DOCUMENT RESUME

ED 119 883 RC 009 023

TITLE	Arizona TeleMedicine Project.
INSTITUTION	Arizona Univ., Tucson. Coll. of Medicine.
SPONS AGENCY	Office of Economic Opportunity, Washington, D.C.
REPORT NO	OEO-B2C-5379
PUB DATE	Jun 73
NOTE	61p.; Related documents are RC 009 024-027
EDRS PRICE	MF-$0.83 HC-$3.50 Plus Postage
DESCRIPTORS	*American Indians; Delivery Systems; Design; Evaluation Methods; *Health Services; Interagency Coordination; Objectives; *Program Descriptions; Project Applications; Reservations (Indian); *Rural Areas; *Telecommunication
IDENTIFIERS	*Arizona TeleMedicine Project; IHS; Indian Health Service

ABSTRACT

Designed to provide health services for American Indians living on rurally isolated reservations, the Arizona TeleMedicine Project proposes to link Phoenix and Tucson medical centers, via a statewide telecommunications system, with the Hopi, San Carlos Apache, Papago, Navajo, and White Mountain Apache reservations. Advisory boards are being utilized to ensure project objectives and coordination with the Indian Health Service (IHS). Project activities are to involve: (1) design, installation, operation, evaluation, and maintenance of the TeleMedicine Network; and (2) application of network capabilities to IHS and assessment of network impact on services and patient outcomes. Specific network objectives are to include: (1) providing on-line supervision, advice, and medical consultation to health service personnel; (2) directing diagnostic, medical, and therapeutic services; (3) providing x-ray, laboratory interpretations, and other technical ancillary services via use of biotelemetry, video, facsimile, and computer analysis of medical data; (4) providing on-line computerized health information on individual patients; (5) providing educational activities to upgrade skills of health care personnel; (6) studying the communications systems design, operation, and reliability; (7) studying the system's cost effectiveness; and (8) encouraging development and application of telecommunications systems. (JC)

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ARIZONA TELEMEDICINE PROJECT
UNIVERSITY OF ARIZONA
COLLEGE OF MEDICINE

O.E.O. Contract #B2C-5379

U S DEPARTMENT OF HEALTH,
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ARIZONA TELEMEDICINE PROJECT

UNIVERSITY OF ARIZONA COLLEGE OF MEDICINE

TUCSON, ARIZONA

June 1973

Developed Under Office of Economic Opportunity

Contract #B2C-5379

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PART I

INTRODUCTION

This Project is based on the need to provide comprehensive health care to Indian populations living in an area characterized by great distances, low population density and inadequate transportation and communication services. The Indians living on reservations have severe and unusual health and social handicaps requiring sophisticated health and educational services usually available only in metropolitan areas.

In addition, there has been a rapidly declining availability of needed health services in rural or isolated areas due to reduced numbers of physicians entering Family Practice and progressive migration of physicians to the metropolitan areas.

For these and other reasons the Project was initiated and designed to meet the needs of people in isolated areas. This will be accomplished by making health services reasonably accessible and by extending the sophisticated health services of medical centers in metropolitan areas through the application of presently available aerospace communication technology.

It is the design of this Project to provide a health services communication system linking medical centers in Phoenix and the University Hospital in Tucson with the following Indian reservations:

Hopi
Navajo
Papago*
San Carlos Apache
White Mountain Apache

* The Papago Reservation has been selected as the site for the NASA IMBLMS project which is somewhat similar in that it is a microwave communications system but with quite different long-term objectives.

It is believed that at the conclusion of the NASA project (proposed 2 years of operation) the installation can be readily modified and integrated into the TeleMedicine Network.

Papago representatives will continue to serve on the Advisory Committee and assist in the development of the total TeleMedicine Network.

PART II

COORDINATING RELATIONSHIPS

To insure understanding, acceptance, input and participation on the part of the Indian population the Project staff has worked continuously with Indian Tribal Councils, Indian Health Councils and committees at all levels. To provide continuity of relationships with these Indian groups, a Project Advisory Committee of designated tribal representatives was formed to advise the Project Director and staff and to inform tribal organizations and tribal staffs of Project developments. This group also carries the primary responsibility for advice and consultation on community education among the Indian groups to be served. The membership of the Project Advisory Committee is as follows:

- Donald Antone - Lt. Governor, Gila River Pima-Maricopa Indian Community, Member, Arizona Inter-governmental Coordinating Committee, Chairman, Arizona Intertribal Council
- Andrew Benallie - Staff Assistant to the Vice-Chairman, Navajo Tribal Council
- Hollis Chough - Program Analyst, Economic Opportunity Unit, Arizona Department of Economic Security, (ex officio)
- Billy Kane - Representative, White Mountain Apache Tribe
- Roy Kitchyun - Councilman, San Carlos Apache Tribal Council
- Ethelyn Secakuku - Representative, Hopi Tribe
- Cecil Williams - Chairman, Executive Health Staff, Papago Tribe, Councilman, Papago Tribal Council

To insure the attainment of the objectives of the Project and provide compatibility with other efforts in the area of telemedicine, a Technical Advisory Board was established, with membership as follows:

- Donald Antone - Lt. Governor, Gila River Pima-Maricopa Indian Community, Member, Arizona Inter-governmental Coordinating Committee, Chairman, Arizona Intertribal Council
- George Bock, M.D. - Area Director, Navajo Area, Indian Health Service
- Ralph Christenson, M.D. - Lister Hill National Center for Biomedical Communications
- Albert Feiner, Ph.D. - Director, Lister Hill National Center for Biomedical Communications

- Alvin Leonard, M.D. - Representative of the Director of Comprehensive Health Planning Authority for the State of Arizona
- Charles McCammon, M.D. - Area Director, Phoenix Area, Indian Health Service
- D. W. Melick, M.D. - Coordinator, Arizona Regional Medical Program
- E. S. Rabeau, M.D. - Director, Office of Research and Development, Indian Health Service
- Y. B. Rhee- University Hospital, University of Arizona
- Larry Schooley, Ph.D. (EE) - College of Engineering, University of Arizona
- Paul Smith - Chairman, Salt River Pima-Maricopa Indian Community, Member, National Council for Indian Opportunity

The purposes of this Board are:

- To advise the Project Director on the operation of the program

- To develop coordination and operational procedures with the Indian Health Service

- To insure coordination of health planning, medical care operations, communications system operations and educational activities

- To insure coordination with State planning agencies

These activities are necessary for attainment of the objectives of the Project in the delivery of broad spectrum, comprehensive health services to the Indian people.

PART III

STATEMENT OF HEALTH PROBLEMS

The Indian population groups in Arizona are severely disadvantaged. They have suffered severe handicaps because of cultural, social, geographic, economic, educational and health factors resulting from long isolation from the mainstream of national development. Health resources have not been available in sufficient quantity to correct the accumulated health needs and to achieve a satisfactory health status.

The tribal profile and health status detailed in the following tables indicates the sharp contrast between the Health status of the Indian and that of the rest of the nation.

Table 1
Demographic Data

Reservation	Tribal Population (2)	Per Capita Income	Size
Hopi	7,250 Hopi 8,250 Navajo	$ 300	630,000 Acres Joint Use - Hopi & Navajo approx. 2,000,000 Acres. Ex. Order 1882
Navajo	126,720 (1)	300	12,000,000 Acres
Papago	13,800	700	2,000,000 Acres
San Carlos Apache	5,400	444	1,648,000 Acres
White Mountain Apache	6,700	1,130	1,664,872 Acres

(1) There are 135,000 Navajo on the Navajo and Hopi Reservations.
(2) Totals reflect numbers receiving service at health facilities and include off-reservation Indians who return to the reservations because of culture and language problems.

