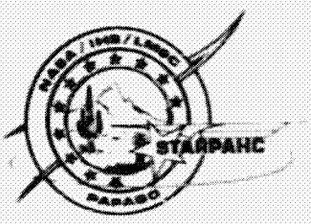

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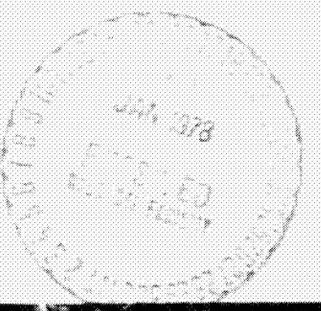
STARPAHC SYSTEMS REPORT



Volume 2 — OPERATIONAL PERFORMANCE

LOCKHEED MISSILES & SPACE COMPANY, INC.
A SUBSIDIARY OF LOCKHEED AIRCRAFT CORPORATION

FOREWORD

Lockheed Missiles & Space Company, Inc. (LMSC) submits this STARPAHC System Report (Vol. 1 and Vol. 2) in compliance with Contract NAS 9-13170 dated 15 December 1972, covering the total four and one-half year contract period evaluation.

This, Vol. 2, contains the in-depth summaries of the data resulting from 2 years of operational evaluations. Vol. 1 should be consulted for a brief summary of the STARPAHC Program, its history, and report highlights.

This program for Space Technology Applied to Rural Papago Advanced Health Care (STARPAHC) is being conducted under the auspices of the NASA (Johnson Space Center), Norman Belasco, Project Officer, working in conjunction with DHEW (IHS-ORD), Stuart Rabeau, M.D., Director, and the Papago Indian Tribe, Cecil Williams, Chairman of the Tribal Council, and the Executive Health Staff of the Papago Tribe. The LMSC STARPAHC Team is under the direction of Frank Riley, Program Manager.

The STARPAHC system (description in Appendix B) was evaluated over a 2-year operational period. Evaluation of the medical aspect is being conducted by IHS under the direction of James W. Justice, M.D., and evaluation of the hardware aspect is being conducted by LMSC under the direction of William C. Wyatt.

GLOSSARY OF ABBREVIATIONS

(See Table 2-33 for Glossary of Computer Terms)

ACC	Albuquerque Computer Center
APU	Auxiliary Power Unit
B&W	Black and White
baud	Unit of Signaling Speed
BIA	Bureau of Indian Affairs
CHR	Community Health Representative
CHM	Community Health Medic
CHN	Community Health Nurse
DHEW	Department of Health, Education, and Welfare
ECG	Electrocardiogram
EHS	Executive Health Staff of the Papago Tribe
EMCRO	Experimental Medical Care Review Organization
HIS	Health Information System
HRA	Health Resources Administration
HSA	Health Services Administration
HSSCC	Health Services Support Control Center
Hz	Hertz (cycles per second)
I.D.	Identification - LMSC Employee Number or IHS Medical Record Number
IHS-ORD	Indian Health Service - Office of Research and Development
IMBLMS	Integrated Medical and Behavioral Laboratory Measurement System
IPO	IMBLMS Program Office
JSC	Johnson Space Center
LHSC	Local Health Services Center
LMSC	Lockheed Missiles & Space Co., Inc.
LPN	Licensed Practical Nurse
MHU	Mobile Health Unit

GLOSSARY OF ABBREVIATIONS
(continued)

MHW	Mental Health Worker
MHz	Megahertz (million cycles per second)
MUX	Audio Multiplexer Unit
NASA	National Aeronautics and Space Administration
NASA-MEDICS	NASA Medical Information Computer System
OPD	Outpatient Department
OPV	Outpatient Visit
PAM	Portable Ambulance Module (Telecare Unit manufactured by SCI Electronics, Houston, Texas)
PAR	Performance Acceptability Ratio $\text{Gross PAR} = \left(1 - \frac{\text{Failures}}{\text{Telecommunications}}\right) 100 = \%$ $\text{Net PAR} = \left(1 - \frac{\text{Anomalies (Fair, Poor, Failures)}}{\text{Telecommunications}}\right) 100 = \%$
PHN	Public Health Nurse
PHS	Public Health Service
PIMC	Phoenix Indian Medical Center
PRC	Phoenix Referral Center (STARPAHC terminal equipment located in Phoenix Indian Medical Center)
QRS	Quijotoa Relay Station
R&DD	Research and Development Division (of LMSC)
rf	Radio Frequency
STARPAHC	Space Technology Applied to Rural Papago Advanced Health Care
TCE	Telecommunication Equipment
TTY	Teletypewriter
UPS	Uninterruptible Power System
VA	Veterans Administration
VHF	Very High Frequency (STARPAHC 170-MHz Band)
VTR	Video Tape Recorder
WDG	Wind-Driven Generator

CONTENTS

FIGURES

TABLES

TABLES (continued)

Section 1

SUMMARY

The major goal of the STARPAHC project was to evaluate the value and potential of telemedicine using Physician's Assistants for providing quality health care delivery to people in a remote area. Generally, the program goals were to:

- Establish the feasibility of the STARPAHC concept in the delivery of health care.
- Gain information for developing health care systems for future manned spacecraft.
- Determine the constraints and capabilities involved in the interaction between physicians and non-physician health care personnel.
- Determine effectiveness and exportability* of the STARPAHC technique.
- Define the additional developments that are needed and/or most valuable to improving telemedicine and its exportable potential.

OUTSTANDING CHARACTERISTICS

Outstanding characteristics that may distinguish the STARPAHC project from the many others called telemedicine projects are:

- STARPAHC is the only project where both consumers, health providers, and engineers jointly developed the initial design requirements, and cooperated in every step of the project including operations.
- STARPAHC may be, today, the only project to operate in a large remote area for two years, serving a population of about 10,000 people.

*Exportability is defined as "The potential for transferring in whole or in part, the STARPAHC concept, data, and information. Purposes may be to utilize for analyses or decision judgements in planning, engineering, and implementing telemedicine systems to meet the needs of specific operational sites".

- o To date, the most extensive hardware, medical, and cost evaluation data for any telemedicine project have been collected during the two years of operation of STARPAHC.
- o STARPAHC is the only system to continually upgrade capabilities with developing technological innovations.
- o STARPAHC is one of the few telemedicine projects where significant cultural and language diversities were included in both the planning and operational phases.
- o STARPAHC is one of the few projects directly associated with NASA and other space contractors whose engineers and physicians have had prior experience in the design and manufacturing of equipment to support remote health care.
- o STARPAHC is the only project to operate within a rural comprehensive care setting, with as many and diverse types of health providers, e.g., MDs, DDSs, Pharmacists, Laboratory Technicians, Physical Therapists, Community Health Medics (CHM), and Tribal Health Workers.

BASELINE COMPARISON To give evaluation data on the project, reference baseline data on prior-to-STARPAHC operation was collected for the prior five years and compared against the STARPAHC 1st year (May 1, 1975 through April 30, 1976) and the 2nd year (May 1, 1976 through April 30, 1977). Results of this comparison for the nine districts comprising the Papago reservation's main body were:

- o Increased utilization of all health care facilities after STARPAHC was initiated.
- o Increases in (1) the number of patient visits, (2) the ratio of patients to patient ambulatcry care visits by district of residence, and (3) the percent of total population using services.
- o Increases in the three factors, itemized above, were significantly greater for those patients residing in the three most western districts whose closest and most frequently used health care facility was the Mobile Health Unit (MHU).

Increased utilization of the health care facility after STARPAHC initiation was evidence of achieving the general health objectives of the Papago Executive Health Staff and the Indian Health Services. The increase is attributed to the expanded field clinic operations under STARPAHC, by use of a Mobile Health Unit and the Santa Rosa Clinic.

It was noted that accompanying the increased utilization of health care facilities was the increased utilization of non-physicians to provide direct health care. The number of visits to Physician Assistants and LPNs, as well as the number of patient contacts by tribal health workers were significantly increased.

A principle objective of the STARPAHC project was to improve or match the quality of care provided prior to STARPAHC. Results showed that:

- o CHM's, working independently, achieved quality of care comparable to physician staffed sites.
- o Quality of care provided at the MHU is equal to or better than other health care facilities, whether staffed by physicians or CHMs.
- o All health care facilities evaluated (Sells Hospital, San Xavier Health Center, Santa Rosa Health Center, and the MHU) demonstrated quality of care equal to or better than that provided prior to STARPAHC.

MEDICAL TELECOMMUNICATION UTILIZATION

Utilization of telecommunication for patient consultation averaged 9.2% of the total patient visits. The MHU two-year average was significantly greater than the Santa Rosa Clinic (18.6% compared to 3.2%). This difference is partly attributed to the predominant use of telephone consultations at the Santa Rosa Clinic, which were not monitored as contrasted to the MHU telecommunications, which were monitored. Routine school examinations and influenza immunizations at the Santa Rosa Clinic accounted for a large number of patient visits and this type of visit does not generate a need for remote consultation, which also helps to account for the difference in the percent of the total patient visits between the two health care facilities.

Of the 3,648 patient visits to the MHU during a one-year period, teleconsultations were needed for 439 health problems, about 12% of all problems. Video teleconsultations, between the MHU's, CHM and the Sells physician, were used for approximately 3.5% of all visits.

Highest percentage of problems requiring telecommunications was accidents and injuries (38% out of the total of 79 accident diagnoses). Next was diseases of the skin (27.9% out of the total of 179 skin diagnoses). Metabolic, nutritional, and blood disorders required 21.4% out of the total of 206 disorders. Respiratory diseases resulted in the largest total number of diagnoses (771 or 21.4% of total diagnoses), however, they only required 55 telecommunications (7.1%) of the total telecommunications.

Physician direction has been effective in diagnosing and/or treating patients by telemedicine in cases of fractures, lacerations, minor surgery, throat lesions, skin ulcers, snake bites, respiratory infections, gastroenteritis, etc. Physician and CHM users have reported that the TCE capability has been critical and/or essential in a large percentage of the teleconsultations. (86.3%)

VALUE OF VOICE AND VIDEO TELECONSULTATIONS

Quality of medical telecommunications perception by the health providers (Physicians, CHMs) during the 12-month evaluation period, indicated that 85% of the total telecommunications were acceptable.

Video teleconsultations were used most often for help in diagnosis, treatment, or therapy. Voice telecommunications were used most often to gain information from the lab, records, appointments, etc.

During a 12-month period, there were 170 TV teleconsultations which resulted in;1) elimination of 49 physician or dental referrals which removed the necessity for the patient to make round trips of from 76 to 150 miles, and 2) 43 referrals which indicated the need for the physician/CHM interaction.

Physicians rated 78.3% of all TV teleconsultations and 72.5% of all voice teleconsultations as either critical, or important and useful for proper care.

CHMs indicated that they believed 93.1% of all TV teleconsultation and 97.0% of all voice teleconsultations were critical, important, or useful for proper care. Video teleconsultations has resulted in many hundreds of miles of patient travel saved. Slo-Scan TV evaluation experiments are not included in the above data.

RESEARCH EVALUATION OF LOW COST, INNOVATIVE SLOW SCAN TV

Radiology. A medical X-ray evaluation experiment was conducted during which selected test X-ray images were transmitted from Sells hospital to the Phoenix Indian Medical Center over dial-up telephone lines to be read there by a radiologist. Excellent agreement (100% reliability) on the interpretation of the negative or positive pathology was obtained by the radiologist and the original interpretations; however, the radiologist had difficulty with lesions identification and location on the positive images. Explanation for the missed diagnosis was indeterminate. The radiologist stated, "lesions were seen on the monitor, but were not appreciated when the film images were mixed in with normals during the transmission sequence". The need for training of the radiologist to interact with the video presentation is a valuable result of the evaluation. Another is improvement of resolution.

Patient Examination

Specific experiments were carried out to determine the effectiveness of the color TV system to transmit adequate skin tones and orbital structure over the slow scan TV from Sells to Phoenix.

Limitation of the camera capabilities and lighting resulted in inadequate color differentiation within the skin tone range of hue for diagnosis of dermatological lesions. Similar difficulties were encountered in ophthalmologic problems, where it was found that elevated light levels needed to produce adequate coverage caused the eyes to tear. The existing system requires considerable improvement by providing higher quality cameras and peripheral supporting equipment.

