a computer. The interpretations are then sent back to the mobile health unit. Additional equipment includes a facsimile for hard copy transmission and a telewriter that enables the Base Health Center physician to write remote prescriptions for on site field use.

CONTACT: Cornelius L. Hopper, M.D.
The John A. Andrew Clinics
Tuskegee Institute
Tuskegee, Alabama 36088

ALASKA, ANCHORAGE

TITLE: ATS-6 Satellite Advanced Health Care and Education--Alaska Health Experiment

PERIOD: 1974-1975

TECHNOLOGY: Satellite, 2-Way Black-and-White Television

APPLICATION: Primary Care

This project was designed to assess the potential of a satellite system for the presentation of health, education, and information programs. All four sites included in the project had local exchanges in addition to ATS-1 satellite radios which linked them to Tanana Hospital, Anchorage Medical Center, and other ATS-1 sites. Services included teleconsultation, the transmission of x-rays by the video capability, and EKG tracings over the audio channel. The demonstration also included the computerized patient record system, Health Information System (HIS), developed by the Indian Health Service.

REFERENCES: Boor, J. L., G. Braunstein, and J. M. Janky, "ATS-6: Technical Aspects of the Health/Education Telecommunications Experiment." IEEE Transactions on Aerospace and Electronic Systems. AES-11, 6, 1015-1032 (November 1975).[20]

Wilson, M. R., M.D., and C. Brady, "Health Care in Alaska via Satellite." AIAA Conference on Communication Satellites for Health/Education Applications (Denver, Colorado, July 21-23, 1975).[40]

CONTACT: Martha R. Wilson, M.D.
Office of Program Development
Alaska Area Native Health Service
Alaska Native Medical Center
Anchorage, Alaska 99501

ALASKA, ANCHORAGE

TITLE: Continuing Medical Education by Satellite

PERIOD: 1977-1978

TECHNOLOGY: Satellite, Color Television

APPLICATION: Education

This project is a collaborative effort of the Indian Health Service, the Veterans Administration, and the Public Service Satellite Consortium. Live continuing medical education broadcasts are being received at the Alaska Native Medical Center weekly from the VET-SAT network over CTS satellite by way of an interconnect at the Denver Up-link to the ATS-6 satellite.

CONTACT:

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Public Services Satellite Consortium
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Denver, Colorado 80211

ALASKA, ANCHORAGE

TITLE: Operational Satellite Communication for Health Care

PERIOD: On-Going

TECHNOLOGY: Commercial Satellite, 2-Way Audio

APPLICATION: Primary Care

This project is a collaborative effort between the Indian Health Service, The State of Alaska's Office of Telecommunication, and Radio Corporation of America (RCA). It is the operational follow-on of the ATS-1 Satellite Doctor Call, the experimental program limited to the Tanana Service Unit. At the present time approximately 60 of the total planned 120 remote Alaskan villages are equipped with small earth terminals and are conducting Doctor Call by satellite on a 24-hour availability basis.

CONTACT: Martha R. Wilson, M.D.
Office of Program Development
Alaska Area Native Health Service
Alaska Native Medical Center
Anchorage, Alaska 99501

ALASKA, JUNEAU

TITLE: ATS-1 Satellite-Doctor Call

PERIOD: 1971-Present

TECHNOLOGY: High-Frequency Radio, ATS-Satellite Radio

APPLICATION: Primary Care, Education

This demonstration project was conducted to gain experience in the exchange of medical and educational information between remote and urban Alaskan communities via satellite. Emphasis was placed on the exchange of medical and health information between health aides in twenty-six isolated communities and Public Health Service physicians.

REFERENCE: Kreimer, O., H. Hudson, and D. Foote, Health Care and Satellite Radio Communication in Village Alaska. (California Institute for Communication Research, Stanford University: Palo Alto, California, June 1974).(41)

CONTACT: Martha R. Wilson, M.D.
Office of Program Development
Alaska Area Native Health Service
Alaska Native Medical Center
Anchorage, Alaska 99501

TITLE: Veterans Administration ATS-6 Health Care Experiment in Appalachia

PERIOD: 1974-1975

TECHNOLOGY: Communications Satellites

APPLICATION: Primary Care, Education

This project involved ten Veterans Administration hospitals in the Appalachian region of the United States. It tested how communications satellites can be employed on a cost-effective basis for biomedical purposes in terms of diagnosis, therapy and continuing education. These experiments involved weekly telecasts with audio return over a period of eleven months in 1974 and 1975 and included video seminars, grand rounds, outpatient clinic activities, teleconsultations, and computer-assisted instruction.

REFERENCE: Annual Report: Exchange of Medical Information Program, Fiscal Year 1976. (Veterans Administration, Department of Medicine and Surgery, Learning Resources Service: Washington, D.C., August 1976).(42)

CONTACT: Mr. Robert B. Shamaskin
Deputy Director
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810 Vermont Avenue, N.W.
Washington, D.C. 20420

ARIZONA, SELLS

TITLE: Space Technology Applied to Rural Papago Advanced Health Care (STARPAHC)

PERIOD: 1975-Present

TECHNOLOGY: Microwave, 2-Way Audio/Video/Data, Slow-scan Video

APPLICATION: Primary Care

STARPAHC is a ground-based remote area health care delivery system. It was designed to demonstrate the feasibility and potential of utilizing space technology in communications and systems engineering to upgrade health care access and delivery. The test site is southern Arizona's Papago Indian Reservation. This telemedicine system uses microwave transmission to provide interactive color and black and white television, audio, and data communications between a central hospital-based medical facility at Sells, Arizona, and para-medical personnel attending patients in a fixed clinic (the Santa Rosa area) and a mobile clinic at a series of prescheduled remote sites on the reservation. It also provides referral and consultation capability to the large Indian Medical Center in Phoenix through good resolution, slow-scan color and black and white television, that is transmitted over commercial dial-up telephone lines. Thus the physician's skill, knowledge, and capabilities are made available over great distances to patients in remote geographical areas through the physician's assistant utilizing the telemedicine system.

REFERENCE: STARPAHC Systems Report, 2 Vols. (National Aeronautics and Space Administration, Johnson Space Center: Houston, Texas, Contract No. NAS9-13170, LMSC D566138, October 1977). (43)

CONTACT: Norman Belasco, SD2
National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
NASA Road 1
Houston, Texas 77058

ARIZONA, TUCSON

TITLE: Arizona Rural Health Federation

PERIOD: 1977-1979

TECHNOLOGY: Computer Terminals, Facsimile

APPLICATION: Primary Care, Administration, Education

The goal of this project is to organize a network of comprehensive health care services in a five-county area of southern Arizona. There are now seven rural community health clinics linked together in a communications network. When the project began in 1976 as the Southern Arizona Rural Health Initiative at the University of Arizona, plans included implementation of the Health Information System (HIS), installation of a computer terminal at one location to establish close ties with a tertiary care center in Tucson, the utilization of direct telephone lines to link communities with the next higher level of health care, and use of facsimile for transmission of medical records. New plans include using CB radios to link a mobile health clinic to a base community health center or hospital. Neither computer terminals nor facsimile were productive and have been discontinued. Services to be provided within this system include primary care, health education programs, technical assistance, organizational development, and administrative support. Telephone is the major link for the present network.