Table 2
Selected Indian Mortality '71
Compared to General Population

Accident Deaths	3.0 times higher
Gastroenteritis	11.0
Tuberculosis	3.5
Diseases of Newborn	2.1
Influenza and Pneumonia	2.4
Cirrhosis of Liver	4.4
Suicide	2.1
Infant Deaths	2.0

Table 3
Selected Navajo Morbidity '71
Compared to General Population

Disease	Navajo Incidence per 100,000 pop.	Gen. Population Incidence per 100,000 pop.
Tuberculosis	270	19.2
Rheumatic Fever	90	1.6
Streptococcus Infection	7,120	223.1
Hepatitis	270	24.0
Measles	140	12.8
Gonorrhea	2,480	265.2
Syphilis	380	45.7
Pneumonia	5,720	Not reported
Acute Otitis Media	12,310	" "
Chronic Otitis Media	1,900	" "
Gastroenteritis	12,700	" "
Influenza	2,660	" "
Trachoma	950	" "

Age and Education

The median age of the Indian population is approximately 17 years, compared to over 30 in the general population. About 60% of the population requesting health services are under age 20, compared to 38 years in the general population.

The median years of schooling for Indians in Arizona is 2.7. The average number of school years completed by Indians age 14 and over is 8.2 for males and 8.1 for females.

Language and Culture

The Indians have barriers of language, culture, communication and understanding of health practices which complicate the delivery of health services. Over 50% require bilingual interpreters in order to communicate with physicians.

Welfare

Approximately 70% of the Arizona Indian population receives state or BIA welfare payments.

Housing

Housing on all reservations is exceedingly inadequate. Sixty-five percent of the Papago live in houses of sun-dried mud adobe bricks which are considered below minimal standards. Seventy-six percent of the Navajo live in houses of two rooms or less, and 46% live in houses of one room, usually the traditional hogan. Insulation, heating, ventilation and sanitation are inadequate and result in a high incidence of respiratory and gastrointestinal infection.

Malnutrition

Among preschool Navajo children malnutrition is very common. During the 5 year period 1963-1967, of 4355 medical admissions of children under age 5 years, 616 had a diagnosis of malnutrition, forty-four had a diagnosis of severe malnutrition, 15 had kwashiorkor, and 29 had marasmus (American Journal of Clinical Nutrition, October, 1969).

Sanitation

There is a widespread lack of adequate water and sanitation facilities. The nature of the terrain and the rigors of the climate and the need to transport water over great distances make availability of water an acute problem. Less than one-fourth of the homes have running water or electricity, and only one-fifth have a refrigerator. The additional related problems of vermin and rodents are important health problems.

Mental Health

Poverty, cultural conflict, isolation, lack of employment opportunities, low level of education, adverse physical environment and degradation of the role of the father lead to frustration and to a marked increase in mental health problems. This results in excessive use of alcohol, disintegration of the family, increased accidents, attacks of violence and increased numbers of suicide, especially in young adults.

Transportation

No public transportation is available. The roads are largely undeveloped except for a few trunk lines. The weather in winter is a severe handicap to travel. Many Indians are without means of transportation, and must rely on relatives and friends to take them to the nearest health facility, usually at a cost ranging from $1 to $10. This constitutes a real handicap to the delivery of health care.

PART IV

RELEVANCE OF TELEMEDICINE NETWORK

TO SOLUTION OF HEALTH PROBLEMS

The health problems described in Part III involve the totality of the life style and circumstances of the Indian people. Solutions to these problems will come from programs broadly based in not only medical services but also in education, housing, employment, transportation and general communications. Each of these areas is linked to the others by a complex set of interactions.

The delivery of quality medical services on a timely basis to all individuals is a major point of entry for a positive program to improve the quality of life of the Indian people. The prevention of disease and the optimal treatment of those who become ill or injured strengthens the Indians' ability to acquire education, to seek and hold jobs and to maintain a positive self identity essential to a productive family in community life. Each increment in the medical care system is thus an increment in the total health status of the Indian.

The TeleMedicine system is uniquely suited to provide a significant improvement in the quantity and quality of health services available to the vast majority of Indians who live in small isolated communities where time and distance prevent the optimal delivery of health services. As detailed in subsequent sections of this report the TeleMedicine Network will improve the delivery of some services which are currently available only on a limited basis and will make possible other services which currently are not available at all.

The areas where TeleMedicine can be expected to have significant impact are:

- Increasing the availability of broad spectrum health services in the Indians' home communities
- Improving the supply of health manpower
- Extending the services of physicians by the use of trained physician assistants
- Linking field health stations, community hospitals and metropolitan medical centers together into a mutually supporting, fully integrated and coordinated system

- Providing on-line consultation with specialists in metropolitan medical centers

- Providing on-line laboratory, X-ray, EKG, Phonocardiographic and other technical services

- Providing a broad scope of health services in rural isolated communities without the necessity of traveling great distances and undergoing unusual delay

- Providing real-time comprehensive medical data on all patients who have received care anywhere in the health care system

- Bridging the gaps of understanding and acceptance due to culture and language

- Improving health education, prevention, health maintenance and rehabilitation services

- Improving surveillance and quality controls in health care delivery through direct interaction between medical centers and remote health service providers

- Providing a mechanism for planned and continuous upgrading of the knowledge and skills of peripheral health service providers by the conducting of continuing education programs.

PART V

GOALS AND OBJECTIVES

This Project is in support of the goals of the Indian Health Service:

"To contribute to the quality of life of American Indians through the elevation of their health status to the highest acceptable level."

The goals and objectives of the TeleMedicine Project are as follows:

Goals

- To apply advanced communications technology to the problems of comprehensive health care delivery in rural, geographically isolated areas

- To develop an economically sound, technically feasible TeleMedicine model capable of improving health services delivery in all classes of rural or isolated communities

Objectives

The University of Arizona TeleMedicine Project, in cooperation with the Papago, San Carlos Apache, White Mountain Apache, Navajo and Hopi Tribes and the Indian Health Service, will install and operate an advanced technology communication network as a means of improving the quality and quantity of comprehensive health services delivery to rural or isolated areas.

Activities of the Project will involve two broad areas:

- Design, installation, operation, maintenance and evaluation of a TeleMedicine Network.

- Application of Network capabilities to an existing health services delivery system (IHS) and assessment of Network impact on services and patient outcomes. This concept is visualized as follows:

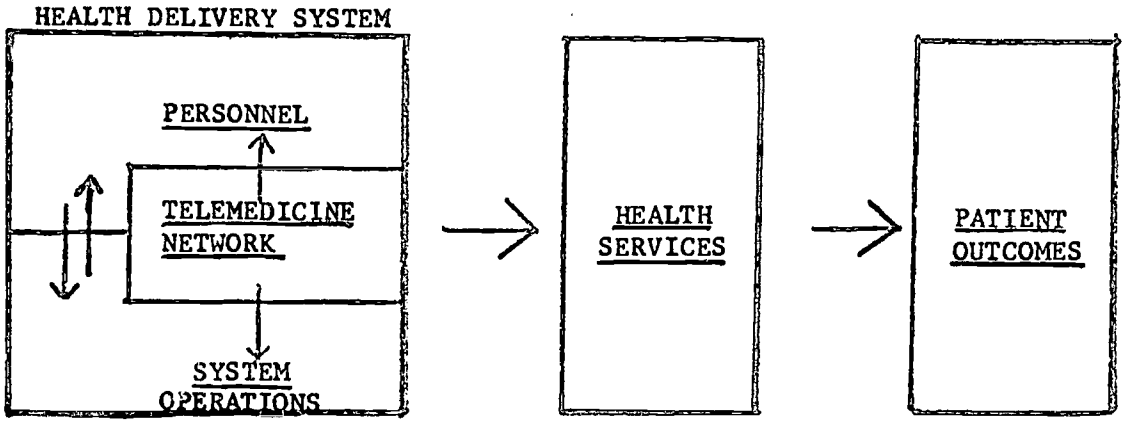


Figure 1

TeleMedicine Project

Objectives of the Network and Health Service Delivery System are discussed below. (Services and Patient Outcomes are discussed under Part IX: Evaluation)