Microscopy

Experiments were carried out to evaluate the quality of transmitted microscopic slide images over slow scan TV. It was found that out of the transmission of 110 slides of blood smears, 98 were judged as acceptable quality (89%). Out of 56 slides of mixed flora transmitted, 50 were judged as acceptable quality (89%).

Accuracy of reading 98 slides of blood smear was graded as 89% correct out of the total transmissions. Accuracy of reading 50 slides of mixed flora was graded as 58% correct out of the total transmissions.

Conclusions reached were that blood smears and large specimens could be transmitted over slow scan TV with acceptable accuracy. The mixed flora slide transmissions revealed that when the size of the cells was very small, the morphology and gram stain category of the cells were difficult to read.

EQUIPMENT PERFORMANCE

The STARPAHC system equipment performed exceptionally well after the early months of shakedown were over. Significantly, the use of reasonably priced (commercial) off-the-shelf equipment has been a firm program rule. Historical reliability performance data on this equipment are sparse, contrary to popular belief, and quality control is largely indeterminable. These factors contributed in large measure to early equipment failures, to the necessity of a "burn-in" period to establish performance, and to the importance of thorough system engineering and selective integrated system testing. Results to date strongly indicate that off-the-shelf equipment can be synthesized into a reasonably dependable and maintainable well-performing telemedicine system.

An average of 273 patient visits per month were made to the MHU while the Santa Rosa averaged 427 per month. 57.6% of all telecommunications were used for medical purposes. Teleconsultations between the physician and the CHM accounted for 25.7% of the total. An average of 308 telecommunications per month were held. Quality of transmissions, as measured by the system operators, was rated excellent/good 90.5% out of the total telecommunications.

Performance of 22 telecommunications equipment subassemblies was monitored during the 2 years of operation. Of the 7390 uses, there were 120 classified as having some equipment failure. The resulting performance acceptability ratio (PAR) was 98.4% for the entire 2 years. Telecommunications equipment for each 6-month period was used from 1520 to 2022 times, with reductions in failure rates from 43 to 19, progressively improving from start to completion.

The MHU, on a schedule of four village stops per week, lost only 13 days of service in the 2 years and traveled 43,346 kilometers (26,940 miles). Twelve of those days were scheduled for major maintenance of the MHU. On only one of those days were alternate clinic arrangements not provided to the village scheduled for service. Trouble reports on the MHU vehicle and equipment dimished progressively, indicating the value of early remedial actions, preventive maintenance, and proper care.

USAGE OF TCE

TV microscopy had a low usage due to: 1) lack of training, knowledge, willingness and familiarity with the microscope and slide image transmission, 2) pricrity decision by the CHM to assign set-up time in a crowded high density patient-load environment, and 3) limited need for that type of data.

Instruments used for examining inner orifices (ears, mouth, etc.), e.g., endoscope, had a low usage because: 1) cumbersome design was time-consuming to set up, 2) oral pathology could be more easily achieved through attaching a close-up lens to a standard color camera, and 3) excessive dust caused damage to fiberoptics. Other examining instruments which had low usage were the ECG and Heart Sound monitor. This low usage was attributed to the low evidence of heart disease in the Papago Indians, lack of cardiologist at the Sells Hospital, and relatively easy referral to a hospital with a cardiologist.

Communication modes most often used were the dedicated voice channels of the narrowband system (hotline and hands-free audio channel). The wideband audio channel which was a back-up to the prime narrowband audio channel was seldom used due to the reliability of the prime audio mode.

The telemtry used for remotely controlling the TV cameras in the MHU and the Santa Rosa Clinic were used frequently by the physician and/or support personnel assisting the provider.

In summary, usage of the TCE varied from high usage for the most direct means of communications (audio) to low usage for specialized instrumentation. Fifty percent (or twelve) out of the list of 24 TCE identified for STARPAHC had high usage and accounted for 97.6 percent of the total use.

PROVIDERS AND PATIENTS ACCEPTANCE

A series of interviews were completed by a DHEW behavioral scientist from outside the Office of Research and Development.

Twenty-one physicians and 5 CHMs were interviewed. Six physicians stated that training in many cases was not enough and that retraining is needed if constant use of the equipment doesn't take place. More training was requested by one CHM. The majority of physicians had not used computers or TV before STARPAHC, however, they had worked with CHMs.

It was reported, as anticipated, in 15 interviews out of 65 interviews (23%) that a teleconsulation, although acceptable, was not a substitute for a face-to-face encounter.

Major negative effects of telemedicine mentioned were: 1) time lost by physician when CHM had to set up equipment for consultation or had to modify set up, 2) leaving the patients in the exam room while having to go to the special teleconsultation room, and 3) time lost from equipment malfunctions.

Most important findings were; the majority of physicians said the teleconsulation has resulted in change of treatment plans, and one physician reported that STARPAHC had given him more confidence in the CHM's ability to deal with patients and consequently gives the CHM more credibility and authority. Other changes in treatment reported were; 1) that more precise descriptions were

required than in face-to-face encounters, and 2) the CHM relies more on the physician and can show area of problem to physician on TV.

Both the physician and CHM felt that STARPAHC was useful in helping to learn about difficult cases as they came up. The potential value for education of physicians, CHMs, and community was also mentioned.

Out of the twelve practicing physicians at Sells, five physicians said they had no consultation where voice communication alone couldn't have solved the problem. The other 7 physicians at Sells said TV was important in making a diagnosis.

Only one physician was apprehensive about using TV and other STARPAHC equipment. The remaining eleven said they were either neutral or enthusiastic. The majority of interviews indicated that the providers thought that STARPAHC would be successful, attributed to the fact that the improved access afforded many Papago patients medical care. All providers see value in technology that provides better access of care to the patient and encourages more appropriate and equitable use of medical services.

The majority of Papago patients interviewed said; 1) they liked the service provided (93.3%), 2) they liked the attitude of the mobile staff (100%), 3) questions had been clearly answered (75%), 4) waiting periods were about the same as at the Sells Hospital (61.3%), 5) the MHU had not been late (74.1%), and 6) they prefer to visit the health service at the MHU site rather than go to either the Sells OPD, or the Santa Rosa health center.

There was requirement to transmit the physician's image from the Sells hospital to the MHU or to the Santa Rosa clinic and display it on a TV monitor. Patients when asked the question whether it was important to see the Sells physician on the monitor, 71.5% responded yes.

OPERATING COSTS

Cost considerations as evaluating factors must be viewed in the context of the program's principle goal and that, as previously stated, is to provide quality health care to people in remote areas both nationally and internationally. Offering physicians excessive monetary rewards has not been a workable or permanent solution (although in isolated cases, it may have been an acceptable temporary stopgap measure). Therefore, when cost is being used as a decision and/or evaluation factor, it must be considered relative to the value and need for a solution to the problem of remote-area health care delivery. In this context the STARPAHC effort was essentially for research and development and not "production".

To provide objective, accurate cost data, STARPAHC conducted a continuous, thorough cost analysis, considering both the recurring and non-recurring costs for the system and each of its major elements and functions. Existing data reveal that the "cost per outpatient visit" figures are most meaningful and do equate favorably with costs for outpatient visits in comparable facilities without telemedicine capability.

For example, the total annual recurring cost for all maintenance and operations resulted in a cost of $49.69 per outpatient visit (OPV).

To further understand the significance of cost per outpatient visit, one must consider other hypothetical applications of STARPAHC: the MHU and Santa Rosa clinic could be operated either on a longer schedule (such as a two-shift basis), or the patient density could increase significantly. In the former application, there would be additional costs associated with the salaries of the operating personnel; in the latter application, there would not be any cost increase. In both applications, one could expect a significant reduction in the cost per outpatient. In view of these potential operational changes, one must carefully assess the environment in which the system operates and recognize that cost per outpatient can be directly proportional to the number of outpatient visits, which can vary widely depending upon the application of the system.

IHS projected costs of operating STARPAHC after the transfer from NASA resulted in certain economies effecting a reduction of OPV cost to $47.22.

SOFTWARE PROGRAMS VALUE

The Health Information System, a computer-based source of patient histories, was invaluable in assisting the providers with up-to-date medical records. The STARPAHC computer performed a data concentrator function in acting as the port of entry for request for this data.

The Medics application software consisted of programs designed to interact with a user at his terminal. They supplied the user with; 1) reports of medications due for inpatients, 2) schedule for any clinic in the system, and 3) guidelines of care for diagnosing diseases. These programs, except for scheduling, showed low usage due to: 1) low number of patient medications, and 2) communication between physicians and CHM's resolved most problems associated with diagnosis.

EXPORTABILITY

The STARPAHC concept, data, and information will be of benefit and significance to future planners of another telemedicine project. The concept of interactive telecommunication between professional health care personnel operating from fixed and/or mobile health facilities and physicians based at central hospitals has proven to be practical, and quality of care has matched or has improved upon that provided by the conventional physician/patient relationship. Modification of the concept by placing less qualified (dependent) CHM's in the field monitored by more qualified (independent) CHM's is under investigation. Expanding the concept to include larger hospitals with medical specialization has been successfully demonstrated with research evaluation of Slow-Scan TV transmission for radiology, patient examination, and microscopy.

In Section 4, a cross-index between the report data and its location in this volume is provided that will be of value in telemedicine planning. Information is provided regarding the various options that are available in terms of telecommunication equipment, computers, facilities personnel-services/ skills, and logistics.

Telecommunications equipment (TCE) as defined for STARPAHC consists of the communication transceivers, and their associated peripheral sensor instruments such as the narrowband transceivers and an ECG recorder.

Selection of specific TCE is dependent on the system requirements. If voice/ data transmission is the requirement, then there is a broad selection of RF equipment in the narrowband and VHF range. If video transmission is required, two options are available, wideband and Slow-Scan TV. If audio is also required with the video, program audio channels (hi-fi) can be provided with the wideband transceivers. Voice requirement is easily supplemented with Slow Scan by simply adding an additional telephone line. Twenty-four TCE items have been identified and their performance discussed in this report.

There are four basic communication modes that can be recommended: 1) telephone link, 2) VHF, 3) narrow-band microwave, and 4) wideband microwave. The telephone link option provides the lowest cost option. Voice, data, and Slow-Scan TV can be transmitted using this option. ECG or any other data adaptable to the voice range can be transmitted over standard telephone lines. The VHF option permits a low-cost RF link that provides all the telephone link option capability plus the capability to transmit or receive while in transit.

The narrowband option permits multiple-voice grade channels, all the capabilities provided by the telephone or VHF, private dedicated (hotline) voice channels and separate maintenance lines.

The wideband microwave option offers the one or two way television images, one or two way voice, and all capabilities provided by the narrowband microwave option. There are advantages to combining some of the communication options. For example, VHF can be added at a low cost to provide a backup.

A decision-making process for exportable models of the STARPAHC concept must be initiated by taking a systematic approach to defining a telemedicine system to meet the requirements of a specific locale. The starting point in the process is establishing criteria and guidelines for the concept. The criteria and guidelines that have evolved from STARPAHC are offered below as a model:

- o Expertise of physicians (and other health professionals) are extended great distances by physician monitoring of the remotely located CHM. Visible and audible communication should be provided.
- o Easily accessible points of entry into the health care establishment should be provided by appropriate combinations of fixed and mobile facilities.
- o Screening and routing of patients by a central control is required.
- o Unique technology and management skills tailored to the environment and patient need should be applied.
- o Maximum use of existing medical establishments and capabilities should be applied.
- o Restraints imposed by unique social, economic, and health characteristics of the locality under consideration must be recognized.
- o System design must be amenable to orderly, expeditious extension. Basic design should be applicable to all future-area situations.

The end products of the decision making process are; 1) criteria and guidelines, 2) a selected configuration, and 3) basic system requirements. These products now permit the orderly initiation of a system engineering effort to give further definition to the concept, establish end item specifications, and the preliminary design. Further sequential action requires the detailed design, fabrication/assembly, test, and operation.