REFERENCE: Anderson, C., and W. Rappaport, Technology Applications in Rural Health Care Systems. MTR-7537 (The Mitre Corporation: McLean, Virginia, May 1977).(27)

CONTACT: Seth Linthicum
Executive Director
Arizona Rural Health Federation
5447 East Fifth Street, Suite 227
Tucson, Arizona 85711

CALIFORNIA, SAN DIEGO

TITLE: Navy Remote Medical Diagnoses System (RMDS)

PERIOD: 1972-Present

TECHNOLOGY: Slow-scan Television, Telemetry

APPLICATION: Primary Care

RMDS is an interactive slow-scan television system for linking ship-to-ship, ship-to-shore, and land-to-land points to provide a variety of diagnostic services. Patient x-rays from naval vessels at sea have been examined via UHF, HF and satellite using narrowband slow-scan transmissions. EKG and electronic stethoscope devices have been used to send physiological data using UHF and HF links.*

REFERENCE: Rasmussen. W. T., and J. Silva, Navy Remote Medical Diagnosis System. (Naval Electronics Laboratory Center: San Diego, California, 1976).(9)

Rasmussen, W. T., R. L. Crepeau, and F. H. Gerber, Resolution Requirements for Slow-Scan Television Transmission of X-Rays. TR-150 (Naval Ocean Systems Center: San Diego, California, 1977).(44)

CONTACT: Willis T. Rasmussen, Ph.D.
Naval Ocean Systems Center
Biomedical Engineering Branch, Code 8233
San Diego, California 92152.

*Earlier versions of the system have operated between central facilities (San Diego and Port Hueneme) and remote facilities (El Centro, San Clemente Island, and San Nicolas Island).

CALIFORNIA, SAN DIEGO

TITLE: TELEMED System in North County Health Project

PERIOD: 1977-Present

TECHNOLOGY: Telephone, 1-Way Slow-Scan Video

APPLICATION: Primary Care

The TELMED System in the rural back country area of North San Diego County is being developed and used to extend the primary care coverage of the nurse practitioner and physicians to provide 24-hour, 7-day a week communication to the primary care clinic in Ramona. The systems have been placed in Santa Ysabel and Ranchito where qualified individuals in the community are being trained to act as communicators. The objective of the use of telecommunications in these areas is to resolve the challenges of the small (100-2,000 population) rural community in developing a health care system.

CONTACT: Dorothy Reno
Director, North County Health Services
309 Firebird Lane
San Marcos, California 92069

COLORADO, DENVER

TITLE: Mountain/Plains Outreach Program

PERIOD: 1976-1979

TECHNOLOGY: Computer, WATS

APPLICATION: Primary Care, Administration

This program is designed to provide improved health care to rural areas of Colorado through the establishment of telecommunications and data processing linkages between health resources of urban areas and newly formed physician-staffed primary care centers in rural areas. The program includes a computer data system with CRTs to provide on-line patient information. Planned uses for this information system include evaluation of preventive health care methods, pharmacologic surveillance, health education, medical practice audit, and cost of care.

REFERENCE: Anderson, C., and W. Rappaport, Technology Applications in Rural Health Care Systems. MTR-7537 (The Mitre Corporation: McLean, Virginia, May 1977).[27]

CONTACT: Perry Warren
Program Director
Mountain/Plains Outreach Program
4545 E. 9th Avenue, Room 435
Denver, Colorado 80220

COLORADO, DENVER AND BOULDER

TITLE: University of Colorado Seminars

PERIOD: 1973-Present

TECHNOLOGY: Microwave, 2-Way Audio/Video

APPLICATION: Education

The purpose of this project is to broadcast medical seminars, including grand rounds and clinical presentations, between the Denver Medical Center campus of the University of Colorado and the campus at Boulder. Selected presentations are also rebroadcast by Instructional Television Fixed Service (ITFS) to Boulder Valley Community Hospital.

REFERENCE: Chan, S., and J. R. Messick, 33 Telecommunications Projects in Medical Education and Health Care. (Office of Medical Education, Research and Development, Michigan State University: East Lansing, Michigan, March 1975).(45)

CONTACT: Norman Fringer
Director of Biomedical Communication
University of Colorado - Medical Center
4200 East Ninth Avenue, Hosp. Box A066
Denver, Colorado 80262

CONNECTICUT, FARMINGTON

TITLE: Network for Medical Communications

PERIOD: 1971-Present

TECHNOLOGY: Microwave, 2-Way Audio/Video

APPLICATION: Primary Care, Education

This system uses live television to link the University of Connecticut Health Center in Farmington with Newington Veterans Hospital and New Britain General Hospital. Uses include consultations, student education, and continuing education.

REFERENCE: Chan, S., and J. R. Messick, 33 Telecommunications Projects in Medical Education and Health Care. (Office of Medical Education, Research and Development, Michigan State University: East Lansing, Michigan, March 1975).(45)

Sanborn, D. E., et al., "Interactive Television and the Rural Family Physician." Journal of the Maine Medical Association, Vol. 66, 276-279 (October 1975).(46)

CONTACT: Warren Kyprie
Manager, Interactive Television
The University of Connecticut Health Center
Farmington, Connecticut 06032

FLORIDA, MIAMI (DADE COUNTY)

TITLE: Telemedicine Health Care Delivery in Dade County Florida Penal Institutions

PERIOD: 1974-1977

TECHNOLOGY Microwave Slow-scan, 2-Way Audio/Video, Facsimile, Audio Support Devices

APPLICATION: Primary Care

This system links Jackson Memorial Hospital with three Dade County penal institutions. Evaluation tasks included analyzing the effects of a telemedicine system on an existing health care delivery system and studying patient groups randomly assigned to baseline and telemedicine groups to evaluate the existing and upgraded systems.

REFERENCE: Final Report: An Evaluation of the Impact of Communications Technology and Improved Medical Protocol on Health Care Delivery in Penal Institutions. (University of Miami Medical School: Miami, Florida, NSF Grant No. GI-39471, December 1976).(47)

CONTACT: Jay H. Sanders, M.D.
Principal Investigator
Chief of Medicine
Jackson Memorial Hospital
Miami, Florida 33157

GEORGIA, ATLANTA

TITLE: Georgia Regional Medical Television Network

PERIOD: 1967–Present

TECHNOLOGY: Two-Channel ITFS (Instructional Television Fixed Service)

APPLICATION: Education

This system services approximately thirty-one medical institutions, primarily to provide continuing education for the participating health professionals. Run by Emory University, the system operates out of Grady Hospital, the teaching hospital for the University. Between three and ten hours per week are dedicated to broadcasting live medical programs in color by ITFS transmitter, including regularly scheduled medical conferences, OB/GYN conferences, and cardiology conferences. These programs are also rebroadcast for the benefit of those who may have missed the live presentations.