TeleMedicine Network Objectives

- To provide on-line supervision, advice and specialist medical consultation to health service providers working in isolated Indian communities and Indian Health Service facilities in Arizona

- To direct the provision of diagnostic procedures, medical and therapeutic services which are beyond the capabilities of local health service providers

- To provide X-ray, laboratory interpretations and other technical ancillary services through the use of biotelemetry, video, facsimile, and computer analysis of technical medical data

- To provide on-line computerized health information on individual patients undergoing health care in Indian Health facilities and included in the Indian Health Service Health Information System

- To provide educational activities (lectures, seminars, clinics) designed to upgrade diagnostic and therapeutic skills of health care personnel and improve understanding of modern health practice by patients, their families and their community

- To study the communication systems design, operation and reliability

- To study the cost effectiveness of the system

- To encourage the development and application of new and innovative health services utilizing communications techniques

Health Delivery System Objectives

- To make broad spectrum health services reasonably available to population groups resident in geographically isolated areas

- To develop new and innovative health service personnel and teams and provide the means for their supervision and quality controls

- To develop techniques and procedures for the monitoring, audit and control of the quality of health services

- To bridge the barriers of culture and language by the use of interpreters and medicine men

- To study the impact of the delivery system on the health of the population being served

PART VI

RESOURCES AVAILABLE

Health care responsibility for Arizona Indians on reservations rests with the Indian Health Service. Accordingly, this Project has been developed in full cooperation with the Indian Health Service staff at all levels of planning, administration and operation. Indian Health Service facilities and staff will be available for delivery of comprehensive health care on the five reservations covered in this Project.

The Engineering Master Plan describes the network of Indian Health facilities at the specific locations in the Project. Included are Field Health Stations, Field Health Centers and peripheral community-type hospitals. All of these field facilities will receive real-time backup and specialized professional support from the Navajo Medical Center at Fort Defiance, Arizona; the Phoenix Indian Medical Center in Phoenix, and the University of Arizona Medical Center in Tucson. Consultants in all the medical specialties, as well as laboratory and technical services, will be available for immediate consultation. The Indian Health Service Contracts with community hospitals and metropolitan medical centers will be available as needed for the hospitalization of Indian patients.

The IHS Health Programs Systems Center at Tucson has a computerized real-time Health Information System available. The system is patient and problem oriented and is fully operational on the Papago Reservation. The Phoenix Indian Medical Center can access the HIS in relation to patients referred from the Papago. The TeleMedicine Project will work closely with the Health Programs Systems Center in their planned expansion of HIS to all Arizona Reservations.

IHS also has a computerized Data Processing Service Center located at Albuquerque, New Mexico which includes among its programs a comprehensive health reporting system by service area and by local Indian community.

It is proposed to utilize the capability of both the systems referred to above in acquiring the data needed for the operation and evaluation of the TeleMedicine system.

The resources and cooperation of the various tribal organizations have been assured through the coordinating relationships set forth in Section II. Specifically, each tribal organization has both area and local health councils to insure tribal consumer input and to

foster understanding, acceptance and participation in all on-going health programs. In addition, each tribe has a significant number of Community Health Representatives (CHRs) at work in the individual Indian communities or reservation sections. The CHRs are local health advocates, providing some transportation for patients and maintaining liaison with the local health staff.

The Indian Health Service, with the assistance of the University of Arizona College of Medicine, developed a training program for Community Health Medics (physician assistants) for duty in Indian Health facilities. Twenty-five CHMs have completed their two years of training. An additional twenty are in their second year of training and will complete that training in the Spring of 1974. A new class of twenty will commence training in September of 1973. The physician assistants are physician extenders and are essential to the expanded health program that the proposed communications system will make possible.

Available communication resources include Indian Health Service Public Health Nurse automobiles with radio communication and an unreliable commercial telephone network.

Certain microwave towers and facilities of existing non-medical networks (e.g., utilities, tribal police) will be utilized and are described in the Engineering Master Plan.

PART VII

SCOPE OF TELEMEDICINE PROJECT

Equipment and Network Design and Installation

The Project provides for designing, installing, operating and evaluating a broadband health communications network linking the hospitals, health centers and stations on the Navajo, Hopi, San Carlos Apache, White Mountain Apache and Papago Indian Reservations with the Indian Health Medical Centers, the Health Program Systems Center, the University of Arizona Medical Center and other metropolitan medical centers. A full-service telecommunications system will have the capability for duplex (two-way) transmission of:

- Voice
- Data
- Telemetry signals
- Slow-scan video
- Real-time monochrome/color video
- Telefacsimile.

Network design will permit, with some limitations, the following:

- Duplex communication between any two stations
- Conference-mode communications between three or more stations in the System.

The stations in the TeleMedicine Network will be of four functional levels:

- Field Health Stations - staffed by Community Health Medics
- Primary Level Referral Centers - staffed by physicians
- Area Hospitals - staffed by physicians
- Major Medical Centers - full spectrum of specialists and services.

The Network design will parallel this pattern, so that consultation service and patient referral patterns will, in general, coincide.

The details of the equipment and network design are specified in the Engineering Master Plan developed for this project by Atlantic Research Corporation.

Clinical Programs

The TeleMedicine Network will operate as an integral part and in full support of a comprehensive health care system (Indian Health Service). This health care system is conceptualized as being comprised of two major elements - personnel and operations - to which the Tele-Medicine Network will contribute to functional effectiveness. The interaction of personnel and operations results in delivery of services which in turn influence health status (outcomes).

This entire concept is diagrammed in Figure 2, page 18.

ACTIVITY	COMMUNICATION MODE (A=Audio, V=Video) (T=Telemetry, D=Data)
PERSONNEL SUPPORT	
Remote Clinical Consultation, Supervision and Support - Acute and Chronic Conditions	
Diagnosis	
Medical History	
- Medical Record	D* A/V/Facsimile
- Interview	A/V
- Language Translation	A
Physical Examination	
- Observation (Appearance, Behavior, visible lesions)	V
- Auscultation (Heart, lungs and abdominal sounds)	T
- Special physiological measurements (EKG, pulmonary function testing, other telemetry)	T
Laboratory Procedures and Interpretation	
- Body fluid examination (Blood, urine, CSF, etc.)	A/V
- Microbiology (Cultures, stained slides)	A/V
X-Ray Interpretation	V

ACTIVITY	COMMUNICATION MODE
Treatment	
- Problem solving assistance and advice regarding diagnosis and specific treatment plan (e.g., decision about diagnosis and treatment of patient with pneumonia)	A/V/T
- Remote prescribing and pharmacy services (transmission of prescriptions written by consultants, advice regarding drug dosage and schedules, identification of unknown medications, poison control services)	A/V/Facsimile
- Real-time remote observations and supervision of task performance (e.g., application of cast, suturing of laceration, preparation of severely injured patients for safe transport)	A/V
- Direct treatment (e.g., individual or group psychotherapy or speech therapy by remote therapists	A/V
- Utilization of tribal medicine men and practitioners	A/V
- Continuity and follow-up control	D*
Formal Education Programs	
- Interactive lectures, seminars, discussions	A/V
- Printed text transmission	V/Facsimile
- Remote observation, evaluation and discussion of performance of clinical skills	V
- Individual tutorials	A/V
Group Conference Calls - Non-Medical	
To provide CHM or other health care group an opportunity for discussion of common interests, problems and activities	A
DELIVERY SYSTEM OPERATION	
Health Maintenance and Preventive Medical Service	
- Health Surveillance and Maintenance	D*
- High risk patient identification and intervention	D*

ACTIVITY	COMMUNICATION MODE
- Therapy-oriented patient instruction and education (e.g., diabetes, hypertension, obesity)	V
- Family and community education (e.g., hygiene, nutrition, child care)	V
Hospital and Field Station Coordination (e.g., expediting tranfer of patient to hospital; insuring follow-up continuity for discharged hospital patients by discharge notification, transmission of records, treatment schedules, etc.)	A/V/D
Health Station Operation (Scheduling, supply, patient transportation, etc.)	A/D
Follow-up Advisory (Notification of patient care activity subsequent to initial care by CHM; CHM will know of outcome of diagnosis or treatment even if he does not see patient for follow-up)	D
Population Study, Epidemiological Analysis (Disease pattern analysis; assessment of health needs; health care planning; early detection of epidemics)	D
Emergency and Semi-Emergency Response System (large-scale accidents; area-wide disasters; epidemics)	A/D

* In areas where the Health Information System is available, medical record availability will utilize computer-generated individual medical summaries. Where HIS is not available, or where additional information is required, direct voice call-up to record libraries will be utilized, supplemented by telefacsimile or video-mediated document transmission. In all cases the medical record, whether computer-based or paper, should be in 'problem oriented' format.