Export decision objective factors and test candidate concepts can be compared against these factors; 1) accessibility - improve access of rural patients to health care through use of interactive telemedicine, 2) quality - provide quality of care equal to or better than that previously available, 3) acceptability - assure acceptability as perceived by the involved providers and patients, 4) cost - to the patient, equal or below that of conventional health care, 5) funding - capital costs to be competitive with alternative forms of health delivery, 6) hardware - reliable and maintainability, 7) growth potential - ability to perform research and testing, 8) population shifts - response of the system to population changing location, and 9) service demands change - response of system to increase/decrease in utilization.

SUMMARY OF FINDINGS

The major goal of the STARPAHC project, "to provide quality health care to people in a remote area" has been achieved. The general goals of the project and assessment of our performance in meeting these goals, are addressed below.

Feasibility of the STARPAHC Concept. The STARPAHC concept is indeed an effective, realistic way to administer quality health care to people isolated in remote areas. There have been overall increases in the utilization of all health care facilities, and appreciable increases in the utilization of both the mobile and fixed clinics. The quality of care administered by CHM's at these facilities has been rated as "better than or as good as" that administered in facilities staffed by physicians and other health professionals.

Interaction Between Physicians and Non-Physicians. Physician direction has been effective in diagnosing and/or treating patients by telemedicine in a wide variety of case types. Physician and CHM users have reported that the TCE capability has been critical, important, or useful in 86.3% of the teleconsultations for providing proper treatment and diagnoses. A major value of the telediagnostic capability is reassurance to the initiator that the proposed treatment plan is satisfactory (whether the initiator is a CHM or a physician).

Exportability of the STARPAHC Concept. The STARPAHC approach to providing access to quality health care at remote locations may be a model for other health care delivery systems. If, in fact, the problem of remote health care is of the magnitude and importance indicated by the news media and statistical data - and it is - those charged with the responsibility of providing care to remote areas (local community, state, national, and international) should seriously consider implementing programs that use the knowledge and data gained through STARPAHC.

The feasibility determination of the STARPAHC concept for remote-area health care delivery is indicative of future growth potential. As a first step, one-of-a-kind, demonstration system, its possibilities for exportability, growth, and expansion appear to be very good.

Any combination of the major system elements can be used singly or in multiples to accommodate each area's specific needs. The present and near-future communication satellite capabilities enable any degree of partial or total service networks to be synthesized, and to go beyond regional medical centers to national medical centers and, perhaps, international medical centers.

Medical/Engineering Evaluation of the Value and Potential of Telemedicine. Video teleconsultations were used most often for help in diagnosis or therapy, while voice communications were used most often to gain information from the lab, records, or appointments. TV teleconsultations resulted in elimination of unnecessary referrals, or decisions to include needed referrals. These decisions resulted in savings of many hundreds of miles of patient travel. Physicians indicated that 78.3% of all TV teleconsultations were critical, important, or useful for proper care. Seventy-two and five-tenths percent (72.5%) of all voice teleconsultations were judged similarly.

It has proven feasible to design, construct, test, operate, and maintain a reliable telemedicine system in a remote environment. Performance and quality of the system was rated high. Maintenance was within the capability of the crew. Computers were found valuable in storing and providing current patient histories to the field health care personnel. Computers were also useful for storing evaluation data and providing statistical analysis.

In summary, the STARPAHC project has demonstrated that telemedicine with the use of physicians' assistants is one answer to the problem of providing quality health care to people in isolated areas and, indeed, may be the only practical way of providing health care in a world of ever-increasing population in dire need of such care.

Section 2

SYSTEM OPERATIONAL RESULTS

2.1 ORGANIZATION AND PRESENTATION

In order to collect and assess evaluation data and present operational results, the STARPAHC system was broken down into five functional subsystems. Figure 2-1 gives the organization for evaluation purposes of the five functional subsystems comprising STARPAHC. This organization permits the medical and engineering presentation of operational results based on the evaluation data collected and analyzed.

Engineering evaluation data was collected for twenty-four telecommunication equipment (TCE) types, computer hardware and software, each of the major operational facilities, and logistic support. Medical data was collected on the health care personnel performance, the patients acceptance of the system, the quality of care provided, and the health care personnel interaction with the telecommunication equipment. A format to acquire accurate cost data evolved from this system organization.

2.2 SYSTEM ASSESSMENT

2.2.1 Project Philosophy and Goals

The STARPAHC project goal was to provide, through demonstration, comprehensive and accurate information about the feasibility of the STARPAHC concept as a solution to the problem of quality health care delivery to people in remote geographic areas, and at the same time, gain information for space planning uses. This includes information as to the operation of a relatively sophisticated "telemedicine" system functioning in a rural area. (STARPAHC is, at the time of this report, still the most advanced telemedicine system anywhere in the world).

In order to evaluate the degree of success of a demonstration project and give system operational results, it is necessary to answer the following types of questions:

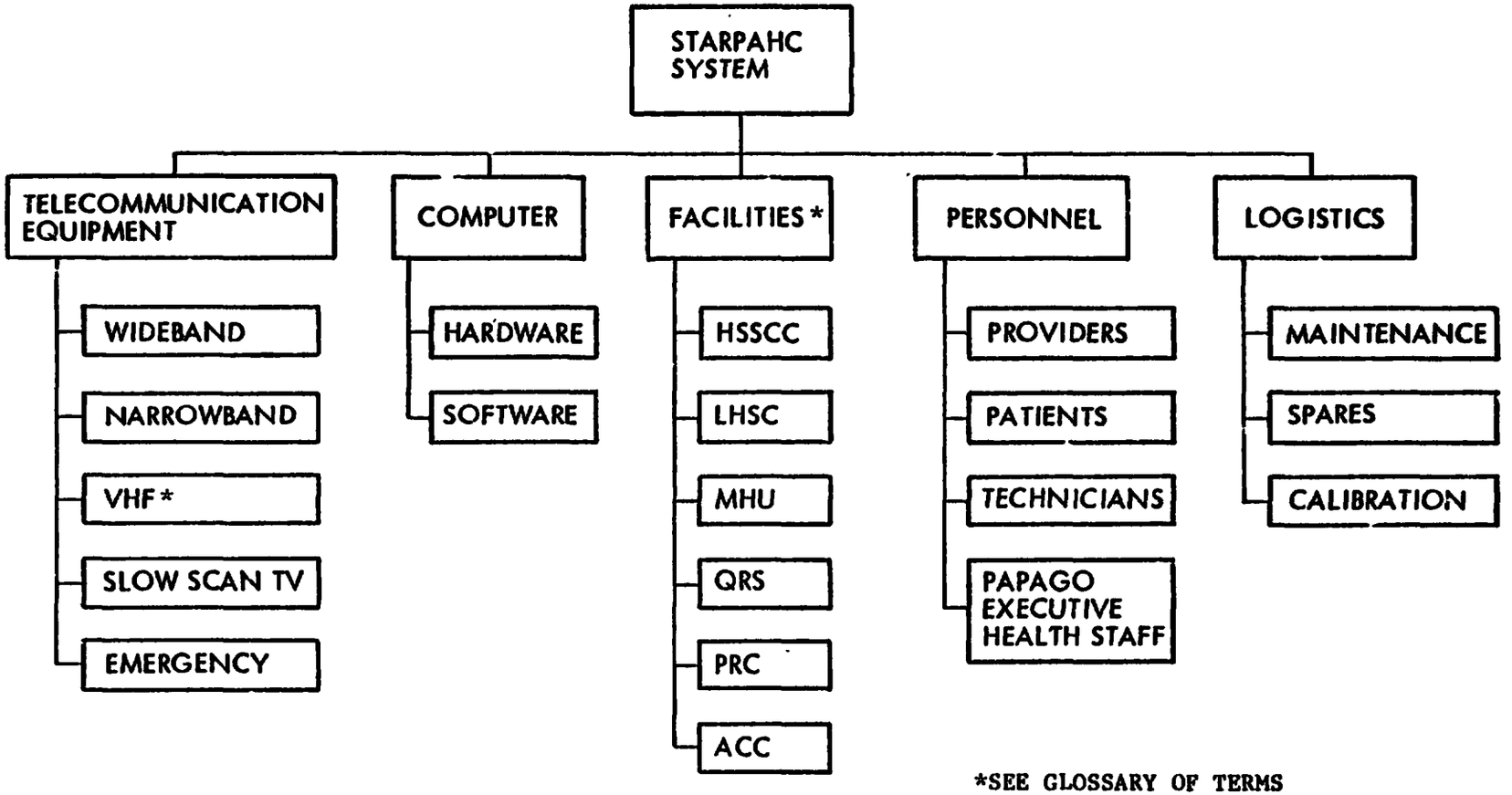


Figure 2-1 STARPAHC Systems Organization

Question 1. Has the necessary data been accurately collected and reasonably evaluated regarding the objectives stated above?

Answer 1. This system report on operational performance presents data to answer the first question.

Question 2. To whom have the project operational results been demonstrated?

Answer 2. The second question refers to those demonstrations occurring during the evaluation period and its response includes a lengthy list of other telemedicine projects, corporations, professional associations, governmental agencies, universities, consumer groups, individuals and representatives of foreign governments who have visited the project site during the 2-year evaluation period, each receiving the information available at the time of the visit. Such a list might also include the audiences for the motion picture "STARPAHC" produced by NASA, those who attended professional conferences, conventions, workshops, etc., where papers about the project were presented, plus others who have read the articles published in professional journals and the mass media.

Question 3. Are the health services that are being provided to the Papago in their remote villages satisfactory?

Answer 3. Providing service has been, obviously, of the highest priority to the entire STARPAHC team. The initial agreement formulated by IHS, the Papago Tribal Council, and NASA when the Papago Reservation was chosen as the demonstration site, stipulated that should the STARPAHC project have failed to at least satisfy the major objectives of the health program, or overburden the minimally staffed health delivery system, then there would be no further operation within the present site.

IHS decision to continue the major portions of the present tele-consultation system with dollars that otherwise could be used in other ways in health service programs, is in itself a value judgment about the success with which service has been provided. In addition, the Papago people have reported on the success, acceptability, and value of the health services being routinely provided in their remote villages.

Question 4. How well have the equipment and logistics systems and their supporting operational functions accommodated the needs of the health care procedures (direct and indirect), necessary to remote delivery by telemedicine.

Answer 4. The commercial off-the-shelf equipment selected for STARPAHC has proven dependable, reliable, and easily maintainable. Out of 7390 telecommunications during the two-year period, there were only 120 failures, resulting in a 98.3% performance acceptability ratio. The Mobile Health Unit (MHU), on a schedule of four village stops per week, lost only 13 days of service in the two years of operation and traveled 26,940 miles. Twelve of the those days were scheduled for major maintenance of the MHU. On only one of those days were alternate clinic arrangements not provided to the village scheduled for service.

Question 5. What has been the immediate and the long-range effect of the project following completion?

Answer 5. Part of the fifth question can be answered briefly, at least for the present. The IHS, Sells Service Unit and the Papago Tribe have agreed to assume the responsibility for the continuation of operations beyond the original 2-year evaluation period of the project (to April 30, 1978). NASA will maintain an interest in considering the capabilities of this demonstration system as a "test bed" for future field trials of medical support equipment and systems. It will be of value to gain knowledge applicable to the health care of humans in space and for application of space technology to the public sector.

The major question about the future application of the knowledge and experience gained during this two-year STARPAHC demonstration period, obviously, cannot be answered in this report. Time will be the final evaluator; however, the data compiled in the STARPAHC reports will surely serve to guide decision making processes for future telemedicine projects as a "handbook" to designers and operators of telemedicine systems.

2.2.2 System Evaluation Plan

The STARPAHC evaluation plan established prior to the start of field operations was structured to provide data and information for the system assessment. Each agency participating in the demonstration project incorporated their performance objectives into the plan.

In summary, these were:

NASA objectives were to:

- Provide data for developing health care for future manned spacecraft.
- Determine the effectiveness and exportability of the STARPAHC technique for improving the delivery of quality health care to remote populations.