REFERENCE: Kaminsky, A., "A Circulating Medical Library on Video Cassettes." Educational and Industrial Television. 9,3,41–44 (March 1977). (48)

CONTACT: Alan Kaminsky
Business Manager
Georgia Regional Medical Television Network
69 Butler Street
Atlanta, Georgia 30329

HAWAII, HONOLULU (AND PACIFIC)

TITLE: ATS-1 PEACESAT (Pacific Education and Communication Experiment by Satellite)

PERIOD: 1971-Present

TECHNOLOGY: Satellite, 2-Way Audio, Facsimile

APPLICATION: Primary Care, Education

PEACESAT is an interactive narrowband system servicing eleven nations or jurisdictions in the Pacific area to provide health education and community services. Uses of the system have included teleconsultations between physicians, teacher education, student classes, and sharing of library resources.

REFERENCE: Bystrom, J. W., "The Application of Satellites to International Interactive Service Support Communication," Proceedings of the Royal Society of London, A.345,493-510 (October 1975).(4

CONTACT: John W. Bystrom, Ph.D.
Director
PEACESAT Project
University of Hawaii
Honolulu, Hawaii 96822

ILLINOIS, CHICAGO

TITLE: Bethany/Garfield Community Health Care Network

PERIOD: 1972-1976

TECHNOLOGY: Microwave, Picturephone®, 2-Way Audio/Video/Data

APPLICATION: Primary Care, Administration, Education

The goal of this program was to serve the Bethany/Garfield Hospital complex, including two community hospitals, three store-front health centers, and three drug rehabilitation clinics. The overall objective was to explore the use of both Picturephone® and broadband television for solving communications problems of a large health care network in an urban ghetto area. Uses included in-service staff training, continuing education of health officials, and supervision of employees.

REFERENCE: Two-Way Visual Communications Experiment: The Final Report. (METCOR Incorporated: Chicago, Illinois, December 1973). (50)

CONTACT: Vernon Showalter
Bethany Brethren Hospital
3420 W. Van Buren Street
Chicago, Illinois 60624

ILLINOIS, CHICAGO

TITLE: Cook County Hospital, Department of Urology, Picturephone® Network

PERIOD: 1972-1975

TECHNOLOGY: Picturephone®, 2-Way Audio/Video

APPLICATION: Primary Care, Administration

Ten Picturephones® were located within the Cook County Hospital multi-building medical complex. The basic objective of this network was to improve administrative control and effective communication between the personnel and the patients, and among the personnel themselves through increased and better visual and verbal exchange, and to generally improve patient care.

REFERENCE: Chan, S., and J. R. Messick, 33 Telecommunications Projects in Medical Education and Health Care. (Office of Medical Education, Research and Development, Michigan State University: East Lansing, Michigan, March 1975).[45]

CONTACT: Irving M. Bush, M.D.
Division of U[illegible]y
Cook County [illegible]al
1825 W. Harris[illegible] Street
Chicago, Illinois 60612

ILLINOIS, CHICAGO

TITLE: Illinois State Psychiatric Institute Picturephone Program

PERIOD: 1973-1974

TECHNOLOGY: Picturephone, 2-Way Audio/Video

APPLICATION: Primary Care, Education

This network was established to link the staffs of institutions within the Illinois Mental Health Institute Network, including two mental health centers, a school for emotionally disturbed children, and three psychiatric institutes. The objective was to explore the utility of two-way visual communications between clinic paramedical personnel and the consultative expertise at the hospital in solving mental health care delivery problems. Use of the equipment facilitated continuous patient treatment, staff consultation and training, and communication flow regarding patient treatments and staff efforts.

REFERENCE: Chan, S., and J. R. Messick, 33 Telecommunications Projects in Medical Education and Health Care. (Office of Medical Education, Research and Development, Michigan State University: East Lansing, Michigan, March 1975).(45)

CONTACT: William H. Lewis
Coordinator, Administrative Services
Illinois State Psychiatric Institute
1601 W. Taylor Street
Chicago, Illinois 60612

INDIANA, INDIANAPOLIS

TITLE: Medical Educational Resources Program (MERP)

PERIOD: 1967-Present

TECHNOLOGY: Microwave, Cable, 1-Way and 2-Way Video, 2-Way Audio via Telephone Talkback Device

APPLICATION: Education

This program seeks to enhance medical education within the State of Indiana. It is utilized mainly for continuing education, but has also been used on occasion in the training of medical students. Seven Indiana University centers and over forty hospitals are serviced by this system. Additionally, one hundred locations participate in a video cassette mailing program.

REFERENCE: Friman, E., "Medical Minicam Projection: Why Portable Color Systems Prove a Boon to Medical Uses of Television." Educational and Industrial Television, 7,12,17-20 (December 1975). (51)

Friman, E., "The New Age of Medical Television Networks: The Potential Satellite Transmission Holds for Networking Medical Education." Educational and Industrial Television, 19-22 (May 1977). (52)

CONTACT: Elmer Friman
Director
Medical Educational Resources Program
Indiana University School of Medicine
110 West Michigan Street
Indianapolis, Indiana 46202

KENTUCKY, MOREHEAD

TITLE: Gateway District Health Department

PERIOD: 1975-Present

TECHNOLOGY: Mobile Van, Telephone

APPLICATION: Primary Care, Administration

This newly formed district health department provides public health services for the population of five northeast Kentucky rural counties. A central district office is staffed by personnel who rotate through the district offices located in each of the five counties. A mobile van staffed by a dentist, hygienist and clerk travels throughout Morgan County remaining two or three months at each site. The GDHD operates three dental operatories within elementary schools. A major objective of the GDHDs program is to provide existing administrative support services. A radio communications system linking support personnel in the field with the core staff and a unified financial management system with formalized linkages between third party payers and the district office are being developed. The GDHD has entered into major innovative services delivery supported by The Kentucky Medical Assistant Program (Title XIX Agency).