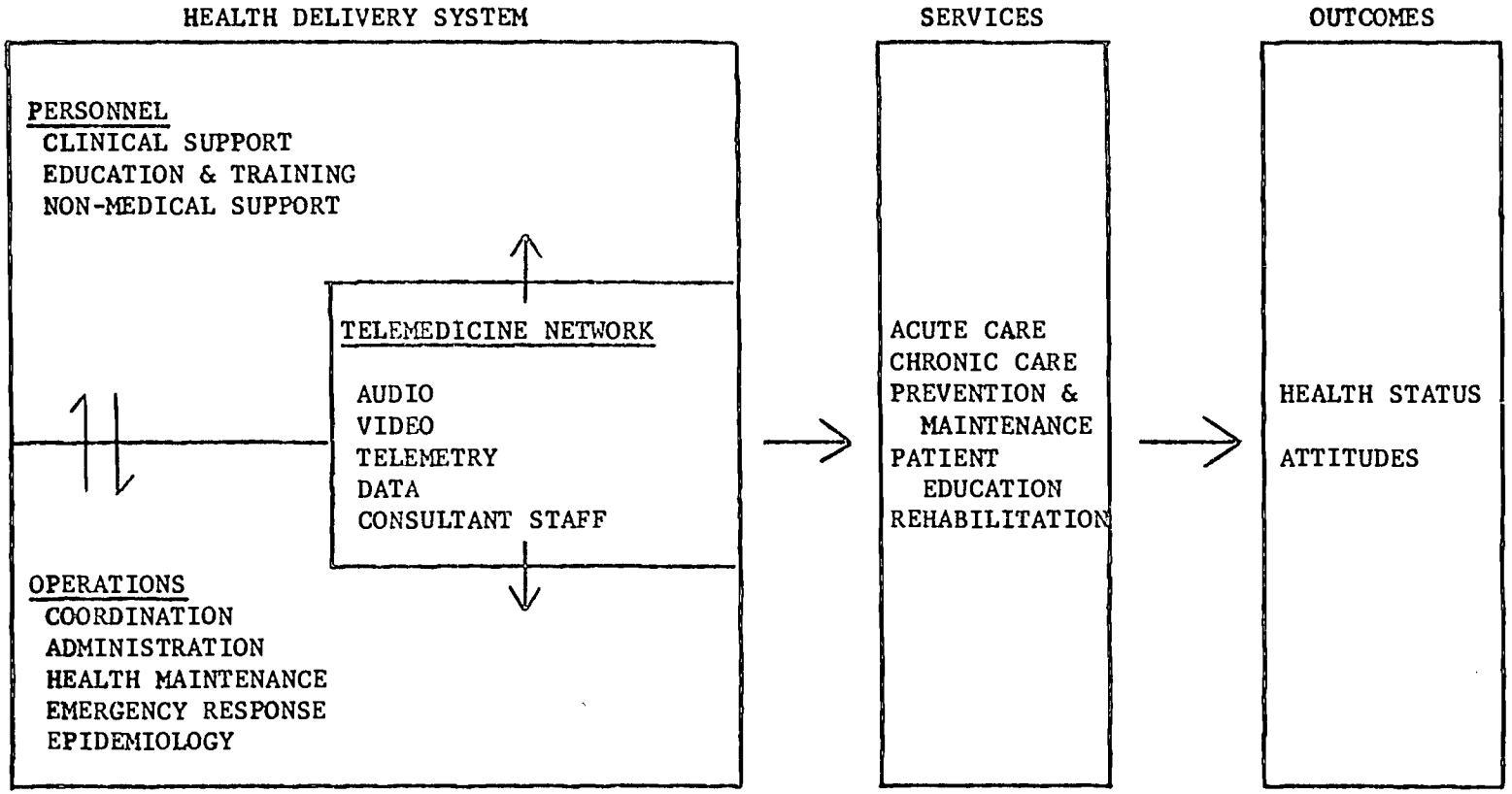


Figure 2

SCOPE OF PROJECT

CLINICAL SERVICES

Communication System Technical Study

One test program of the Project is related to the technical characteristics of the Network per se (apart from its impact on health services). This program will involve:

- Determination of optimal configuration of communication equipment for specific clinical tasks
- Assessing network demand, utilization, switching and time patterns
- Determining system reliability
- Establishing operational user manuals, logs and documentation
- Assessing human factors: patient and user response to equipment
- Determining safety and legal requirements
- Developing organizational utilization and remuneration procedures for the Medical Consultant Staff
- Determining feasibility of effective utilization of a mobile health care facility fully equipped with communication equipment
- Development of new health applications of communication technology

Cost Effectiveness Study

Activities, Services and Outcomes of the Network and of the delivery system will, as far as possible, be converted to cost figures for purposes of comparison and evaluation. This will involve:

- Comparison with alternative methods of providing the same or equivalent service. For example: some remote field clinics employ a radiologist who visits once a week to interpret X-rays. This cost (which in one clinic is $2500/month) will be compared to cost of interpreting an equivalent number of X-rays via the TeleMedicine Network.

These studies can become very complex and the TeleMedicine Project will budget for a full-time person experienced in these types of studies.

New Health Services Application

It is anticipated that as the Network becomes operational, users will suggest new and innovative applications of communication technology in the delivery of comprehensive health care services. Proposals for new applications will be encouraged from all levels of personnel. Programs having merit will be tried and appropriate evaluation methodology developed.

Non-Medical Applications Study

At a later date, after the TeleMedicine Network is fully operational, the Project scope may readily be expanded to develop a concept of multiple use of the communication system for educational, economic, social and recreational needs, utilizing capacity of the Network beyond that needed for health services consistent with medical priority and confidentiality.