The IHS and the Papago tribe wanted to improve health care delivery to a previously underserved population by utilizing support to recently trained Community Health Medics whom also serve many functions beyond that of being assistants to primary care physicians. (The STARPAHC project offered IHS an opportunity to learn what kind of consultative support was needed by medics who delivered health care in places removed from the physical presence of physicians).

Specific evaluation objectives established prior to operation, were to provide answers to the following questions:

1. How does the utilization of health services compare before and after STARPAHC operation?
2. Is the quality of care provided under STARPAHC equal to or better than that previously provided?
3. How did the utilization of STARPAHC telecommunication equipment support health care in terms of health problems?
4. What was the level and usefulness of voice and video consultations between the CHM/Physician?
5. What was the value of teleconsultations in the view of the physician and the CHM?
6. Determine by research evaluation the diagnostic value of Slow Scan TV in the areas of radiology, patient examination, and microscopy?
7. What was the quality, purpose, and utilization of the TCE, computer, facilities, personnel, and logistic support?
8. What TCE items received high or low usage and why?
9. Of what value were the medical aid software programs to the providers?
10. What were the attitudes of the patients and providers to the STARPAHC concept and technology?
11. What is the cost for operating STARPAHC?
12. What benefits can be derived from STARPAHC that will be useful for future planners of another telemedicine project?
13. What recommendations can be made for specific equipment, configurations, and decision-making for exportable models of STARPAHC?

For the system evaluation, Figure 2-2 illustrates the evaluation goals and processes. As noted in the figure, monthly data retrievals are summarized periodically in the form of semi-annual evaluation reports. The hardware and medical data have been coordinated between MSC and IHS and have been integrated in this report. Cost data reflects inputs from all participating organizations.

For achieving the medical evaluation objectives, a method was established to: (1) document field activities, (2) interview the health staff, the patients, and community residents, (3) provide special evaluation forms to be completed by the health providers, (4) review and analyze the computer printout for telecommunication data, and (5) perform a detail cost analysis of the health care system correlated with a hardware cost study.

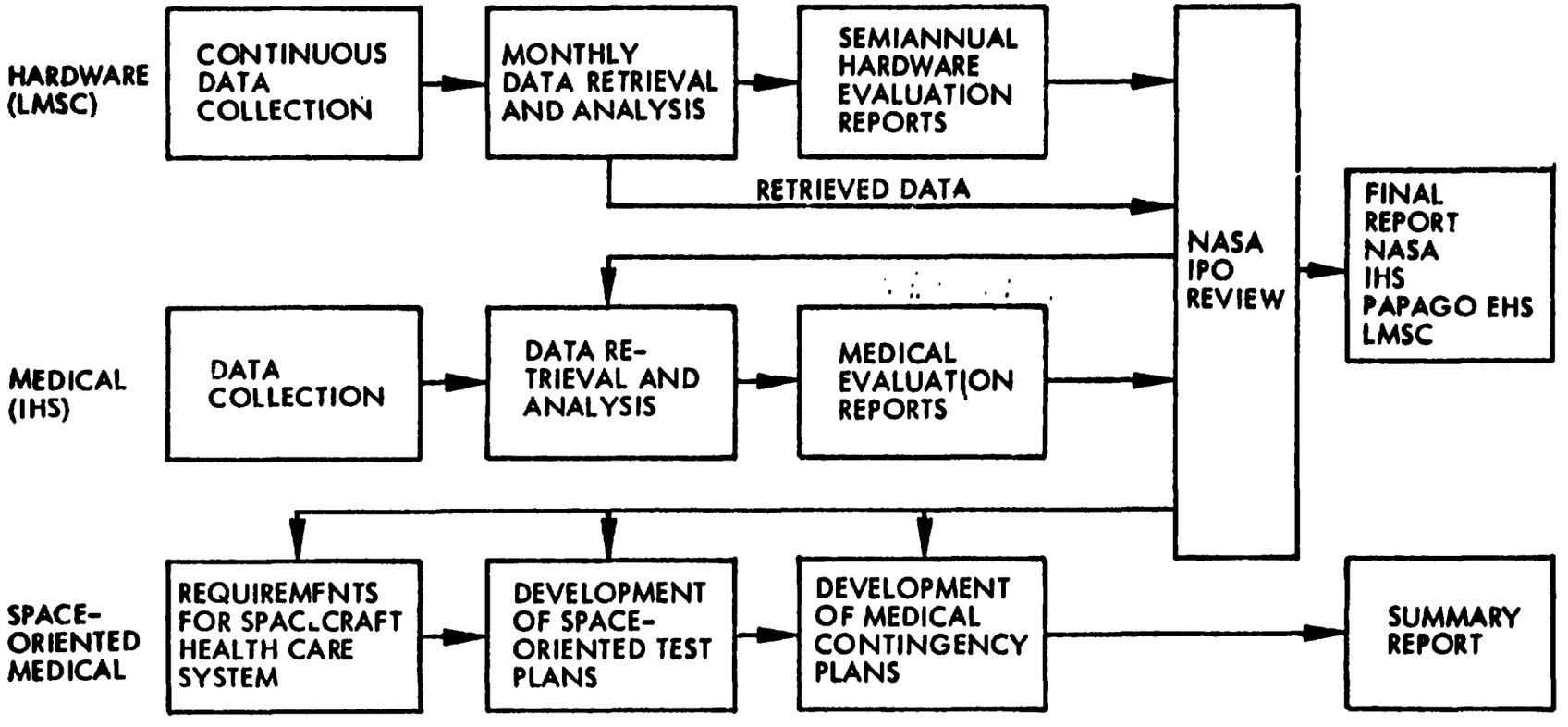


Figure 2-2 Evaluation Information Reporting

For achieving the hardware evaluation objectives, a method was established to: (1) acquire field data by daily data collection in manual records by the site personnel, (2) incorporate the data into computer-based logs, (3) reduce, analyze, interpret, and compare the raw data to obtain specific answers to satisfy the stated objectives, and (4) perform a calibration program which affords an insight into any performance change in the video/audio links of the system.

A cost accounting system was developed and implemented that provided the cost of operation and maintenance. In addition, there are 3 independent investigations conducted by IHS and by NASA that supplements the final evaluation: (1) quality of care analysis by IHS for certain specific diagnostic categories, (2) study of the history of the planning, development, and implementation of the STARPAHC Project by Rashid Bashshur, Ph. D., University of Michigan for IHS, and (3) NASA conducted a space-oriented Medical Evaluation contracted with the Boeing Company. Results of these studies have been incorporated into this report, as appropriate.

2.3 MEDICAL EVALUATION

The Medical Evaluation Plan, Appendix A, was designed to achieve the goal of assessing the impact of STARPAHC on patient health care. To quantitatively evaluate the impact and assess the improvement, studies were carried out for: 1) utilization of health services before and after STARPAHC operation, 2) quality of health care, and 3) medical utilization of STARPAHC facilities and telecommunication capabilities. Specific questions answered are:

- Is it an improvement over the pre-STARPAHC system?
- Is the system improving quality of care to the Papago people?
- Is the use of the STARPAHC facilities and telecommunication capabilities supporting the health delivery system?

2.3.1 Utilization of Health Services Before and After STARPAHC Operation. Baseline data on prior-to-STARPAHC operation was collected for the years 1970 through April 30, 1975 and compared against the STARPAHC 1st year (May 1, 1975 through April 30, 1976) and 2nd year (May 1, 1976 through April 30, 1977). Three separate studies were initiated to establish the role of the availability of advanced telecommunications through the STARPAHC Program.

The district of residence of the patients were grouped into regional areas depending upon the one health service site closest to the district, and the site where the greatest proportion of each district's utilization occurred.

For example, the central district, Sells, uses the Sells outpatient department for the greatest proportion of services. This is also the closest site. However, residents of Sells also receive home visits, and utilize the other sites such as the San Xavier and Santa Rosa health centers, and the mobile clinic, but use them proportionately less.

The ambulatory services in the tables of this subsection include all reporting points and categories in the computerized Health Information System (HIS). The complete list includes:

1. Sells hospital outpatient department
2. San Xavier Health Center
3. Santa Rosa Health Center
4. The Mobile Health Unit
5. Field clinics at Pisinimo, Chui Chu, Santa Rosa Ranch, and other locations
6. Home visits by all providers, i.e., Public Health Nursing, Community Health Representatives, Mental Health Workers, Disease Control staff and others.
7. Office visits to Papago Disease Control and Papago Nutrition Programs
8. School visits to special clinics such as for immunizations, and mental health programs
9. Outpatient visits to contract care facilities such as the VA Hospital, St. Mary's Hospital, University Hospital, Tucson Medical Center, Pima County Hospital, and others
10. Sites that either are unspecified or unknown, but a visit was known to have occurred
11. Visits to tribal community centers for certain special services such as provided by the Papago Nutrition Program

First Study - Base Year/Pre-STARPAHC/STARPAHC Year Operation. The first study compared health service utilization for:

- o Base year (May 1, 1973 to April 30, 1974)
- o Pre-STARPAHC Year (May 1, 1974 to April 30, 1975)
- o STARPAHC 1st Year (May 1, 1975 to April 30, 1976)
- o STARPAHC 2nd Year (May 1, 1976 to April 30, 1977)

Three comparisons were made, the first was between the base year and the pre-STARPAHC year, the second was between the pre-STARPAHC year and the 1st STARPAHC year, and the third was between the pre-STARPAHC year and the 2nd STARPAHC year.

Tables 2-1, 2-2, and 2-3 lists: 1) the number of visits and percent change to all ambulatory health services; 2) the ratio of patient ambulatory care visits to number of patients; and 3) percent of population utilizing any ambulatory health care facility; respectively. The numbers and percentage are given for the nine districts comprising the Papago reservation's main body.

Table 2-1

NUMBER OF VISITS AND PERCENT CHANGE TO ALL AMBULATORY HEALTH SERVICES (EXCLUDING DENTAL AND SCHOOL CLINICS)

Districts of Residence	Number of Visits				Percent Change		
	Base Year	Pre-Starpaho Year	1st Starpaho Year	2nd Starpaho Year	Pre-Starpaho/ Base Year	1st Starpaho Year Pre-Starpaho Year/	2nd Starpaho Year/ Pre-Starpaho Year
1. Western Districts (primarily served by mobile unit)							
• GuVo	1,701	1,845	2,458	2,478	+8.5	+33.3	+34.3
• Hickiwan	2,643	2,803	3,522	3,499	+5.9	+25.7	+24.5
• Pisinemo	2,031	1,986	2,325	2,299	+2.2	+17.1	+15.8
1. TOTAL	6,390	6,634	8,305	8,276	+4.0	+25.2	+24.8
2. Northern Districts (primarily served by Santa Rosa Health Center)							
• Sif Oidak	2,966	2,827	3,115	3,048	-4.7	+10.2	+7.8
• Gu Achi	4,481	4,442	5,702	5,436	-0.9	+28.4	+22.4
2. TOTAL	7,447	7,269	8,817	8,484	-2.4	+21.3	+16.7
3. Southeastern Districts (primarily served by Sells Hospital, OPD)							
• Pisinemo	3,760	4,124	4,601	4,179	+9.4	+11.6	+1.3
• Chukut Kuk	962	835	951	941	-13.2	+13.9	+12.7
• Schuk Toak	3,155	2,189	2,325	2,229	+1.0	+6.2	+1.8
3. TOTAL	5,836	7,148	7,877	7,349	+3.8	+10.2	+2.8
4. Central District, Sells	12,944	12,954	15,603	14,477	+0.1	+20.45	+11.8
5. TOTAL: 9 Districts	33,657	34,005	40,602	38,586	+1.0	+19.4	+13.5

1) All dental services excluded.
2) Data from IHS as of September 1, 1976.
3) Includes all sites, IHS + tribal visits + contract care, home visits, nongovernment hospitals, etc.