REFERENCE: Anderson, C., and W. Rappaport, Technology Applications in Rural Health Care Systems. MTR-7537 (The Mitre Corporation: McLean, Virginia, May 1977).(27)

CONTACT: Robert G. Matthews Jr., Ph.D.
Gateway District Health Department
Box 666
Owingsville, Kentucky 40360

LOUISIANA, BATON ROUGE

TITLE: Louisiana Health Television Network (LHTN)

PERIOD: 1967–Present

TECHNOLOGY: Cable, Microwave, 2-Way Audio Statewide, 2-Way Video

APPLICATION: Education

The system is a statewide, closed-circuit medical television network serving Louisiana's charity hospitals in nine cities. Also included in system are the Louisiana State University Schools of Medicine in Shreveport and in New Orleans and the Tulane University Medical Center in New Orleans. Network control is in Baton Rouge and is operated by the Louisiana Educational Television Authority on behalf of the State's Health and Human Resources Administration. Primarily an educational project, LHTN seeks to provide programs to train interns and residents, in-service education for nurses and paramedical personnel, and continuing education for health professionals. Programming includes live conferencing with instruction and taped continuing education programs. The service of LHTN is supplemented by a videocassette subscription service provided by the Louisiana State University School of Medicine in New Orleans.

REFERENCES: Chan, S., and J. R. Messick, 33 Telecommunications Projects in Medical Education and Health Care. (Office of Medical Education, Research and Development, Michigan State University: East Lansing, Michigan, March 1975).(45)

Stephens, H. J., "'Doctor to Doctor' Via CCTV: Continuing Medical Education in Louisiana." Educational and Industrial Television (July 1974). (53)

CONTACT: Harold J. Stephens, Jr.
Acting Director
Biomedical Communications
1430 Tulane Avenue
Tulane Medical Center
New Orleans, Louisiana 70112

MAINE, FARMINGTON

TITLE: Rural Health Associates: Interactive Medical Microwave Television (RHA)

PERIOD: 1971-Present

TECHNOLOGY: Microwave, 2-Way Audio/Video/Data

APPLICATION: Primary Care, Administration, Education

RHA, a private medical group practice in Farmington, was the first health care organization to include interactive television communications as an integral part of its organizational plan. A two-way link has been established between RHA and two ambulatory care satellite clinics in Rangeley and Kingfield. Objectives include providing comprehensive health care to rural areas, establishing support for health care professionals living away from major medical centers, and providing these professionals with sufficient coverage to allow time for continuing education.

REFERENCE: Bashshur, R. I., P. A. Armstrong, and Z. I. Youssef, Eds., Telemedicine: Exploratlons in the Use of Telecommunications in Health Care. (Thomas: Springfield, Illinois, 1972). (2)

CONTACT: Clinton A. Conant
Project Administrator
Rural Health Associates
Farmington, Maine 04938

MAINE, STONINGTON

TITLE: Blue Hill-Deer Isle Telemedicine Project

PERIOD: 1973-1977

TECHNOLOGY: Microwave, 2-Way Audio/Video

APPLICATION: Primary Care, Administration, Education

This project was instituted to provide expert consultative services via two-way interactive television from Blue Hill Memorial Hospital to a nurse practitioner-staffed clinic in the isolated community of Stonington on Deer Isle. The link was also used to train Deer Isle ambulance attendants in first aid and primary care.

REFERENCE: Chan, S., and J. R. Messick, 33 Telecommunications Projects in Medical Education and Health Care. (Office of Medical Education, Research and Development, Michigan State University: East Lansing, Michigan, March 1975).[45]

CONTACT: Richard Britt, M.D.
Blue Hill Memorial Hospital
Blue Hill, Maine 04614

MASSACHUSETTS, BOSTON

TITLE: Nursing Home Care Program

PERIOD: 1972–Present

TECHNOLOGY: Telephone

APPLICATION: Primary Care

This is a system where Nurse Practitioners and Physician Assistants provide primary medical care to 330 Boston area nursing home patients in ten locations in the context of a primary care group practice affiliated with the Beth Israel Hospital. This program initially developed at Boston City Hospital demonstrated that improved quality of medical care and accessibility could be provided to inner city nursing home residents with reduced reliance on the hospital and with significant cost savings.

REFERENCE: Bashshur, R. I., P. A. Armstrong, and Z. I. Youssef, Eds., Telemedicine: Explorations in the ·e of Telecommunications in Health Care. (Thomas. Springfield, Illinois, 1972).(2)

CONTACT: bert J. Master, M.D.
irector, The Urban Medical Group, Inc.
545D Centre Street
Jamaica Plain, Massachusetts 02130

MASSACHUSETTS, BOSTON

TITLE: Massachusetts General Hospital/Logan Airport

PERIOD: 1968-Present

TECHNOLOGY: Microwave, 2-Way Audio/Video/Data

APPLICATION: Primary Care

Although currently not in operation, this system has the capability, and was used in the past, to link a nurse clinician at Logan Airport with the physicians at Massachusetts General in Boston, providing telediagnosis and teleconsultation services. The system was designed to provide fuller utilization of the skills of the health professionals via telecommunication's capacity to overcome the problems of accessibility and travel time in an urban setting.

REFERENCE: Murphy, R. I., "Accuracy of Dermatologic Diagnosis by Television." Archives of Dermatology. 105,833-835 (June 1972).(19)

CONTACT: Kenneth T. Bird, M.D.
Program Director
Te[illegible]ne Medical Service
Massachusetts General Hospital
Warren Building
275 Charles Street
Boston, Massachusetts 02114

MASSACHUSETTS, BOSTON

TITLE: Massachusetts General Hospital/Bedford Veterans Administration Hospital

PERIOD: 1970-Present

TECHNOLOGY: Microwave, 2-Way Audio/Video

APPLICATION: Primary Care, Education

Based in part on the experience gained from the Massachusetts General Hospital/Logan Airport project, the Bedford link was established for teaching as well as teleconsultation. It has been utilized to teach health-related courses to community college students at Bedford and provide continuing education for physicians at Bedford. In furthering patient care, it has been used in cases of psychiatric or neurological disorders, dermatology, speech therapy, drug abuse, and alcoholism.

REFERENCE: Bird, K. T., <u>The Veterans Administration Massachusetts General Hospital Telemedicine Project</u>. (Massachusetts General Hospital: Boston, Massachusetts, June 1974).(54)

CONTACT: Kenneth T. Bird, M.D.
Project Director
Telemedicine Medical Service
Massachusetts General Hospital
Warren Building
275 Charles Street
Boston, Massachusetts 02114

MASSACHUSETTS, CAMBRIDGE

TITLE: Cambridge Telemedicine Project

PERIOD: 1972-1974

TECHNOLOGY: Microwave, 2-Way Audio/Video

APPLICATION: Primary Care

The Cambridge Telemedicine Project was established to employ audio-visual links to provide consultation and support from physicians at Cambridge Hospital to nurse practitioners providing care at three neighborhood satellite health clinics. In each of the three clinics, one nurse practitioner used two-way television. Two of the clinics had an additional nurse practitioner who only used a telephone for consultation.