PART VIII

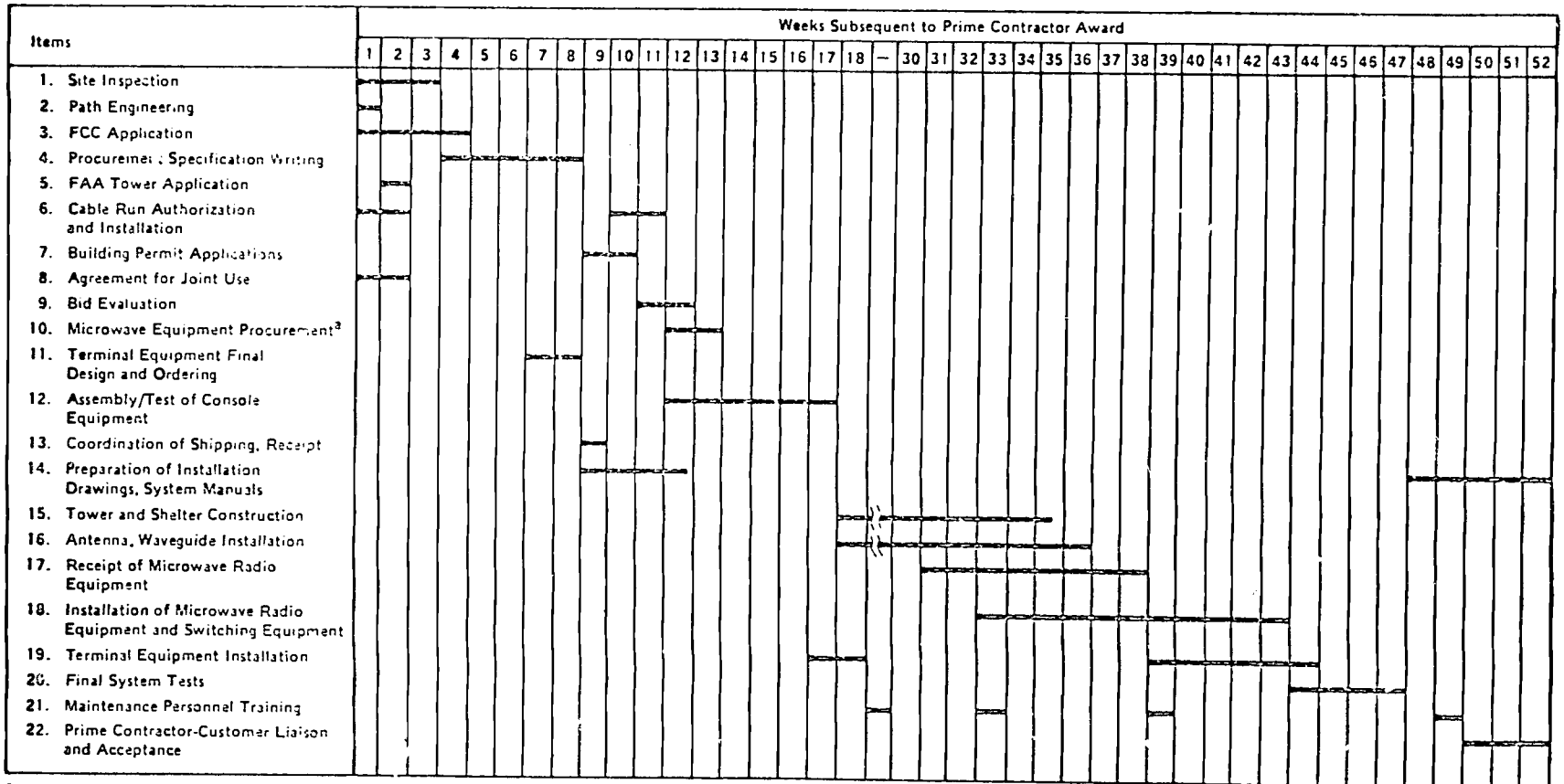
IMPLEMENTATION

A construction schedule was developed as a part of the engineering study (see following page).

The contractor selected to construct the network will be required to develop operational manuals relating to the use and maintenance of the communication equipment and microwave network installation. The contractor will also be required to train local Indian people in the installation, operation and maintenance of the system.

Since the TeleMedicine Network will operate within the context of the total Indian Health Service program, operations will be governed by existing IHS operations manuals, standing orders, etc.

Project Construction Schedule for the Arizona TeleMedicine Network.



[a]Equipment ordering will begin upon receipt of authorizations or licenses.

NOTE: Mobile unit to be constructed concurrently (schedule not shown).

PART IX

EVALUATION

The evaluation program will utilize a number of techniques. Results will have variable specificity in terms of the goal of the entire Network: namely, the improvement of the health status of the American Indian and the effectiveness of the Network in supplying needed health services.

Methods of evaluation will be based largely on actual field performance, although laboratory studies may be possible in some instances, particularly those related to validation. Individual impressions will be obtained by use of questionnaires. Clinical evaluation will be assisted by analysis of System-generated data and by chart audit of selected records.

In cooperation with the Indian Health Service Center, full use will be made of both their computerized Health Information System and their computerized comprehensive health reporting system.

Evaluation Techniques and Measures

- Use of common 'indicator diseases' as measures of system functioning
- Comprehensive study of small but representative population subsets
- Study of single cases representative of a class
- Measurement of direct care services and activities
- Measurement of preventive services
- Estimate of quality of services (i.e., compliance with medical standards)
- Patient and user attitude surveys
- Educational and training activities
- Utilization of system by provider
    - Referral pattern and frequency
    - Consultant travel
    - Time needed to effect referral
    - Type and number of services provided at primary station
    - Time delay between disease onset and detection
    - Time delay between disease onset and definite diagnosis and treatment plan
    - Occurrence of type 1 and type 2 errors.

Cost Effectiveness

Determination of cost:benefit ratio will be a major evaluation tool. Each section of the Project will be studied from this perspective. Examples of such studies might include costs related to:

Personnel Support		
CHM & TeleMedicine costs	vs	On-site physician staffing
On-site education programs	vs	Periodic return to training centers
Remote consultant staff and TeleMedicine	vs	Visiting consultant service
System Operation		
CHM & TeleMedicine & on-site care	vs	Transportation and referral center care
Services		
Network costs	vs	System charges incurred from clinical error, delay or break in continuity
Outcomes		
Cost of system	vs	Social costs of death and disability

Evaluation Design

The impact of the TeleMedicine Project will be measured, insofar as possible, by the selection of two Indian populations of comparable size and condition, both of which will receive services of a Community Health Medic one year prior to anticipated start of TeleMedicine Network. During this period baseline data related to personnel, operations, services and outcomes will be collected. Data collection will continue at both stations following the installation of telemedicine capability at one of them.

Since it will not be possible in all cases to identify comparable population groups, in many cases impact will be measured by gathering

baseline data for a period of one year prior to the start of the TeleMedicine Network and comparing those data with similar data gathered on a continuing basis following incorporation of the TeleMedicine Network into the Health Service Delivery System.

Evaluation Programs

The total effort of the TeleMedicine Project involves a number of separate but interrelated programs, as presented in the sections on Goals and Objectives and Scope. Each program will be evaluated within the context of its objectives.

The following outline summarizes the elements and parameters of each program. The outline parallels the statement of Goals and Objectives.

> The clinical goals and objectives of the TeleMedicine Project will be achieved by the interaction of communication technology with a comprehensive health care services delivery system (Indian Health Service). The TeleMedicine Network will support
>
> - Personnel
> - Systems Operations
>
> which will result in health services which in turn result in patient outcomes.

ELEMENTS	PARAMETERS
Health Delivery System Activities	
Personnel Support	
Supply	Recruitment, tenure, retention
Productivity	Types and number of services per unit time
Knowledge	Recall and retention of information
Skills	Task performance
Satisfaction	Attitudes, supervisor assessment

ELEMENTS	PARAMETERS
System Operation	
Station Capabilities	Number of referrals to other centers; referral error rate
Utilization of personnel/ facilities	Types and numbers of services per unit time; audit of task assignments and qualifications
Team Coordination	Professional time analysis
TeleMedicine Network Activities	
Communication System Design	
Configuration	See page 15
Demand/Utilization Patterns	Number of requests granted/ refused
Reliability	System down time
Human Factors Assessment	Utilization; patient and user attitudes
Mobile Unit Feasibility	(deferred pending the results of NASA findings during the course of their IMBLMS project)
Cost Studies	See page 15
Network Services	
Consultation Services	Numbers and types of services delivered; accuracy and effectiveness of remote services; validation
Lab & X-ray Services	
Health Information Medical Records	
Direction of Diagnostic and Therapeutic Services	

ELEMENTS	PARAMETERS
Clinical Services	
Quantity and Types	Types and numbers of encounters completed at first contact station
	Type and number of referrals; referral error rate (type 1, type 2)
Quality	
Accuracy	Type 1 & type 2 errors
Comprehensiveness	Compliance with medical standards
Continuity	Scheduled encounter compliance
Time	
Availability and Promptness	Time from illness onset to first encounter; appointment waiting time; time to appropriate action plan
Patient Outcomes	
"Health"	
Morbidity	Morbidity Rates
Mortality	Mortality Rates
Disability	Rates and Duration
Satisfaction	Attitudes toward System; return visits; family referrals into System

This concept is graphically represented in Figure 3, page 30.