Table 2-2

RATIO OF PATIENT AMBULATORY CARE VISITS TO PATIENTS

Districts of Residence	Number of Individual Patients				Percent Change		
	Base Year	Pre-Starpahc Year	Starpahc Year	1st Starpahc Year	Base Year/ Pre-Starpahc	1st Starpahc Year Pre-Starpahc Year/	2nd Starpahc Year/ Pre-Starpahc Year
Study Groups							
1. Western Districts (served by MHU primarily)							
• GuVo	298	316	344	344	+6.0	+8.9	+8.9
• Hickiwan	475	474	518	521	-0.3	+9.3	+9.9
• Pisinamo	322	309	313	351	-4.4	+11.3	+14.0
1. TOTAL	1,095	1,098	1,205	1,216	+0.3	+9.7	+10.7
2. Northern Districts (served by Santa Rosa Health Center primarily)							
• Sif Oidak	566	554	546	577	-2.1	-1.4	+4.2
• Gu Achi	771	741	799	830	-3.9	+7.8	+12.0
2. TOTAL	1,337	1,295	1,345	1,407	-3.1	+3.7	+8.6
3. Southeastern Districts (served by PHS Hospital OPD primarily)							
• Baboquivari	635	666	648	631	+4.9	-2.4	-5.3
• Cuakut Kuk	176	172	176	168	-2.3	+2.3	-2.3
• Schuk Toak	345	361	342	349	-5.3	+5.9	-3.3
3. TOTAL	1,156	1,199	1,166	1,148	+3.7	-2.8	-4.3
4. Central District, Sells (as above)	1,971	2,021	2,141	2,083	+2.5	+5.9	+3.1
5. TOTAL 9 Districts	5,559	5,613	5,857	5,854	+1.0	+4.4	+4.3

1) Data from IHS, September 1, 1976.
Includes all persons who received services at all sites by IHS or tribal staff except Dental Services.
Excludes all persons discharged from hospitals.

Table 2-3

PERCENT OF POPULATION UTILIZING ANY AMBULATORY HEALTH CARE FACILITY

Districts of Residence	Population: Estimated IHS Data Base 1961 to 1975	Number Utilizing				Percent Utilizing			
		Base Yr	Pre-Starpahc Year	Starpahc Year	Starpahc Year	Base Yr	Pre-Starpahc Year	1st Starpahc Year	2nd Starpahc Year
1. Western Districts									
• GuVo	507	298	316	344	344	58.8	62.3	67.9	67.9
• Ilickiwan	719	475	474	518	521	66.1	65.9	72.0	72.5
• Pisinemo	529	322	308	343	351	60.9	58.2	64.8	66.4
1. TOTAL	1,755	1,095	1,098	1,205	1,216	62.4	62.6	68.7	69.3
2. Northern Districts									
• Sif Oidak	919	566	554	546	577	61.6	60.3	59.4	62.8
• Gu Achi	1,175	771	741	799	830	65.6	63.1	68.0	70.6
2. TOTAL	2,094	1,337	1,295	1,345	1,407	63.9	61.8	64.2	67.2
3. Southeastern Districts									
• Baboquivari	932	635	666	648	631	68.1	71.2	69.5	67.7
• Chukat Kuk	249	176	172	176	168	70.7	69.1	70.7	67.5
• Schuk Toak	484	345	361	342	349	71.3	74.6	70.7	72.1
3. TOTAL	1,665	1,156	1,199	1,166	1,148	69.4	72.0	70.0	70.0
4. Central District, Sells	3,193	1,971	2,021	2,141	2,083	61.7	63.0	67.1	65.3
5. TOTAL	8,707	5,559	5,613	5,857	5,854	63.9	64.5	67.3	67.2

From IHS Data Base September, 1976.

The general health objectives of the Papago Executive Health Staff and the Indian Health Services were stated as a goal, "To improve the health of the Papago people to the highest possible level and to assist the Papago people to live in harmony with their environment."

The STARPAHC system was designed to assist in meeting this goal by providing:

- o A mobile health unit to increase utilization of health service in the three most western districts.

The results of the first study indicates that this goal of the Papago health staff and the Indian Health Service regarding the utilization of health services by the three most western districts have been achieved. The rate of increase in all factors, (1) patient visits; (2) ratio of patients to patient ambulatory care visits by district of residence; and (3) percent of total population using services measured; has been the greatest for those districts whose closest and most frequently used health service facility is the mobile unit.

At present, it appears that the increased home visits, increased use of Sells OPD and the mobile unit accounted for almost all the increases in the three western districts in about equal proportion.

Second Study - Comparable 12 Month Periods Since 1970/STARPAHC Year. The second study compared health service utilization for:

- o Comparable 12-month periods since 1970
- o STARPAHC Year compared to pre-STARPAHC years 1970, 1971, 1972, and 1974.

In this study, only visits to IHS facilities on the Papago reservation were tallied. Visits included those to the dental service at Sells, San Xavier, and Santa Rosa Clinic. Visits excluded were visits to other dental services, all patients who were either admitted or discharged from any hospital, and outpatient visits to the Sacaton Service Unit.

In general, the conclusions of this study support the conclusions of the first study, but the rates cannot be directly compared because of the different methodology.

The following is a summary of the major analysis for the seven objectives covered in the second study.

First Objective

- o To compare the growth in the total demographic register versus the utilizing population.
- o To perceive any "real increase in utilizing population", particularly with regard to any MHU-served areas.

Findings: Rate of population growth between CY 1970 and FY '76 in the three western districts, on the average, exceed that of the remaining districts; 1.5 times greater in the case of demographic base and 2.3 times in the case of utilizing population.

In the case of MHU activity, the trend in demographic register increase in the three western districts was accelerated, particularly the utilizing population count.

Second Objective

- o To compare the development of IHS clinic utilization levels, district by district and overall.
- o To perceive any "real" increase in utilization rate, particularly in the districts served by the MHU.

Findings: Since 1970, utilization has increased in all districts of the reservation, more so in some than in others. Overall, the increase has been quite substantial (about 11% between 1970 and 1976).

The trend towards utilization increase has also involved the three western districts. Here the increase over the 1970 rate was 24% in 1976; 4.7% of this occurring in the period of MHU service. This may indicate that the utilization rate increase during the MHU-served period was mostly part of the general trend toward increased utilization, and at best, only moderately accelerated by MHU activity directly.

Third Objective

- o To make a general comparison of workload (outpatient visit) distribution among the clinical facilities, by district and overall.
- o To determine geographically influenced utilization patterns of IHS clinical facilities on the Papago Reservation.

Findings: Sells clinic serves all reservation districts, some more so than others. Through the years, the general trend is increased utilization of Sells by all districts, except San Xavier.

San Xavier clinic serves San Xavier district and the off-reservation population (Tucson) almost entirely.

Santa Rosa clinic serves primarily Gu Achi, Hickiwan and Sif Oidak. In 1970, it took substantial workload from Gu Vo and Pisinimo.

The Pisinimo community clinic, in the years it operated (1 day a week) took care of a substantial amount of the workload at Gu Vo as well as the Pisinimo district.

The MHU serves the three western districts almost exclusively. In its time of operation, it has absorbed all of the Pisinimo clinic workload and apparently about 1/6 of the Santa Rosa clinic workload.

Fourth Objective

- o To show the per capita IHS clinic utilization rate, based on the utilizing population.
- o To compare per capita utilization levels among the districts and to show the changes occurring since 1970.

Findings: The general trend toward increased per capita utilization is unmistakable. Some districts lagged behind others in attaining increased per capita utilization (note Baboquivari, Gu Achi, Hickiwan, and Schuk Toak in the 1970-1972 change comparison). In 1976, most of the districts attained levels between 6 and 7 visits per utilizer per year.

Substantial increases in per capita utilization in Gu Vo and Pisinimo were found in the 1970-72 comparisons, while substantial gain in Hickiwan first shows in the 1972-74 comparisons.

The gains in per capita utilization in Gu Vo and Pisinimo probably were stimulated by the opening and operation of the Pisinimo clinic (1 day a week). The gains in Hickiwan probably arose from increase in Santa Rosa outreach or increased availability of transport to Santa Rosa.

Ostensibly, Hickiwan alone shows greatly increased per capita utilization in the MHU activity period -- but it is difficult to say that this was caused by the MHU alone, since the trend started between 1972 and 1974.

Fifth Objective

- o To show the change in problem-specific workload between CY 1974 and FY 1976 (June 75-July 76) the "year of the MHU".
- o To determine whether a local surge in disease prevalence might account for differences in utilization levels.

Findings: Except for "Other Bacterial and Parasitic Diseases", the surges or declines in services for particular problems appear to be random. Since visits for "other bacterial and parasitic diseases" accounted for only 5% of the visits in 1976, both overall and the "3 Western districts", the apparent increase is insignificant. The overall conclusion is that evaluation of utilization is not affected by shifts in problem or disease prevalence.

Sixth Objective

- To compare distribution of workload among the main facilities serving the western districts with regard to disease problem categories.
- To ascertain whether nature of problem may have caused selective (or discriminatory) utilization of facilities.

Findings: The nature of the problem obviously affected facility utilization, particularly when comparing the Sells clinic and MHU. The higher levels of MHU utilization (accounting for 44 to 56% of the visits within problem class) involved the infectious disease problems plus cardiovascular and musculoskeletal problems. The higher level of Sells utilization occurred with tuberculosis (mostly preventive care), venereal disease, neoplasms, metabolic-nutritional, mental-behavioral, neurological, and digestive (mostly dental) problems. The combined utilization of Sells and Santa Rosa caused a low utilization of the MHU (between 29 and 38%) in 8 remaining problem areas.

Seventh Objective

- To show the changes in utilization of the principal clinical facilities available to the western districts since 1970.
- To show specific utilization levels of Sells, Santa Rosa, Pisinimo, and MHU clinics and changes occurring chronologically.

Findings: (1) The utilization of the Sells facility continues to increase, (2) The MHU has, in essence, taken up the load of the closed Pisinimo clinic, and has caused decreased Hickiwan utilization of the Santa Rosa clinic, (3) Years before the MHU arrived, there was decreased utilization of the Santa Rosa Clinic, by Hickiwan (and even Gu Vo) between 1972 and 1974. An earlier drop in Gu Vo utilization coincides with the Pisinimo clinic operational increase. After 1972, the physician was replaced by a CHM at Santa Rosa. After 1972, all districts increased their utilization of the Sells OPD, especially Hickiwan, Gu Vo and Gu Achi.

Third Study - Pre-STARPAHC Three Year/STARPAHC Year. The third study compared health service utilization for:

- o STARPAHC 1st Year compared to three past years (1973, 1974 and 1975).

This study measured the changing proportion of patient visits by district to different types of health services. (IHS clinics, home visits, mobile clinic (1975 and 1976 only), school, and "other" sites).

It also measured the changing visits to different categories of health providers (i.e., physicians, CHNs, PHN, Nursing Aides, and Papago Tribal Health workers).

The distribution of visits by sex, for reservation districts, was also measured.

Visits to the dental clinic were included in these studies, as in the second study. Only reservation facilities or services were included.

For comparison purposes, the data has been grouped into six sections -- each of the three MHU districts: Gu Vo, Hickiwan, and Pisinimo; Sells, San Xavier, and all <u>others</u>. The <u>others</u> category includes districts 01, 02, 03, 07, and 09.

During the past four years (July 1, 1972 through June 30, 1976) residents of ten districts[1] on the Papago Reservation had approximately 167,453 reported out-patient/field contacts for an average of 4.4 contacts per population[2] and an average of 6.6 contacts per utilizing population[3]. The average contacts annually are 41,864 while there were 6,330 average number of individual contacts annually.

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(1) Gila Bend district residents are excluded from this analysis.
(2) Population data used is based on September 1975 information as reported from IHS
(3) Source - HIS printouts.