REFERENCE: Moore, G. T., et al., "Comparison of Television and Telephone for Remote Medical Consultation." The New England Journal of Medicine, 292:14, 729-732 (April 1975). (55)

MINNESOTA, WACONIA

TITLE: Lakeview Clinic Bi-Directional Cable Television System

PERIOD: 1972-1974

TECHNOLOGY: Cable, 2-Way Audio/Video/Data

APPLICATION: Primary Care

This system was instituted to evaluate a two-way audio-video cable link between the rural Lakeview practice clinics at Waconia and Jonathon and Ridgeview Hospital in Waconia. A major goal of this project was to assess the behavioral and attitudinal changes of the participating physicians and allied health personnel and the care of the patient participating in the health care process and the telehealth link. The system was used for teleconsultations, telediagnosis, monitoring, and augmented verbal communication-follow-up exams. Data transmissions, including EKGs, x-rays, and charts, were performed.

REFERENCE: Lasden, G., Ed., Improving Ambulatory Health Care Delivery. (Lexington Books, D.C. Heath and Company: Lexington, Massachusetts, 1977).[56]

CONTACT: Jon Wempner, M.D.
Lakeview Clinic Group
200 West Highway #5
Waconia, Minnesota 55387

MISSOURI, ST. LOUIS

TITLE: Veterans Administration Nuclear Medicine Project

PERIOD: 1974-Present

TECHNOLOGY: Telephone, Computer

APPLICATION: Primary Care

It is the intent of this system to provide nuclear medicine services of the large-city Veterans Administration Hospital at St. Louis to Veterans Administration hospitals in a rural area outside of St. Louis, in southern Illinois, and in southern Missouri. Each hospital is equipped with a computer and gamma camera, operated by a trained technician. Each day patient studies are recorded and stored on magnetic disks. At the end of the day the technicians at the remote hospitals re-format the data into picture format and transmit it via data phones to the main computer at the St. Louis Veterans Administration hospital. From these images, diagnoses are determined and reports are transmitted the next morning to the three rural hospitals.

REFERENCE: Annual Report: Exchange of Medical Information Program, Fiscal Year 1976. (Veterans Administration, Department of Medicine and Surgery, Learning Resources Service: Washington, D. C., August 1976).[42]

CONTACT: Robert Donati, M.D.
St. Louis Veterans Hospital
St. Louis, Missouri 63125

NEBRASKA, MULLEN

TITLE: Rural Initiative Health Grant

PERIOD: 1976-1979

TECHNOLOGY: Telephoto Transmitters, Radio, Telephone

APPLICATION: Primary Care

Only one of the seven counties included in this project had a physician prior to the project's inception. The project plans to provide services through both a home health care service program and two satellite clinics. A biocommunications network is also proposed, including telephone communications to link existing area medical centers and the new clinics.

REFERENCE: Anderson, C., and W. Rappaport, Technology Applications in Rural Health Care Systems. MTR-7537 (The Mitre Corporation: McLean, Virginia, May 1977).(27)

ADDITIONAL REFERENCE SUGGESTED BY PROJECT:

Baxter, W. E., Dr. P.H., "A Substitute System for Rural Health Care." Hospital and Health Services Administration. 22:3 (American College of Hospital Administrators: Chicago, 1977).(75)

CONTACT: Wesley Moench
Director
Sandhills Development Corporation
Mullen, Nebraska 69152

NEBRASKA, OMAHA

TITLE: University of Nebraska Medical Center

PERIOD: 1959-Present

TECHNOLOGY: Microwave, 2-Way Audio/Video

APPLICATION: Primary Care, Education

The University of Nebraska Medical Center began using two-way closed-circuit television in 1959 to transmit educational demonstrations with neurological patients and case information from the Nebraska Psychiatric Institute (NPI) to medical students in the Department of Anatomy. From 1964 to 1969 a 112-mile link was active between NPI and Norfolk State Mental Hospital to facilitate joint conferences, to improve patient care at the isolated Norfolk health facility, and to carry out collaborative psychiatric projects. Since 1970 the Medical center has been linked with three Veterans Administration hospitals, a dental school, and a medical school to provide education and training in a wide variety of medical specialty areas. In 1976 the Omaha and Lincoln campuses of the University of Nebraska School of Nursing were linked to provide sharing of faculty and instructive material.

REFERENCES:

<u>Annual Report: Exchange of Medical Information Program, Fiscal Year 1976</u>. (Veterans Administration, Department of Medicine and Surgery, Learning Resources Service: Washington, D. C., August 1976).[42]

Wittson, C., M.D., and R. Benschoter, M.S., "Two-Way Television: Helping the Medical Center Reach Out." <u>American Journal of Psychiatry</u>, 129:5 (November 1972).[57]

ADDITIONAL REFERENCES SUGGESTED BY PROJECT:

Benschoter, R., "Multi-Purpose Television." <u>Annals of the New York Academy of Sciences, 142:2, (March 1967)</u>.(58)

CONTACT:

Cecil Wittson, M.D.
Chancellor Emeritus
University of Nebraska
Medical Center
42nd and Dewey
Omaha, Nebraska 68105

NEBRASKA, OMAHA

TITLE: Remote Radiographic Transmission for Diagnostic Interpretation

PERIOD: 1973-1975

TECHNOLOGY: Microwave, Cable, 2-Way Audio, 1-Way Data (x-rays), Telephone

APPLICATION: Primary Care

This project was designed to provide on-demand interpretation of x-rays transmitted between the small rural community of Broken Bow, which had no radiologist, and the Department of Radiology of the University of Nebraska Medical Center. The purpose was to implement and evaluate a slow-scan system for transmitting x-rays.

REFERENCE: Chan, S., and J. R. Messick, 33 Telecommunications Projects in Medical Education and Health Care. (Office of Medical Education, Research and Development, Michigan State University: East Lansing, Michigan, March 1975).[45]

CONTACT: William J. Wilson, M.D.
Memorial Hospital Medical Center
2801 Atlantic Avenue
Long Beach, California 90806

NEW HAMPSHIRE, HANOVER

TITLE: New Hampshire/Vermont Interactive Medical Television Network (Interact)

PERIOD: 1968-Present

TECHNOLOGY: Microwave, 2-Way Audio/Video/Data and Videotape

APPLICATION: Primary Care, Administration, Education

Interact developed from a 1968 link between Dartmouth-Hitchcock Medical Center, Hanover, New Hampshire, and the Claremont General Hospital, Claremont, New Hampshire. By late 1972 the network also included the University of Vermont Medical Center at Burlington, the Central Vermont Medical Center at Montpelier, the Rockingham Memorial Hospital, and the Windsor Prison. Additional links are being established in both states with current construction of links at the White River Jct., Vt. Veterans Administration Hospital and the St. Albans, Vt. Correctional Facility. The system seeks to provide medical services to communities that have had only limited access to specialty care and to pool faculty resources between institutions involved in health manpower training to optimize the use of professionals. Services include patient consultation, specialty conferences, continuing education, Grand Rounds and joint faculty/student programs. As an adjunct to the two-way microwave network, Interact/Media Outreach provides videotapes of "airtime" programs on a loan basis to regional hospitals not interconnected with the Interactive Television Network.