DISCUSSION:

The measurable parameters which will be affected by the communication system are themselves variables in processes influencing health status. The relationship between a significant change in these independent variables and changes in health status (dependent variable) may require detailed analysis and interpretation. In general, any of the following patterns may exist between a change in functioning of the health care system and change in patient outcome:

- Independent and dependent variables may be directly related
- Independent and dependent variables may be inversely related
- No relation may exist
- Both may change as a function of a second, more comprehensive variable

It is recognized that ideally a demonstration of benefits and testing of hypotheses must be objective, not impressionistic. At the same time, it is acknowledged that evaluation of a communication system operating within a complex health care system which itself operates within a complex culture presents significant difficulties, among which are the following:

- Populations under evaluation are not of sufficient size for changes in morbidity and mortality statistics to be significant. Some significant changes may be obtained, however, in common acute conditions such as gastroenteritis.
- Change in health trends may not occur for many years following initiation of new programs.
- Many other programs exist or will be activated concurrently with the TeleMedicine Project; the contribution of each may not be ascertainable.
- Some changes are a result of evolutionary cultural social processes or scientific programs.

- Some types of health data are not obtainable at reasonable cost or without disruption of the health delivery process; other types of data are of unsatisfactory accuracy.

- Accurate data often has interpretive value only in very limited areas whose relation to broader questions is uncertain.

- Any element is likely to have impact on multiple problem areas; conversely, any change in a problem area is likely to be the result of multiple programs.

The problem of evaluation is further complicated by the need to evaluate both the TeleMedicine Network as a whole and the many subsystems of the Network, each of which must be assessed within more limited objectives than the main objective for the Network.

Despite the many problems inherent in evaluating a program of this magnitude, it is confidently believed that the evaluation methodology described above will yield valid conclusions regarding the significance of the TeleMedicine Project.

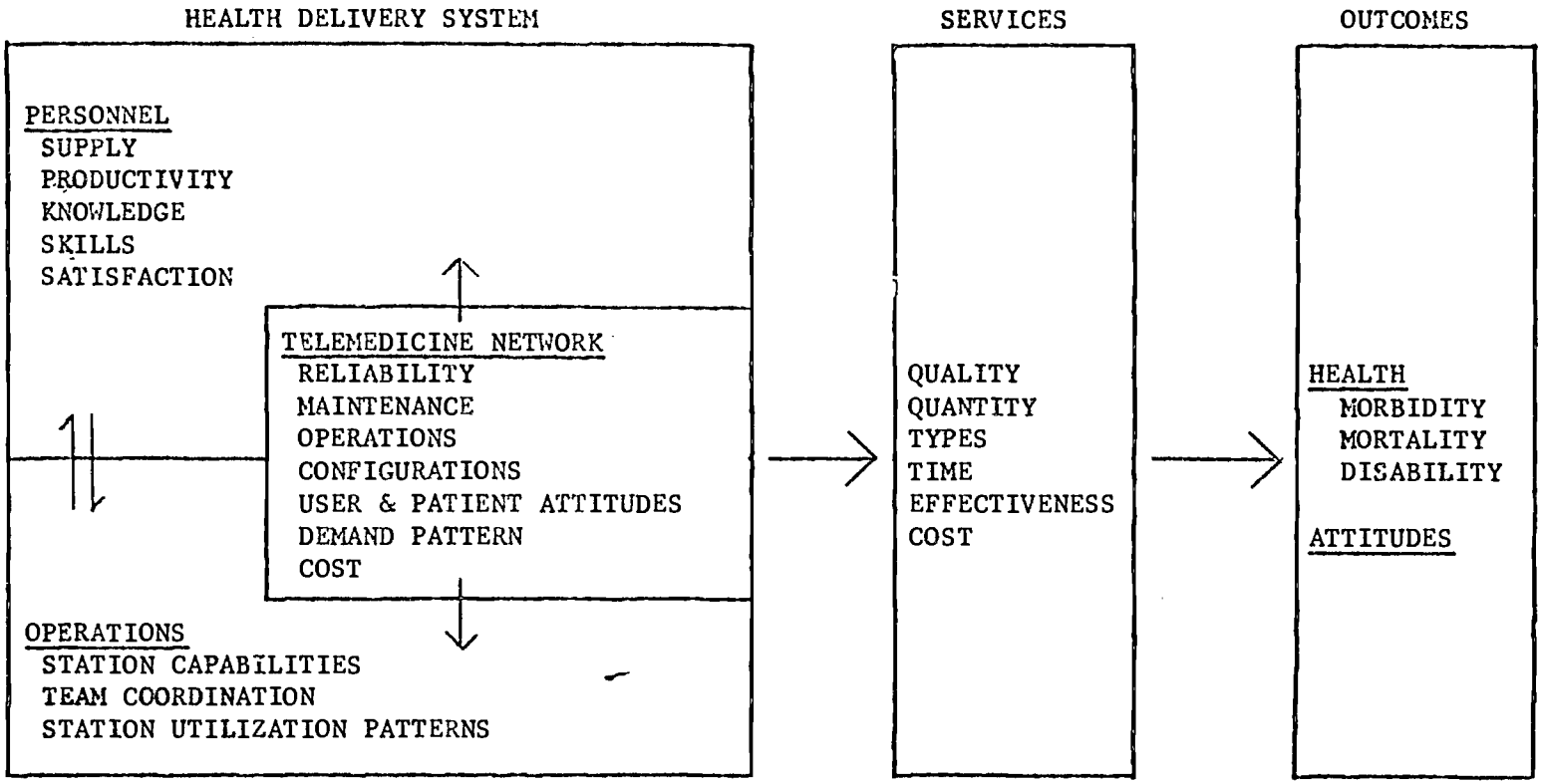


Figure 3

EVALUATION

CLINICAL SERVICES

Arizona TeleMedicine Project

APPENDIX

TELEMEDICINE NETWORK APPLICATIONS

PATIENT CARE	Pages 1-17
EDUCATION	18-21
INFORMATION SYSTEMS	22-24
ADMINISTRATION	25

PREFACE

The application of the TeleMedicine Network in this document has been focused on the use of physician assistants (Community Health Medics) on independent duty which introduces a new category of primary health services deliverer into the total comprehensive health services team.

To clarify and emphasize the CHMs role, the material contained in this appendix relates primarily to the CHMs functions and relationships to preceptors and consultants at all levels of the system.

The staff of the project have not been oblivious to the needs of local community hospitals and their professional staffs for health information, specialty consultation and interpretation of bio-medical data by the medical centers. The relationship between community hospitals and consultation centers will be worked out jointly at such time as a community hospital is included in the TeleMedicine Network dependent on the needs of the professional staff at that particular hospital.

In seeking and obtaining advice and consultation, the CHM will follow the normal referral pattern, that is: the CHMs first point of contact is the facility from which he receives direct medical supervision, either a community hospital or a health center staffed by physicians, second the Indian Health Service medical centers staffed by specialists and finally major metropolitan medical centers.

Activity	Medical Interview
Objectives	1. To enable Consultant to confirm and extend scope of historical data obtained by CHM. 2. To enable CHM Preceptors to unobtrusively observe CHM interview techniques for evaluation and education.
Operational Format	Consultant or Preceptor passively or actively observes interview conducted by CHM. He may interact with a patient to obtain additional data or to demonstrate alternative interview techniques. Tape recording of the interview may be replayed immediately following the clinical encounter so that the CHM and the observer can learn from the interview content.
Communication Modes	Audio and real-time video Video tape recording
Notes	Patient permission will be obtained for all taping.