Findings: There are three distinct trends emerging from the data: (1) IHS services delivered in the field outpatient/clinic setting are becoming more physician oriented and controlled, as reflected in the increasing number of visits with either the physician or physician assistant listed as primary provider, (2) home visiting by PHNs has decreased as percentage of the total, and (3) utilization rates for females are growing more rapidly than utilization rate for males. To summarize:

1. Total outpatient/field contacts have shown a steady increase during the past four fiscal years.
2. San Xavier and Sells have the largest percent of the population contacted, and also the highest average number of visits per patient.
3. Gu Vo is at the bottom of the list in the percent of population who get service, but ranks high in the average number of visits per utilizing population.
4. Visits by Public Health Nursing personnel dropped sharply in 1973 and have not regained 1972 levels of service in any district except San Xavier, where in FY 1976 they exceeded the FY 1973 level of service.
5. Patients living in the Pisinimo and San Xavier districts are the most likely to receive home visits from PHN personnel while those living in the Sells and Hickiwan district are the least likely to receive such service.
6. Gu Vo patients average more home visits per population but rank third (behind San Xavier and Pisinimo) in home visits by PHN personnel.
7. The largest decline in home visiting has been in districts 01, 02, 03, 07, and 09. In 1973, nine percent of all contacts were reported as home contacts. In FY 1976, the percentage dropped to six percent.
8. Total home visits have increased by a percentage of the total health service.
9. Physicians assistants visits have increased to residents of all districts with San Xavier showing the least increase.
10. Males outnumber females in six of the ten districts (Gu Vo, Hickiwan, Pisinimo, San Xavier, Chukut Kuk, and Schuk Toak) but outpatient, field visits show about 57 percent female to 43 percent male ratio. Doctors see proportionally more males than do CHM's.

11. Dentists report more visits to males than females in Gu Vo, Hickiwan, and Pisinimo districts. (4 year total).
12. In those instances where all service reported has been at the MHU (Sept. '75 to Mar. 1 '76) females were seen an average of 2.3 times each while males average 2.0 visits each.
13. Only at Sells do CHM's see more males than they do female patients.
14. There has been an increase in the number of patient contacts by tribal health workers. The largest increase is seen in the three districts served by the mobile unit.
15. Visits to LPN's as primary provider is approximately double the number made to RN's as primary provider.
16. During the four year period there has been a total of 6,978 visits to tribal health workers and a third of these have been home visits. In FY 1976, home visits accounted for over half of the tribal visits in the MHU districts, but less than half of those in Sells and all other districts were home visits.

2.3.2 Quality of Health Care

The principle objective of the STARPAHC project was to increase accessability, increase utilization of non-physicians to provide direct health care, while improving the quality of care delivered.

This selection will address concerns about the quality of care for certain indicators to denote the level of achievement for specific goals or standards. These indicators were selected based on the following criteria; 1) tasks that could be performed by variously skilled primary providers (i.e., not only those performed by physicians), 2) health conditions that are both common in the population and also amenable to results from available therapy, and 3) study areas that use data routinely stored in the Health Information System (HIS) computerized data base for all patient encounters.

Three conditions were selected on the basis of this criteria, 1) one common condition where screening and preventive tasks are closely related to outcome -- prenatal care, 2) one acute condition -- gastroenteritis in children, and 3) one chronic condition -- hypertension.

Three methods of data analysis were used for each condition to answer these questions:

1. Do the patients who regularly visit well equipped facilities staffed with higher skilled providers receive the same quality of care for episodes over a six month period as those who visit other smaller sites staffed with less trained individual providers?
2. Has there been an increase in quality of care during the time when the STARPAHC telemedicine system was implemented as compared to prior times?
3. Is the same quality of care for each patient visit provided by physicians and CHMs?
4. Have the people living in those communities, that have experienced significant increases in health service utilization, received the same quality of care as those residents of communities who are consistently high utilizers? e.g. western districts patients compared to Sells district patients.

Method Analysis of Patient's Care: All studies used the computer programs developed by the Experimental Medical Care Review Organization (EMCRO) project staff, at the IHS-ORD (with a grant from the DHEW National Center for Health Services Research). These programs were written to utilize the data base of the Health Information System (HIS) which is primarily built from all patient encounters (with providers) within the Sells Service Unit System.

The first method of analysis used an EMCRO algorithm that assigned individual patients to only one site for a six months period, regardless of how many other sites were utilized in the same time frame. The specific algorithm used varied with the health condition and with the specific indicator measured. Generally, the patient was assigned to the clinic where the majority of visits had occurred during the time frame previous to the frame being studied for chronic conditions, and for acute conditions, to the clinic most used during the time frame studied if those visits could be linked to an episode of illness in the same time period.

The duration of each time frame was six months (i.e., either from January 5 through June 30, or from July 1, through December 31).

Four sites of health care were chosen for comparisons. Two were always staffed with physicians, registered nurses, pharmacists, dentists, CHMs, nurse practioners, licensed vocational nurses, laboratory and x-ray technicians, medical records clerks, and other personnel. One site was the outpatient department of the primary care (50 bed) hospital servicing about 30,000 ambulatory patients a year. The other site was a well equipped health center near Tucson (60 miles from Sells) with about 11,000 visits annually. The latter site served a distinctly separate population for the conditions selected for study. The two comparison sites were serviced only by CHMs, licensed practical nurses, and clerks and/or drivers. Laboratory facilities were minimal. Physicians saw patients in the health center at bimonthly speciality clinics, but these accounted for less than 5% of the 5,000 visits annually.

The mobile unit patients were served only by the CHM or LPN, and averaged about 3,300 annually. However, patients utilizing these two facilities also heavily used the outpatient department. Consequently, the number of patients assigned to these clinics would not reflect the numbers of visits each made.

Results Analysis of Patients' Care: The information in the following tables (Table 2-4 through 2-6) for each condition studied is interpreted generally to mean that no statistically significant differences in quality of care were detected between either of the two groups of clinics, or among each clinic for the quality indicators measured. Neither was any great improvement noted from the time periods July 1, 1974 to June 30, 1975 (before the STARPAHC project) as compared with the time period after the project started (from June 30, 1975 to June 30, 1976). The study period identified as "1" on Tables 2-4 through 2-6, was the most recent time frame studied, from January through June 1976. The others, 2 through 5, represent sequential time regression periods of six months each (i.e. Number 2 - July - December 1975, Number 3 - January through June 1975, Number 4 - July through December 1974, Number 5 - January through June 1974).

Instructions for reading these three tables are as follows:

1. Quality indicators are described in Note 1, bottom of Table.
2. Time Periods - 2nd column gives the time period during which data was recorded.
3. The last four columns give the facilities that the patient visited.
4. Rate percent indicates the proportion of patients out of the total patients eligible that met the quality of indicator prescribed rate. For example, at Sells Hospital, 83.3% of the total patients seen for prenatal examinations encountered the health system by the 20th week of gestation. This implies that 16.7% of all women who are eventually known to the hospital care system as being pregnant did not make their first encounter before the 20th week of gestation.
5. Number gives the total patients seen at the individual facility for any of the quality indicators.

Rates were calculated from each indicator for two groups of patients: Those at "high risk" and those at "normal risk". These terms are specifically defined in the EMCRO literature. Because these rates by subgroup did not vary significantly from the total group rate for most indicators and also for some factors the numbers were small, only the rate for the total group is reported in Tables 2-4 through 2-6. Value statements about the quality of care measured for each indicator are difficult to make, considering the small numbers of patients involved, and the very low numbers of either deaths or morbidity instances occurring during each six months time frame.

Evaluation studies have shown that the EMCRO programs are performing valid measurements for the data as stored in the HIS computer. Other studies have compared the HIS data to that entered in the original health record. Outpatient encounters were from 97 to 99% complete, and 99.7% accurate. Diagnosis ranged from 98 to 100% complete and 98.1 to 99.6% accurate.

The following presents findings from the three health problem evaluation studies:

Interpretations of Prenatal Study: (Table 2-4)

- o Community Health Medics working independently achieved rates for the quality indicators comparable or better than physician staffed sites for all indicators, especially in the second 6 months study period, except pre-eclampsia screening.
- o Numbers of patients were approximately equal at each site for each period.
- o Generally, disease detection screening rates are low at all sites in spite of the high rates at which pregnant women attend clinics before the 20th gestational week.
- o Service unit policy requires all prenatal patients to be seen by physicians at least three times before delivery (i.e., at 1st, 2nd, and 3rd trimester). Most patients comply. Therefore, fewer patients visit the Health Center staffed by the CHM, and mobile clinic, but rather visit the physician at Sells.
- o Only 6 of the 9 indicators are shown because of small numbers of patients or lack of data which makes comparisons useless.

Interpretations of Gastroenteritis Study: (Table 2-5)

- o Patients with episodes of gastroenteritis who made the majority of their visits to sites where CHMs are primary care providers, had rates equal to or better than sites where physicians are primary providers.
- o Data was retrieved for very few patients/episodes in last study period (January - June 1976) as compared with periods since January 1974. Reported childhood gastroenteritis has been decreasing in all districts of the reservation for several years.
- o Only 3 of the 10 indicators of quality were studied because of lack of visits to sites or low numbers which made comparisons useless.
- o Most sites in the last study period (1976) appeared to be performing with equal or less quality than they had in former study periods, since 1974, for the three indicators reported. The decline is attributable to insufficient record keeping by CHM's and M.D.'s. This may indicate a lack of interest in a health problem of decreasing prevalance.

Table 2-4

PRENATAL STUDY RESULTS

Quality Indicators[1]	Time Periods	Sites of Health Care			
		Sells Hospital OPD	San Xavier Health Center	Santa Rosa Health Center	Mobile Health Unit
Prenatal Entry Rate	Jan–Jun 1976				
	Rate (%)	83.3	69.2	100.0	67.8
	Number	66	26	4	12
	Jul–Dec 1975				
	Rate (%)	89.6	76.2	90.0	100.0
Prenatal Work-up Rate	Jan–Jun 1976				
	Rate (%)	20.3	3.6	33.3	16.7
	Number	64	28	6	12
	Jul–Dec 1975				
	Rate (%)	37.7	8.7	0	66.7
Urinary Tract Infection (UTI) Screening Rate	Jan–Jun 1976				
	Rate (%)	50.0	23.3	100.0	50.0
	Number	66	30	10	16
	Jul–Dec 1975				
	Rate (%)	77.1	21.1	90.0	88.9
Diabetes Screening Rate	Jan–Jun 1976				
	Rate (%)	44.1	6.7	0	0
	Number	68	30	4	14
	Jul–Dec 1975				
	Rate (%)	66.3	5.6	37.5	81.8
Pre-eclampsia Screening Rate	Jan–Jun 1976				
	Rate (%)	28.9	7.7	0	0
	Number	38	26	4	6
	Jul–Dec 1975				
	Rate (%)	19.2	9.4	28.6	20.0
Anemia Screening Rate	Jan–Jun 1976				
	Rate (%)	50.0	20.1	100.0	0
	Number	64	34	8	12
	Jul–Dec 1975				
	Rate (%)	67.2	28.6	60.0	66.7

NOTE 1

Description of Prenatal Quality of Care Indicators Used in Table 2-4

1. Prenatal entry rate: What proportion of the pregnant women encountered the health system by the 20th week of gestation?
2. Prenatal work-up rate: What proportion of the pregnant women had a VDRL, cervical culture, and pap smear by the 20th gestational week?
3. UTI screening rate: What proportion of pregnant patients had urine cultures in 0 to 20th and 26 to 40th weeks of gestation?
4. Diabetes screening rate: What proportion of patients had a MOD GTT in 0 to 20th and 26 to 40th weeks of gestation?
5. Pre-eclampsia screen rate: What proportion of patients was adequately covered by screening blood pressures between 26 to 40 weeks of gestation?
6. Anemia screening rate: What proportion of pregnant women had a hematocrit or hemoglobin in 0 to 20th and 26 to 40th weeks?

Prenatal Quality of Case Indicators Not Used Because of Small Numbers of Patients or Lack of Data for One or More Sites

7. Nutritional Counsel Rate: What proportion of pregnant women received nutritional counseling by the 20th gestational week?
8. Family plan counsel rate: What proportion of pregnant patients received family planning counseling by the time of delivery?
9. Postpartum evaluation rate: What proportion of pregnant women had had a pelvic and breast exam, urinalysis, urine culture, and hematocrit/hemoglobin within 2 months postpartum?