REFERENCE: Siebert, D. J., A Decade of Experience Using Two-Way Closed Circuit Television for Medical Care and Education. Final Report, Contract #1-LM-4-4704 (Lister Hill National Center for Biomedical Communications, National Library of Medicine: Bethesda, Maryland, November 1977).

CONTACT: Marshall Krumpe
Network Manager
INTERACT Television
c/o Dartmouth-Hitchcock Medical Center
Hanover, New Hampshire 03755

NEW MEXICO, CUBA

TITLE: Checkerboard Area Health System

PERIOD: 1973-Present

TECHNOLOGY: Radio, Telephone

APPLICATION: Primary Care, Administration

The Checkerboard Area Health System was established to improve health care services to the largely Navajo population northwest of Albuquerque. The system links a Health Center in Cuba with six outreach clinics staffed by non-physician providers. The Health Center has a nine-bed hospital, outpatient facilities, an emergency room, and dental services. It provides consultative services and administrative support to the satellite clinics. The outreach clinics provide services on an outpatient basis and through a home health visit program.

REFERENCE: Cuba-Checkerboard Area Coordinated Health Program: A Model for a Health Delivery System in a Distressed Rural Area of New Mexico. (Presbyterian Medical Services: Santa Fe, New Mexico, July 1973). (60)

CONTACT: David A. Watson
System Administrator
Checkerboard Area Health System
P.O. Box 638
Cuba, New Mexico 87013

NEW MEXICO, PLAYAS LAKE

TITLE: Playas Telehealth System

PERIOD: 1975–Present

TECHNOLOGY: Microwave, 2-Way Audio/Video, Telephone, Facsimile

APPLICATION: Primary Care, Administration

The Playas Telehealth System installed under the direction of the University of New Mexico and financed by the Phelps Dodge Corporation, was designed to provide comprehensive health care to over five hundred workers and their dependents who live at the Phelps Dodge Corporation copper smelting townsite of Playas, New Mexico. Playas Clinic, operated by physician extenders, is linked to Med Square Clinic in Silver City where physicians are available to supply a wide range of services via telecommunications to the Playas Clinic. These services include consultation, diagnosis, and administrative support. Playas and surrounding community residents now have a broad base of health services available to them, including primary care, emergency care, laboratory/x-ray services, and pharmaceuticals.

REFERENCE: Playas Lake Telehealth System - Phase I Report. (University of New Mexico Regional Health Program: Albuquerque, New Mexico, December 1975).[61]

CONTACT: Shelby King, M.D.
Med Square Clinic
114 W. 11th Street
Silver City, New Mexico 88061

NEW YORK, BUFFALO

TITLE: Communications In Learning Tele-lecture Network

PERIOD: 1968-Present

TECHNOLOGY: 2-Way Audio, Darome "Meeting Bridge"

APPLICATION: Education

The Tele-lecture Network is a two-way communications system linking more than forty hospitals, presently within a 200-mile radius, in Western New York State, Northeastern Pennsylvania, and Ontario, Canada, to provide educational programs, both for credit and for non-credit continuing education. Seventeen different program areas are offered, including nursing, surgery, speech therapy, dietetics, medical technology, medical records, and others. Programs generally consist of two one-half hour sessions. During the first one-half hour, the presentation by the instructor is transmitted from the Communications In Learning Resource Center to the participating hospitals. Questions are then transmitted back from the hospitals to the instructor during the second one-half hour. Each series is sponsored by a professional society or organization. Professionals in their fields from all over the country are invited to participate as instructors on a no-fee basis, as Communications In Learning, Inc., is now operating as a non-profit organization. The programs are then taped and described in a catalog which can be purchased.

REFERENCE: Individuals Working Together for Creative Action. (Communications in Learning, Inc.: Buffalo, New York, 1977). (62)

CONTACT: Emmett C. Murphy, M.D.
President, Communications in Learning, Inc.
2929 Main Street
Buffalo, New York 14214

NEW YORK, NEW YORK

TITLE: East Harlem Broadband Health Communications Network (Mt. Sinai)

PERIOD: 1972-1975

TECHNOLOGY: Cable, 2-Way Audio/Video, 1-Way Audio/Video

APPLICATION: Primary Care, Administration, Health Education

This system was composed of two community projects. One was a two-way interactive audio/video link to provide pediatric services from Mt. Sinai Hospital to a nurse practitioner at the Wagner House's Child Health Station. The second project used closed-circuit television to provide health and community information to over three hundred elderly residents of the Gaylord White Housing Project. Objectives of the project included determining the degree of acceptance of bi-directional cable television by both health providers and consumers, the effectiveness of bi-directional video and audio contact in lieu of in-person physician/patient contact, and cost-benefits of the system.

REFERENCE: Salzer, J. E., C. L. Marshall, and E. R. Glazer, "The Use of Cable Television as a Tool in Health Education of the Elderly: Screenings," Health Education Monographs (Office of Primary Health Care Education, College of Medicine and Dentistry: Newark, New Jersey, Winter 1977).(63)

ADDITIONAL REFERENCE SUGGESTED BY PROJECT:

Muller, C. et al., "Cost Factors in Urban Telemedicine." Medical Care, 15:3 (March 1977).(64)

CONTACT: Carter L. Marshall, M.D.
Director
Office of Primary Health Care Education
CMD/NJ
100 Bergen Street
Newark, New Jersey 07103

OHIO, CLEVELAND

TITLE: Telemedicine Project at Case Western Reserve University

PERIOD: 1972-1978

TECHNOLOGY: Laser, Cable, 2-Way Audio/Video/Data

APPLICATION: Primary Care

This project was instituted to link an operating room at Cleveland Veteran's Administration Hospital and an anesthesia monitoring room at University Hospitals, Case Western Reserve. The consultant at the University Hospitals may view the patient, anesthetizing area, and operating room at the Veteran's Administration Hospital on a color television monitor and may converse with the anesthetist. The initial overall objective was to evaluate the use of two-way, audio/video data communications as a potential remedy to the shortage of anesthesiologists. This objective was expanded to explore the utility of telemedicine in furthering the regionalization of medical care. A link to Forest City Hospital in the inner city was added in 1975, connecting the intensive care unit and the newborn nursery with the consultative and supervisory capabilities of University Hospital. An overall declining census of FCH saw the closure of the ICU in late 1976, which terminated that aspect of the project. Because of its continuing gross inability to compete successfully as a secondary and tertiary patient care facility, FCH closed February 6, 1978. Consequently all clinical telemedicine activities have ceased. The newborn nursery project effort which is now in the process of final evaluation promises to be the most successful aspect of the project from the patient outcome prospective. FCH is considering the role of a primary health care provider. If this becomes a reality, it is conceivable that telemedicine can be utilized on site as a consultative and supervisory tool in patient care as well as expedite patient triage to appropriate health care facilities. There will be continued anesthesia consultation via telemedicine to the Veteran's Administration Hospital.