PATIENT CARE

Activity

General Physical Examination

Objectives

1. Supervise CHM in performance of diagnostic clinical examination maneuvers.
2. Assist CHM in interpretation of abnormal physical findings.
3. Assist CHM in correct performance of clinical examination skills.

Operational Format

CHM will perform standard clinical examination. Upon his request a TeleMedicine consultant will assist in the following ways:

1. Suggesting new physical examination maneuvers for the CHM to perform while consultant observes reponse.
2. Suggest the CHM position patient and/or equipment for remote observation (e.g., place electronic stethoscope in certain chest areas, position video camera to observe specific details).
3. Suggest CHM photograph specific lesions with Polaroid camera where video camera is not accessible (e.g., pharynx, rectum).
4. Demonstrate to CHM typical lesions via photograph for CHM to "match".

Communication Modes

1. Photographic (Polaroid)
2. Slow-scan video
3. Real-time video
4. Telemetry

Notes

PATIENT CARE

Activity	Laboratory diagnosis-bacteriology
Objectives	1. Accurate interpretation of bacteriological preparations, cultures, slides. Examples, beta-hemolytic strep culture plate, urethral smear for GC sputum for predominant organism. 2. Assist CHM in collecting, handling and preparing bacteriological specimens for diagnostic examination.
Operational Format	Scheduled or unscheduled consultation with bacteriologist. On duplex TV consultant could demonstrate examples of differential diagnosis to assist CHM in improving his microscopic skills. Where indicated, consultant will observe CHM collect and prepare bacteriological specimens.
Communication Modes	A Polaroid microscope attachment Video camera microscope attachment Duplex voice video simplex or duplex
Notes	Specific experiments will be conducted to determine optimal visualization needed for diagnostic accuracy.

PATIENT CARE

Activity	Laboratory diagnosis - blood and urine
Objectives	1. To assist CHM in performance of simple laboratory procedures. 2. To assist in interpretation of stained blood smear for RBC and WBC morphology. 3. To assist in the interpretation of spun urine sediment.
Operational Format	Routine consultation - scheduled time daily Emergency consultation - upon request Consultant will remotely view gross and microscopic appearance of prepared blood and urine specimens and assist in interpretation. Consultant will have available educational atlases and demonstration materials for viewing by CHM. Where indicated, consultant will request CHM to prepare specimens and observe procedural technique.
Communication Modes	1. Voice consultation 2. Photomicrograph (Polaroid) 3. Microscope equipped with television camera - slow-scan or real-time video
Notes	Specific experiments will be conducted to determine degree of visualization required for diagnostic accuracy.

PATIENT CARE

Activity	Cardiology
Objectives	1. To assist CHM in diagnosing cardiac status. 2. To assist CHM providing optimal care for cardiac disease. 3. To extend scope of cardiac screening program.
Operational Format	1. Cardiology consultant, after preliminary presentation by CHM, will conduct specific detailed interview, evaluate physical findings by visual observation and auscultation via electronic stethoscope, interpret laboratory, xray and EKG records and may request patient and CHM to conduct special clinical tests (position changes, exercises). 2. Screening programs currently requiring on-site physicians, would be conducted by remote auscultation.
Communication Modes	Audio and video for interview and physical diagnosis Amplified stethoscope EKG - Data phone transmission or facsimile
Notes	

PATIENT CARE

Activity	Dental Care
Objectives	1. To assist CHM in the diagnosis and treatment of acute dental problems (e.g., infection, abscess.)
Operational Format	CHM will request dental specialist to view patient remotely, interpret physical findings and to supervise emergency procedures such as extraction or incision of abscess. Video camera will be remotely controlled by dentist where real-time video is needed. Views of mouth not accessible to video camera will be obtained by Polaroid camera.
Communication Modes	1. Voice and video 2. Photograph (Polaroid) of dental conditions
Notes	

PATIENT CARE

Activity	Neurological diagnosis and treatment
Objectives	1. Assist CHM to perform specialized clinical neurological tests. 2. To assist CHM interpret abnormal findings. 3. To provide patients with specialized therapeutic activities.
Operational Format	1. Neurological consultant would supervise patient and/or CHM in performance of special clinical tests. 2. Neurologist would extend scope of diagnostic evaluation by interactive video interview and physical examination. 3. Neurology service, especially physiotherapy, would instruct and observe patient requiring specialized therapy (e.g., patient recovering from a stroke).
Communication Modes	1. Voice 2. Real-time video
Notes	Brain scans and echograms may be useful between community and referral hospitals.

PATIENT CARE

Activity	Translator Services
Objectives	To provide CHM's assistance in communicating with patients who do not speak English or an Indian language known by the CHM.
Operational Format	A roster of employees of the IHS who speak Spanish and Indian dialects will be maintained by the TM Operations Coordinator. Upon request of the CHM, the appropriate interview will be "patched" into the voice circuit with the CHM.
Communication Modes	Voice
Notes	Phone patch to "Translator Bank" may assist.

PATIENT CARE

Activity	Obstetrics
Objectives	1. To assist CHM provide optimal prenatal and postnatal care. 2. To assist CHM manage labor and delivery where circumstances make this necessary. 3. To supervise administration of simple anaesthesia where emergency labor is in progress. 4. To assist in development of family planning program.
Operational Format	1. Remote viewing by consultant
Communication Modes	1. Voice 2. Real-time video 3. Electronic stethoscope for fetal heart sounds
Notes	Patient acceptance of cameras in an obstetrical setting will require particularly delicate exploration beyond the usual patient consent procedure.

PATIENT CARE

Activity	Pharmacy
Objectives	1. To assist CHM in educating patients in proper use of medications 2. To assist CHM in recognizing identified medications. 3. To advise CHM in cases of drug intolerance or incompatibility 4. To permit remote prescribing.
Operational Format	1. Pre-recorded educational programs 2. Visual inspection of unknown drugs by pharmacology specialists 3. Computerized health information system can be programmed to signal dangerous situation 4. CHM, under remote visual supervision, will prepare medication and label container when pre-packaged medication not available.
Communication Modes	Audio Slow-scan or telefacsimile for transmission of prescriptions
Notes	Legal implications of remote prescribing will be explored

Activity	Surgery
Objectives	1. To assist CHM diagnose surgical conditions 2. To assist CHM provide on-site minor surgery 3. To assist CHM provide optimal initial care to seriously ill patients requiring early transport for major surgery at referral hospital.
Operational Format	1. Minor surgery performed by CHM under intermittent or continuous remote supervision (e.g., suturing a large but not deep laceration). 2. Seriously ill or injured surgical patients evaluated by remote consultant and initial treatment provided by CHM under consulting surgeon supervision.
Communication Modes	1. Slow-scan video 2. Real-time video 3. Telemetry
Notes	

PATIENT CARE

Activity	Radiology
Objectives	1. To provide intermediate interpretation of x-rays 2. To enable CHM to properly position patients for non-routine x-ray views 3. To utilize on-site x-rays to instruct CHM in x-ray interpretation.
Operational Format	1. Non-emergency x-rays - by regular daily schedule 2. Emergency x-rays - consultant on call as necessary *3. Where indicated, consultant would assist CHM position patient in x-ray examination room.
Communication Modes	1. Possible use of Polaroid x-ray film 2. X-ray equipment and view box 3. Slow-scan and real-time video with zoom lens
Notes	*1. May require removal of the video camera from its fixed mount to a movable mount 2. Use of CHM for fluroscopic procedures with remote observer will be explored