Table 2-5

GASTROENTERITIS STUDY RESULTS

Quality Indicators[1]	Time Periods	Sites of Health Care			
		Sells Hospital OPD	San Xavier Health Center	Santa Rosa Health Center	Mobile Health Unit[2]
Staging Rate	Jan–Jun 1976 Rate (%)	46.8	23.1	0	44.4
	Number	94	13	8	9
	Jan 1974–Jul 1976 (5 Six-Month Study Periods) Rate (%)	40–50	40–74	0–38	50–84[2]
Treatment Planning Rate	Jan–Jun 1976 Rate (%)	16.9	5.0	13.3	10.0
	Number	183	20	15	10
	Jan 1974–Jul 1976 (5 Six-Month Study Periods) Rate (%)	20–50	13–50	28–30	0–40
Ambulatory Management Rate	Jan–Jun 1976 Rate (%)	74.7	47.6	92.3	81.3
	Number	87	21	13	16
	Jan 1974–Jul 1976 (5 Six-Month Study Periods) Rate (%)	70–90	80–90	64–90	80–90[2]

NOTE 1

Description of Gastroenteritis Quality of Care Indicators Used in Table 2-5

1. Staging Rate	Percent of patient episodes with all encounters staged
2. Treatment Planning Rate	Percent of patient episodes for which treatment plan included fluid or alteration of diet, and antibiotics for + culture and no non-indicated antibiotics or antidiarrheal agents (see standards for treatment)
3. Ambulatory Mgt. Rate	Percent of all patient episodes receiving all required follow-up encounters

Gastroenteritis Quality of Care Indicators Not Used Because of Either Small Numbers of Patients or Lack of Data for One or More Sites of Care

4. Risk Assessment Rate	Percent of 0 to 2 year olds with a risk level assigned
5. Prevention Rate	Percent of patients with Task A completely within past 6 months (see Protocol for Disease Control Workers)
6. Triage Rate	Percent of patients episodes in which all appropriate referral/ admissions were made (see standards for terms below)
7. Secondary Prevention Rate	Percent of patients with excessive morbidity who received Task A and stool culture
8. Dehydration Mgt. Rate	Percent of dehydrated patient admissions that had an initial sodium determination and repeated if abnormal
9. Total Attack Rate	Proportion of 0 to 3 year population that had one or more episodes of GE in the time frame
10. Total Episode Rate	Number of episodes of GE per population of babies 0 to 3 years

NOTE 2

MHU operated for only 3 of the 5 study periods

Interpretation of Trends in Quality of Care for Hypertension: (Table 2-6)

- Data was of sufficient size to tabulate only 8 of 14 indicators.

- Number of patients for each study period are approximately equal except for #2, where peaks appeared during 3rd study period at Sells OPD and San Xavier (MD) Health Center. Therefore, only rates for periods 2 through 5 are shown.

- Little or no improvement of most rates are evident for any site since 1974.

- The two sites where CHMs work independently have approximately equal or better rates for quality of care than sites staffed with physicians.

- All sites have low quality rates for the outcome indicator for therapeutic effect (#8C) for the process indicators of those given medication (#5), and those receiving appropriate follow-up visits (#7), within the six months study period.

  However, paradoxically, all sites have higher rates for number of patients with blood pressure "controlled" (#6). This difference suggests that unknown factors, other than the prescription of anti-hypertensive drugs, are more important in their impact on quality of outcome indicators.

  As a group, the hypertensive population is frequently seen by the health system (#4), and therefore, could be questioned regarding the impact of these other factors.

Table 2-6

HYPERTENSION STUDY RESULTS

Quality Indicators[1]	Time Periods	Sites of Health Care			
		Sells Hospital OPD	San Xavier Health Center	Santa Rosa Health Center	Mobile Health Unit
Percent of Population Screened	Jan-Jun 1976 Rate (%)	41.8	40.3	36.9	34.5
	Number	4038	1831	786	258
	Jan 1974-Jul 1976 (5 Six-Month Study Periods) Rate (%)	33-38	38-40	18-32	44-60[2]
Screening Completion Rate	Jan-Jun 1976 Rate (%)	60.8	69.5	57.7	83.9
	Number	4956	2505	964	223
	Jan 1974-Jul 1976 (5 Six-Month Study Periods) Rate (%)	60	67-69	52-54	73[2]
Percent Hypertension Diagnosed	Jan-Jun 1976 Rate (%)	56	21	37	97
	Number	535	261	100	28
	Jan 1974-Jul 1976 (5 Six-Month Study Periods) Rate (%)	50-59	20	36-40	60-100[2]
System Contact Rate	Jan-Jun 1976 Rate (%)	90.1	78.0	92.1	58.5
	Number	223	50	38	26
	Jan 1974-Jul 1976 (5 Six-Month Study Periods) Rate (%)	85	78-82	84	90
Blood Pressure Control Rate	Jan-Jun 1976 Rate (%)	61.0	70.7	51.5	77.3
	Number	187	41	33	22
	Jan 1974-Jul 1976 (5 Six-Month Study Periods) Rate (%)	50-70	70-78	40-74	71[2]
Drug Coverage Rate	Jan-Jun 1976 Rate (%)	13.9	26.4	10.5	17.4
	Number	247	53	38	23
	Jan 1974-Jul 1976 (5 Six-Month Study Periods) Rate (%)	10-15	10-18	5-10	10-14
Follow-Up Rate	Jan-Jun 1976 Rate (%)	31.7	37.1	17.4	30.4
	Number	161	35	23	23
	Jan 1974-Jul 1976 (5 Six-Month Study Periods) Rate (%)	20-40	20-40	16-24	10
Reduction in Blood Pressure (BP)					
A. Hypertension Patients (HPTN) Whose Mean BP Decreased 10 mm Without Treatment	Jan-Jun 1976 Rate (%)	11.1	22.5	6.7	7.7
	Number	216	40	30	12
	Jan 1974-Jul 1976 (5 Six-Month Study Periods) Rate (%)	10-12	2-6	5-18	14[2]
B. Treated HPTN Patients Whose Mean BP Decreased 10 mm From Period Without Treatment	Jan-Jun 1976 Rate (%)	26.6	38.1	25.6	10.0
	Number	128	21	14	10
	Jan 1974-Jul 1976 (5 Six-Month Study Periods) Rate (%)	20-26	10-42	16-30	44
C. HPTN Population Therapeutic Effect (Condition B-A)	Jan-Jun 1976 Rate (%)	15.5	15.6	21.9	2.3
	Number	58	19	16	2
	Jan 1974-Jul 1976 (5 Six-Month Study Periods) Rate (%)	10-14	8-36	11-12	30

Table 2-6 (continued

NOTE 1

Description of Hypertension Quality of Care – Indicators Used in Table 2-6

1. Percent Population Screened. This indicator looks at the population which is eligible for screening (over 10 years old, no previous diagnosis of hypertension) and finds the percent of patients who had BP measurement in the past 6 months.

2. Screening Completion Rate. This indicator looks at the population which is eligible for screening (over 10 years old, no previous diagnosis of hypertension) and measures the percent of the population which is in compliance with screening criteria (i.e., not overdue).

   If any of the following criteria are met, the patient is overdue for screening:

   a. No previous BP on record
   b. The last BP is over 159/90 and it is over one month since the last BP
   c. All recorded BPs are under 140/90 and it is more than 5 years since the last BP
   d. Last three recorded BPs are under 140/90 and it is more than 5 years since the last BP
   e. Any other BP patterns present and it is more than one year since last BP

   These criteria do not apply to patients under 10 years old. Also BPs of questionable reliability (measurements taken in conjunction with DTs, trauma, etc.) are ignored.

3. Percent Hypertensives Diagnosed. This indicator determines the total number of active hypertensives known to the health system and divides this number by the estimated prevalence = 0.10 x the number of patients over 10. For example, if there are 50% diagnosed hypertensives among 10,000 patients over 10, then the percent of hypertensives diagnosed is 500/(0.1 x 10,000) = 50%.

4. System Contact Rate. This indicator looks at all active hyperter ve patients being cared for in the health system and determines the percent who have an encounter with the system (for any reason) during the 6-month study period.

5. BP Control Rate. This indicator looks at all active hypertensive patients in the health system and determines the average BP for each during a 6-month period. If the average BP is less than 140/90, the BP is assumed to be under control. Active hypertensives with no recorded blood pressures in the study period are excluded.

6. Drug Coverage Rate. This indicator measures continuity of care. It looks at all active hypertensives in the health system and determines the percent who are prescribed enough medication to cover them for at least 150 days of 180 day study period. For example, if there are 300 active hypertensives in the system and 200 are covered by perscriptions, then the drug coverage rate is 200/300 = 0.667 or 66.7%.

7. Follow Up Rate. Percent of hypertensives who were treated and returned in time to maintain continuity of treatment.

8. a. Number and percent of all hypertensive patients who, while not under therapy, had a reduction of 10mm or more in either systolic or diastolic blood pressure during the study period.
   b. Same as above, but for those treated with drugs before and after treatment.
   c. Numbers and percent difference between a. and b. above.

   Indicators studied but not reported because of low patient numbers or lack of data for one or more sites of care.

9. Case Finding Rate. This . ator measures how well the health system is catching up on the backlog of undiagnosed hypertensives. It measures the number of new hypertension diagnoses made in the past 6 months and divides it by the estimated diagnostic backlog. Estimated backlog = (0.01 x number of patients over 10) – number of previously diagnosed hypertensives. For example, if at the start of a 6-month study period, there are 500 diagnosed hypertensives among 10,000 patients, and if 50 new hypertensives are found in the study period, then the case finding rate is: 50/((0.10 x 10,000) - 500) = 0.10 or 10%.

10. Work Up Completion Rate. This indicator looks at patients who were first diagnosed as hypertensive during a 6-month study period. Then it looks to see if an EKG, chest x ray, and serum K were ordered within a 12-month period bracketing the date of the diagnosis. If all three tests were ordered, it is assumed that the work-up is probably complete. For example, if 50 hypertensives were diagnosed and 20 had all three tests ordered within + or -6 months from the date of diagnosis, then the rate of completion is 20/50 = 0.40 or 40%.

11. Incidence of Hypertensives Sequellae. This indicator measures the percent of hypertensives who develop stroke, conjestive heart failure, or renal failure (potentially preventable sequellae) in the 6-month study period. The results are multiplied by 2 to give a projected annual incidence rate. For example, if 10 of 500 hypertensives develop major target organ damage in a 6-month study period, then the projected annual incidence rate is: (2 x 10)/500 = 0.04 or 4%.

12. Missed Diagnosis Rate. Percent of individuals who meet mandatory diagnostic criteria but who are undiagnosed.

13. Mortality Rate, Hypertensive Sequellae. Percent of hypertensives who die from potentially preventable sequellae (stroke, conjestive heart failure, hypertensive renal disease, ruptured aorta aneurism) in a year.

14. Death Rate, Hypertensive Patients. Percent of hypertensives who die from any cause in a year.

NOTE 2

MHU operated only two full study periods: Jan – Jun 1976 and Jul – Dec 1975.

Method - Analysis of Patient Encountered: A second method of analysis for the same four health conditions used an EMCRO computer program that identified individual providers and their performance for each separate encounter where any of the four conditions were noted in their problem list. Each individual's performance was compared with all the other providers in the same category of either physicians or community health medics. This method would better indicate the performance of physicians as compared with non-physicians than the former analysis by clinic site, but others, such as nurses, may have done the initial data gathering and recorded this on the encounter form that would be attributed to the CHM if the patient was seen by a CHM at any time during the encounter. As in the prior analysis, patients were classified for each health problem as either a "high risk" or "normal risk" patient. Separate rates were calculated for each type for each visit -- each provider, but not reported because there was little variance by type from the rate for the total group.

Results of Analysis of Patient Encounters: The data in Table 2-7 compares all 7 physicians with 3 CHMs and one nurse practitioner for 14 indicators related to quality of care statements.

Table 2-8, presents the similar data, but includes the sites of service where the majority of visits for each condition occurred. During the six months study period, the same CHM was assigned to the mobile clinic for all patient visits (except a few that may have occurred during night or weekend duty.)

Similarly, the same CHM was on duty at the health center where more than 90% of all visits (for all conditions) occurred on days when no physicians were present. Regarding the physicians, almost all visits attributed to them occurred in the Sells outpatient department except for 10 days when two physicians alternately visited the CHM staffed health center. The third CHM was rated on visits at all three sites, but the majority of encounters were at the Sells OPD. The data was sufficient in number of visits to compare only 14 indicators. We have interpreted the overall patterns of compliance as generally similar for both physicians and community health medics.