REFERENCES: Gravenstein, J. S., Laser Mediated Telemedicine, Final Report. (Case Western Reserve University: Cleveland, Ohio, December 1973).(65)

Grundy, B. L., et al., "Telemedicine in Critical Care: An Experiment in Health Care Delivery." Journal of the American College of Emergency Physicians, and The University Association for Emergency Medicine, 6:10,439-444 (October 1977).(66)

CONTACT: J. S. Gravenstein, M.D.
Professor and Director
Department of Anesthesiology
School of Medicine, Case Western University
2119 Abington
Cleveland, Ohio 44106

OHIO, COLUMBUS

TITLE: Ohio Valley Medical Microwave Television System

PERIOD: 1974-Present

TECHNOLOGY: Microwave, 2-Way Audio/Video

APPLICATION: Education, Primary Care, Administration

Designed originally to provide tele-diagnosis and tele-consultation to improve the health services in Ohio's Appalachian Region, this system has evolved to providing continuing medical education for physicians, nurses, allied health professionals and undergraduate medical students. The system links six stations serving seven southeastern counties. The teaching-treatment centers of Ohio State University College of Medicine and in 1978 Ohio University College of Osteopathic Medicine are linked with rural town and state hospitals. Applications for which the system is used include continuing medical education of professionals, in-service training, training of allied health personnel, consultation and diagnosis, training of undergraduate medical students at remote training sites, administrative communication and data exchange. The system is a project of the Ohio Educational Television Network Commission and is operated by Ohio University.

REFERENCE: Char, S., and J. K. Messick, 33 Telecommunications Projects in Medical Education and Health Care. (Office of Medical Education, Research and Development, Michigan State University: East Lansing, Michigan, March 1975).[45]

CONTACT: Ronald A. Black
Project Director
Ohio Valley Medical Microwave Television System
353 Grosvenor Hall
Athens, Ohio 45701
(614) 594-6401

OREGON, EUGENE

TITLE: McKenzie River Health Clinic

PERIOD: 1976-1979

TECHNOLOGY: Slow-scan Television

APPLICATION: Primary Care, Administration

The purpose of this project is to establish the McKenzie Health Clinic for providing health services to the medically underserved population of the McKenzie River Valley. The clinic is staffed by physician extenders who use a two-way slow-scan television system for consultations with physicians of a hospital in Eugene.

REFERENCE: Rappaport, W., and F. Skinner, Development and Implementation of the McKenzie Clinic Telehealth System. MTR-7715 (The Mitre Corporation: McLean, Virginia. In Press).(67)

CONTACT: Ronald Castle
Lane County McKenzie River Clinic
P.O. Box 183
Blue River, Oregon 97413

RHODE ISLAND, BLOCK ISLAND

TITLE: Rhode Island Rural Health Demonstration Project

PERIOD: 1976-1979

TECHNOLOGY: Slow-scan Television

APPLICATION: Primary Care

The Rhode Island project is designed to provide comprehensive care to the populations of the medically underserved towns of Glocester and Scituate, Richmond and Charleston, and Block Island. The first two areas are served by mobile vans offering a variety of services. Block Island, medically isolated from the mainland, is linked to a mainland hospital via slow-scan television to permit voice communication and transmission of x-rays, EKGs, and body views for specialty consults.

REFERENCE: Rapaport, W., and F. Skinner. The Block Island-Rhode Island Hospital Tel[illegible] System: A Progress Report. WP12787 (The [illegible] Corporation: McLean, Virginia, January 1978).(73)

CONTACT: Frank Donahue
Rhode Island Department of Health
75 Davis Street
Providence, Rhode Island 02908

SOUTH CAROLINA, HAMPTON (HAMPTON COUNTY)

TITLE: Improving Rural Health Care: A Computer-Based Health Communications System

PERIOD: 1976-1979

TECHNOLOGY: Computer

APPLICATION: Primary Care, Administration

This project was designed to establish an organized computer-based system for the communication of patient information among providers in Hampton County. The main computer, located in Hampton General Hospital, is linked with remote terminals operated by physicians, pharmacists, and other health providers in the County. A computerized billing system has also been developed.

REFERENCE: "The Hampton Project: Initial Census Data for a Community-Based Health Communication System." Journal of the South Carolina Medical Association (October 1977). (68)

CONTACT: Harrison L. Peeples, M.D.
Chairman
Hampton County Health Foundation, Inc.
Hampton General Hospital
Varnville, South Carolina 29944

TEXAS

TITLE: Interactive Closed-Circuit Television System

PERIOD: 1974-Present

TECHNOLOGY: Microwave, Cable, Closed-Circuit Television

APPLICATION: Primary Care, Administration, Education

This system was designed to link three Veterans Administration hospitals within an area of Texas called the "Mini-Region." Each hospital also has its own in-house, closed-circuit television system. The microwave system linking the three hospitals is used for medical consultations and joint administrative conferences. One of the hospitals is also linked by cable to a non-Veterans Administration hospital to facilitate sharing of lecture materials.

REFERENCE: STARPAHC Systems Report, 2 vols. (National Aeronautics and Space Administration, Johnson Space Center: Houston, Texas, Contract No. NAS9-13170, LMSC D566138, October 1977).[43]

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UTAH, SALT LAKE CITY

TITLE: Utah Remote Site Rural Health Program

PERIOD: 1976-1979

TECHNOLOGY: Computer

APPLICATION: Primary Care, Education

This project was initiated to provide primary medical care in two underserved rural areas in Utah. The satellite clinics are staffed by physician extenders linked with physicians by computerized medical audit protocol to ensure consistently high quality services. Computers are located in the remote sites with linkages via telephone to backup physicians located at Salt Lake City and Richfield. Primary care, preventive medicine, and mental health services are provided by the clinics. The computers also maintain medical records and a financial management system for each clinic.

REFERENCE: Anderson, C., and W. Rappaport, Technology Applications in Rural Health Care Systems. MTR-7537 (The Mitre Corporation: McLean, Virginia, May 1977).[27]

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VERMONT, GRAND ISLE COUNTY

TITLE: Grand Isle County Integrated Health Services Project

PERIOD: 1976-1979

TECHNOLOGY: Telephone

APPLICATION: Primary Care

The objective of this project is to provide a comprehensive, integrated, 24-hour health care system to isolated Grand Isle County in eastern Vermont. The Champlain Islands Health Center, the focal point of the project, is staffed by nurse practitioners. Physicians make periodic on-site visits. Using the telephone number of the Champlain Center, a 24-hour call system has been developed which refers calls to physicians after they are screened by specially trained local residents.