Activity	Pediatrics
Objectives	1. To assist the CHM diagnose and treat sick children. 2. To assist the CHM evaluate well children in terms of medical, psychological and social development.
Operational Format	CHM performs Denver Developmental Status Test (DDST) under supervision and with the interpretation of the consulting pediatrician. Consultant extends scope of diagnostic evaluation by interactive interview and examination.
Communication Modes	1. Voice 2. Real-time video 3. Telemetry
Notes	

PATIENT CARE

Activity	Orthopedics
Objectives	1. To assist CHM in diagnosing and treating minor orthopedic conditions (sprains, undisplaced fractures). 2. To assist the CHM in performing on-site reduction of simple fractures and in properly applying splints or cast. 3. To assist the CHM evaluate and initiate care of the seriously injured preparatory to transport. 4. To educate the CHM and the patient in essential post-treatment care (range of motion exercises).
Operational Format	Orthopedic consultant would observe patient and area of injury - would interpret x-ray of injured area and supervise, real-time, CHM as he applied splints or casts if indicated.
Communication Modes	1. X-ray 2. Slow-scan video 3. Real-time video
Notes	

Activity	Pulmonary disease
Objectives	1. Assist CHM perform pulmonary screening tests. 2. Assist CHM in diagnosis of status of patients with pulmonary disease. 3. Assist patients in developing home care programs (e.g., postural drainage or breathing exercises).
Operational Format	Voice and telemetry link established to Pulmonary Function Center - U. of A. CHM would instruct and supervise patient in performance of necessary respiratory maneuvers. Telemetry and printout automatic processed.
Communication Modes	1. Amplified stethoscope 2. Spirometer 3. Spirometer with potentiometer 4. Chest x-rays 5. Send-receive teletype with acoustical coupler for computer program.
Notes	

PATIENT CARE

Activity

Mental health-psychotherapy

Objectives

1. To assist CHM in diagnostic evaluation of emotional and mental problems.
2. To assess severity of mental illness and danger to patient and others.
3. To provide real-time interactive therapy with remote psychiatrist.
4. To develop special group therapy sessions (e.g., alcoholism).
5. To provide counseling for CHMs and mental health workers
6. To provide guided supervision in developing interview skills.

Operational Format

1. Traditional one-to-one interaction via interactive television.
2. Group therapy interactive voice and video (two stations only).
3. Group therapy interactive voice; simplex video (three or more stations).
4. Use of immediate replay of interview for self confrontation techniques.
5. Trainees would observe (with patient permission) actual psychotherapy ("electronic one-way mirror").

Communication Modes

1. Duplex voice
2. Duplex video
3. Tape recorder

Notes

Permission will be obtained for all taping.

Activity	Hospital Liaison
Objectives	To facilitate initiation and completion of hospital care - reduce hospital days
Operational Format	1. Extension of the professional expertise of medical centers by on-line consultation with medical consultants. 2. Use of biotelemetry for medical center interpretation and advice. 3. Familiarize consultant with patient's condition to insure safe transport and planning prior to arrival of patient referred to the medical center, (e.g., spinal cord injury). 4. Daily schedule of medical center x-ray and laboratory consultant interpretation of community hospital x-rays and laboratory data. (Emergency consultation available at any time.) 5. Upon hospital discharge information transmitted to local clinic to permit follow-up and continuity of care. 6. Tribal "Sing" televised for patients with severe cultural and language barriers.
Communication Modes	Voice Video Biotelemetry Telefacsimile
Notes	

Activity	Continuing Medical Education
Objectives	1. To provide CHMs in field with a source of continuing medical education. 2. To provide community hospital professional staffs with scheduled continuing education programs.
Operational Format	1. Discussion and conferences - CHM group and preceptors 2. Discussions and conferences - CHM group alone 3. Individual or small group tutoring 4. Didactic presentation - observe only (films, lectures) 5. Scheduled formal continuing education programs for field and community hospital professional staffs 6. Formal teaching sessions with voice interaction (U of A Medical Center grand rounds with remote questioning) 7. Formal examinations (video display with test materials)
Communication Modes	Voice-duplex Voice conference Video, simplex, voice duplex Video & voice duplex
Notes	

Activity	CHM Evaluation
Objectives	1. To assess clinical ability of individual CHMs 2. To assess CHM level of medical knowledge and information
Operational Format	1. Evaluator remotely observes CHM perform medical interview and physical examination 2. Evaluator develops testing materials such as used by the National Board of Medical Examiners 3. Examination materials developed by CHM office 4. Instant replay of performance for critical analysis
Communication Modes	1. Audio 2. Real-time video 3. Previously distributed test materials coupled with real-time audio or visual conference circuits 4. Video tape recordings of CHM performance to be played back for self-confrontation
Notes	Correlate with Proficiency Certification Record

Activity	Library resources
Objectives	1. To make available on a timely basis published materials related to active medical problems and to make available relevant materials requested by the CHM. 2. To make available materials related to CHM Educational Programs. 3. To make available library materials related to local hospital and clinic professional staff problems and organized continuing education programs.
Operational Format	1. Physician consulting with CHM about a clinical problem may request the library to retrieve relevant recent articles. 2. CHM Training Office may develop materials to be distributed by Telecommunications (educ. materials, bulletins). 3. Director of professional continuing education programs may develop materials to be distributed by Telecommunications. 4. Use of resources of medical library networks as requested by individual professional staffs and transmitted by Telecommunications network.
Communication Modes	1. Telefacsimile 2. Slow-scan video with direct printout
Notes	

EDUCATION-PATIENT

Activity

Patient-Education

Objectives

1. To provide basic health education for patients with common diseases - e.g., diabetes, hypertension, obesity.
2. To provide basic health education for patients with basic health information needs - e.g., prenatal care, child care, dental hygiene, accident prevention, family planning.
3. To provide individual patient instruction for specific patient care - e.g., dietary instruction.

Operational Format

1. Films, lectures. Didactic presentation with interactive questioning for complex patient care problems.

Communication Modes

1. Voice
2. Slow-scan video
3. Real-time video
4. Telefacsimile
5. Tape recorder for development of on-site taped library

Notes

To be compared with on-station communication materials such as video cassettes or motion pictures

INFORMATION SYSTEM

Activity	Patient Follow-Up Registery
Objectives	1. To provide CHM information of patient care outcome.
Operational Format	CHM automatically notified whenever a patient he has been following returns for care within the Indian Health Service.
Communication Modes	Teletype
Notes	Available only in areas served by Indian Health Service Health Information System.

INFORMATION SYSTEM

Activity	Rapid Dissemination of patient and community health information
Objectives	To disseminate information requiring prompt response, e.g., high-risk patients, families and communities and warnings of expected epidemic.
Operational Format	HIS-HPSC analysis will identify high-risk patients and families and existing or developing epidemics. Print-out lists will focus staff attention, determine problem response and facilitate plans to maximize effort of available resources (education, immunization, treatment needs) notify all stations; receive immediate response and modify plans accordingly.
Communication Modes	Voice, duplex Teletype
Notes	Available only in areas served by Indian Health Service Health Information System (see Page 12 of Program). Telecommunications system will make it possible to readily expand HIS to all covered reservations. Staff will work with Indian Health Service to this end.

Activity	Medical Records
Objectives	To provide CHM with rapid access to complete patient health record.
Operational Format	Where Health Information System is available routine Health Information System Computer interrogation and print-out. Dial up to record room for voice report; transmission of documents by video or facsimile.
Communication Modes	Teletype Video Facsimile
Notes	See Page 12 of Program. Telecommunications system will make it possible to readily expand HIS to all covered reservations. Staff will work with Indian Health Service to this end.

ADMINISTRATION

Activity	Communication support for Indian Health Service Administrators
Objectives	1. Coordinate administrative programs 2. Provide mechanism for regular conferences for problem solving purposes.
Operational Format	1. Individual and conference calls. 2. Rapid transmission of messages requiring prompt response.
Communication Modes	Voice - duplex and conference mode Video Telefacsimile
Notes	