REFERENCE: Anderson, C., and W. Rappaport, Technology Applications in Rural Health Care Systems. MTR-7537 (The Mitre Corporation: McLean, Virginia, May 1977).(27)

CONTACT: Elizabeth J. Davis
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WASHINGTON, SEATTLE

TITLE: WAMI (Washington, Alaska, ontana, Idaho)

PERIOD: 1974-1975

TECHNOLOGY: Satellite, 2-Way Audio/Video/Data

APPLICATION: Primary Care, Administration, Education

This project utilized the ATS-6 satellite for long distance training of University of Washington medical students. Two-way live broadcasts were beamed between the University of Washington and Fairbanks, Alaska, and Omak, Washington. The first quarter of the university's medical school training was taught at the University of Alaska, Washington State University, University of Idaho, and Montana State University. This project was designed to educate more doctors and encourage them to practice in rural areas. Video and audio transmission were also used to provide administrative conferencing between officials at all locations.

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Schwarz, M. R., and M. H. Johnson, "Role of Satellite Broadcasts in Regional Medical Education and Health Care Delivery." AIAA Conference on Communications Satellites for Health/Education Applications, Denver, July 1975.

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WISCONSIN, MADISON

TITLE: Nursing Dial Access Library

PERIOD: 1968-Present

TECHNOLOGY: Telephone (for Tape Library Access)

APPLICATION: Primary Care, Education

Presently, this system hosts a library of about four hundred, four to seven-minute tape recordings on a variety of medical and nursing subjects. The service is available twenty-four hours a day, seven days a week and is open to registered nurses throughout Wisconsin. It is also available by contract to Veterans Administration hospitals and National Health Service Corps physicians and nurses around the country. Participating health professionals receive a catalog listing of the tapes and their respective numbers. A person wishing to use the service, dials the library at the University of Wisconsin Medical Center and the operator who answers selects and plays the requested tape.

REFERENCE: Annual Report: Exchange of Medical Information Program, Fiscal Year 1976. (Veterans Administration, Department of Medicine and Surgery, Learning Resources Service: Washington, D. C., August 1976).(42)

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NOTE: We have decided to terminate the service for Wisconsin Physicians during the coming year, but continue it for nurses. Over the last few years fewer doctors have subscribed and used the service.

CANADA, NEWFOUNDLAND, ST. JOHN'S

TITLE: Experimental Use of the Communications Technology Satellite Hermes in Telemedicine

PERIOD: March 1977-June 1977

TECHNOLOGY: Satellite, One-way TV, Audio Teleconferencing

APPLICATION: Education

The goal of the experiment was to test the satellite system as a means of providing continuing education to physicians, nurses and allied health workers at 4 hospitals in the province. The topic included Communications/Development Disorders in Children, Cardiology, Anesthesia, Therapeutics, various areas in nursing and community health education, as well as sessions in hospital administration. The project simulated various sessions at St. John's between a hospital and the teaching centre. In the post-Hermes experiment phase the project office is exploring teaching and consultation applications of the existing telephone network, using at times facsimile and slow-scan technology.

REFERENCE: House, A. M., and W. C. McNamara, Report on Memorial University of the Communications Technology Satellite Hermes in Telemedicine. (Health Sciences Centre, Memorial University: St. John's, Newfoundland, 1977).(69)

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CANADA, ONTARIO, LONDON

TITLE: Canadian Telemedicine Experiment U-6

PERIOD: October 1976-February 1977

TECHNOLOGY: Satellite, One-way Video, Two-way Audio, Facsimile, 1-Way Data

APPLICATION: Professional Supervision and Support, Primary Care

The Hermes Communications Technology Satellite linked a remote Base Hospital via one-way TV plus interactive audio and facsimile to the University Hospital. Further, a nursing station was linked via interactive audio and facsimile to the Base Hospital to support primary care of the nursing station. The camera at the Base Hospital was controlled remotely from the University Hospital. TV link was used for support of practicing physicians and specialists at the Base Hospital in the areas of radiology, anesthesia, psychiatry, cardiology, pathology, hematology, physiotherapy, dentistry, pharmacy, respiratory technology, nursing support, infection control and administration. The experience gained and information gathered in the experiment will be applied to future developments in regard to telehealth care systems in Canada.

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Roberts, R., S. Skene, and G. Lyons, Evaluation of the Moose Factory Telemedicine Project U-6 (McMaster University: Hamilton, Ontario 1978).(71)

CONTACT: Dr. Lewis S. Carey
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TITLE: University of Toronto/University of Waterloo Telemedicine Project

PERIOD: September 1977-September or December 1979

TECHNOLOGY: Telephone, Slow-Scan Video

APPLICATION: Primary care

This is a study of the cost-effectiveness of a slow-scan video system in assisting delivery of health care to Northwestern Ontario. The telephone system links twenty Health Aid Stations, seven Nursing Stations, one Base Hospital at Sioux Lookout, Ontario, and two Consulting Hospitals in Toronto. Slow-scan video links one Base Hospital, one Health Aid Station, two Nursing Stations, and two Consulting Hospitals. Normal telephone lines, satellite lines, radio telephone and radio are used. Slow-scan video systems have been installed at six sites and are planned for communities but await installation of the required telephone lines. The study will compare health care delivery patterns in communities with slow-scan video equipment and communities without the equipment. Patient care and telecommunication data is being collected from all professional/patient encounters in the northern communities, representing essentially a census of primary health care delivery in the region. Cost-effectiveness is expected to be related to patient transfer. After the first six months of the project several health professionals have been trained to operate the slow-scan systems without assistance; data collection and coding procedures are satisfactory. Sufficient data to begin testing hypotheses should be available after 12 to 18 months of data collection.

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BIBLIOGRAPHIC DATA SHEET

NCHSR 79-1

TELEHEALTH HANDBOOK: A GUIDE TO TELECOMMUNICATIONS TECHNOLOGY FOR RURAL HEALTH CARE

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Telehealth is a term applied to the use of telecommunications technology to facilitate the delivery of health care and services among remotely located, geographically dispersed, or physically confined persons. A telehealth system appears to be a potentially valuable resource for improving access to quality health care in rural areas. Telehealth systems can enhance the information exchange that is vital to providing quality health care and help reduce the professional isolation of rural providers. With emphasis on primary care, this Handbook focuses on the role of telecommunications technology in the exchange of patient, educational, and administrative information within a dispersed health care system. Although the emphasis is on planning for rural communities, where there is a severe shortage of health services, the resources, concepts, and issues are applicable to urban areas also. The intent is to provide preliminary guidance to health care planners who are considering telehealth among the many alternatives available for improving the quality, accessibility, and efficiency of care.

15. Supplementary Notes (Continued)

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Maxine Rockoff, Ph.D.: NCHSR P.O.

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