Table 2-7

QUALITY OF CARE FOR PATIENTS COMPARISON
(PHYSICIAN TO CHM) AT ALL SITES

Health Problem	Quality Indicator	Physician (7)		CHM (3)		Rate Difference Physician/CHM (%)
		Rate (%)	No. of Visits	Rate (%)	No. of Visits	
Prenatal Care	Pregnancy Recognition	88.3	775	78.3	143	+10.0
	Overdue Screening	41.6	500	40.5	121	+1.1
Infant Gastroenteritis	Visits Staged for Severity	53.4	103	34.2	38	+19.2
	Data Recorded	96.2	130	85.5	55	+10.7
	Proper Fluids Therapy	20.0	65	34.4	32	-14.4
	Proper Use of Antibiotics	88.3	154	96.4	56	- 8.1
Hypertension	Screening Recognition	64.0	609	45.0	218	+19.0
	Follow-up Needed	49.5	671	59.7	238	-10.2
	BP Control	53.3	30	60.0	16	- 6.7
	Diagnosis Supported	53.3	75	44.4	18	+ 8.9
	Follow-up Proper	24.0	104	25.6	43	- 1.6
	Need for Rx Recognized	45.8	637	55.3	226	- 9.5
	Serum K + Test Ordered (if needed)	8.3	48	3.5	57	+ 4.8
	Standard Rx for Level of BP	8.1	74	16.7	18	- 8.6

Table 2-8 Quality of Care Comparison (Physician to CHM) at Hospital and at Three Health Centers

Health Problem	Quality Indicator	Physician (7) Hospital OPD		CHM					
				MIIU		Health Center		Sells OPD	
		Rate (%)	Number of Visits	Rate (%)	Number of Visits	Rate (%)	Number of Visits	Rate (%)	Number of Visits
Prenatal Care	Pregnancy Recognition	88.3	775	80.9	68	81.6	33	71.1	38
	Overdue Screening	41.6	500	42.6	61	24.0	25	51.6	31
Infant Gastroenteritis	Visits Staged for Severity	53.4	103	66.7	18	0	16	25	4
	Data Recorded	96.2	130	80.8	26	81.7	21	100	8
	Proper Fluids Therapy	20.0	65	47.1	17	15.4	13	50	2
	Proper Use of Antibiotics	88.3	154	100	27	95.2	21	87.5	8
Hypertension	Screening Recognition	64.0	609	31.4	70	49.4	77	53.3	60
	Follow-up Needed	49.5	671	60.9	87	56.0	84	61.3	62
	Diagnosis Supported	53.3	75	36.4	11	100	2	25	4
	Follow-up Proper	24.0	104	30.8	13	7.1	14	37.5	16
	Need for Rx Recognized	45.8	637	58.5	82	49.4	83	57.1	56
	Serium K + Test Ordered (if needed)	8.3	48	6.5	31	0	10	0	12
	Standard Rx for Level of BP	8.1	74	20.0	10	0	2	20.0	5

Table 2-9 presents some justification for this interpretation for both the patients analysis and the encounter analysis. There is no criteria developed that would objectively weigh the importance or value of each indicator even for the same health problem. This problem would be compounded by rating their importance between health problems. Another general trend observed is that for the majority of indicators the performance rates of the mobile unit is equal to or better than other sites whether staffed by physicians or CHMs.

Methods of Analysis for Quality of Care Received by a Population. The reservation was divided in regions based upon studies prior to STARPAHC which indicated significant difference in accessibility and utilization of health services. Seventeen quality of care indicators were studied for the health conditions of hypertension (7), gastroenteritis for children (4), and streptococcal infection for both children (3), and adults (3). The rates which which the indicator was achieved during STARPAHC operations were compared to rates for the prior year for each region. This method measured that net effect of the whole health care system upon a population - not just the individual effects of clinics and providers as in the previous sections.

Results of Quality of Care for a Population. In the following summary, all indicators are assigned equal values. The region served primarily by the mobile unit achieved in the year prior to STARPAHC the same rates for 34 measurement indicators as the three comparison regions, had worse rates for 12 measurements of indicators ($p => .05$), and had five rates better. After the STARPAHC project, the mobile unit region also had 34 measurements the same, but the number worse had decreased from 12 to 7, and the number better ($p =< .05$) had increased from 5 to 10 ($p < .01$). The greatest improvement was in the rates of performance of indicators for hypertension (all 8); next for streptococcal disease control (all 6, but smaller increment of improvement); least improved was gastroenteritis (2 of 4 indicators). Visits for both hypertension and streptococcal infections increased more (+68% and +326%). Visits for gastroenteritis declined in all regions (-13%) and the decline was

Table 2-9

SUMMARY OF CHM AND PHYSICIAN RATE COMPARISONS
FOR QUALITY INDICATORS
SELLS SERVICE UNIT

Health Problem	Number of Indicators			
	Prenatal	G.E.	Hypert.	Total
1. Analysis: 6 Months 1976: Patient Care by Site				
CHM Staffed Sites Compared to MD Sites				
Rates same ±10%	1	2	8	11
CHM Sites Less than MD Sites >10%	2	1	1	4
CHM Sites More than MD Sites >10%	3	0	1	4
Totals	6	3	10	19
2. Analysis: 6 Months 1976: Provider Performance by Visit				
CHM same as MD ±10%	2	1	6	9
CHM less than MD >10%	0	2	1	3
CHM more than MD >10%	0	1	1	2
Totals	2	4	8	14

greatest in the region served by the MHU (-65%). Although only about 12% of all visits were analyzed for quality indicator, the conclusion of these studies and others was that there was a relationship between increased accessibility, increased utilization, and increased quality of care for hypertension and streptococcal disease.

2.3.3 Medical Utilization of STARPAHC Equipped Facilities and Telecommunications Average number of visits to the Mobile Clinic during each of the six-month periods was comparable. Although there were slight variations in the month vs month comparisons, these differences were considered insignificant. The third six-month period for the Santa Rosa Health Center, showed a decrease in patients visits when compared to the other six-months. However the last six months showed a significant increase.

Utilization of Telecommunication. The use of telecommunications for support of the health delivery system has declined slightly during the second year of operation.

On Table 2-10, the number of patient visits and number of consultations for the four 6-month periods are shown.

There are two known reasons for this noted decline, both in absolute numbers, and as a percent of patient visits. One is that the data transmission system has been performing much more successfully during the second year of operation. Therefore, there is less need for the mobile unit to contact medical records at Sells.

The mobile clinic was out of service for only 6 days during the second year compared with 8 days during the first year. Health service was provided by a standby trailer equipped for VHF/voice/data for all but 1 day of scheduled service. This year, more visits to Santa Rosa were for routine school examinations

Table 2-10 Utilization of STARPAHC Equipment for Patient Consultation From the Field Clinics to Sells (All Modes of Consultation)

Evaluation Period	Mobile Clinic			Santa Rosa Clinic			Total Both Sites		
	Visits	Consults.	%	Visits	Consults.	%	Visits	Consults.	%
First 6 months	1,613	308	19.1	2,330	79	3.4	3,943	387	9.8
Second 6 months	1,667	330	19.8	2,593	106	4.1	4,260	436	10.2
Third 6 months	1,497	280	18.7	2,470	88	3.6	3,967	368	9.3
Fourth 6 months	1,780	302	16.9	2,864	51	1.8	4,644	353	7.6
Subtotal 1st Year	3,280	638	19.5	4,923	185	3.8	8,203	823	10.0
Subtotal 2nd Year	3,277	582	17.8	5,334	139	2.6	8,611	721	8.4
Total Two Years	6,557	1,220	18.6	10,257	324	3.2	16,814	1,544	9.2

(September) and for influenza immunizations (October). These reasons for visits are less likely to generate a need for remote consultation.

The need for communication between a community health medic and a physician or other health professional did vary with the health problem or diagnosis The following conclusions are from data presented in Table 2-11.

Some sort of communication mode (either voice or audio plus video) was used most commonly for the following health problems: 10% of all injuries and accidents, 15.7% of all diseases of the skin, 21.4% of metabolic and nutritional problems, 20.9% of diseases of genitals, 19.5% of mental or behavioral health problems, and 16.7% of both urinary tract disorders, however a group categorized as "ill defined signs and symptoms" had the highest rate of 32.9%.

This analysis is based on 12 months data (July 1, 1975 to June 30, 1976) collected for 3,648 visits to the mobile health unit. A total of 634 patients had remote consultation, but sufficient information needed to link the use of communication equipment to a specific diagnosis was present in only 346 or 55% of the total communication episodes. The most common cause for not being able to match the consultation with the diagnosis was that the mobile unit staff was not required to fill out evaluation forms for calls transmitted over the VHF or MUX system and patched into the hospital telephone network. Most of these calls were to the laboratory, pharmacy, or appointments desk. Of the 3,949 diagnosis for a variety of health problems to the mobile clinic telecommunications were needed for 439 problems, about 11% of all problems.

The mobile unit was used for the above study because all communications were monitored while at the health center usually voice communications were held via the existing telephone system which was not monitored. The patients utilizing both sites, however, showed a very similar distribution of diagnosis or health problems for which communications were used. (See Table 2-12).

Table 2-11

COMMUNICATION NEED BETWEEN CHM AT THE MHU AND THE PHYSICIAN AND OTHER HEALTH PERSONNEL AT THE SELLS HOSPITAL

Health Problem Category	Number of Diagnoses	Number of Communication Episodes	Percent of Problems Needing Communications
1. Accidents and Injuries	298	30	10.1
2. Diseases of the Skin	318	50	15.7
3. Metabolic, Nutritional, and Blood Disorders	206	44	21.4
4. Diseases of the Genital System	43	9	20.9
5. Mental Health and Behavior	41	8	19.5
6. Urinary Tract Diseases	120	20	32.9
7. Symptoms and Ill-Defined Causes	79	26	16.7
8. Cardiovascular Diseases	284	46	16.2
9. Supplemental Diagnosis (Routine Examinations, Well Baby, All Others)	485	43	8.9
10. Maternal and Child Health	175	19	10.9
11. Diseases of the Digestive System, Teeth	99	9	9.1
12. Diseases of the Ear	250	21	8.4
13. Bacterial and Parasitic Infections	241	20	8.3
14. Diseases of the Eyes	119	9	7.6
15. Respiratory Diseases	771	55	7.1
16. Other Problem Categories (7)	420	30	7.1
Totals/Problems Diagnosed	3,949	439	11.1
Total Patients Seen	3,376	634	18.8

Note: Analysis is based on 12 months data (July 1, 1975 to June 30, 1976).

Table 2-12

HEALTH PROBLEMS/DIAGNOSIS BY SITE OF VISITS

	Site of Health Center						Video Consultations			
	Mobile Health Unit			Santa Rosa Clinic						
	Number of Visits	Percent of Total Visits	Rank Order	Number of Visits	Percent of Total Visits	Rank Order	Number for MHU	Number for Santa Rosa	Percent of Consultations To Visits – MHU	Percent of Consultations To Visits – Santa Rosa
1. Respiratory Disorders (URI)	771	19.5	1	848	15.1	1	14	12	1.8	1.4
2. Musculoskeletal Disease (Arthritis)	156	4.0	11	224	4.9	9	2	4	1.3	1.8
3. Cardiovascular Disease (Hypertension)	284	7.2	4	320	5.7	7	11	11	3.9	2.2
4. Ear Disease (Otitis Media)	250	6.3	6	442	7.9	4	4	4	1.6	0.9
5. Bacterial – Parasitic Infection	241	6.1	7	296	5.3	8	12	1	4.9	0.3
6. Metabolic (Diabetes and Obesity) Nutritional (Iron Def. Anemia)	206	5.2	8	459	8.2	3	16	4	7.8	0.9
7. Skin Disease (Impetigo)	318	8.1	2	376	6.7	5	22	9	6.9	2.4
8. Maternal Health (Pre & Post Natal)	175	4.4	9	134	2.4	18	2	0	1.1	0
9. Diarrheal Enteric Disease	164	4.2	10	202	3.6	10	5	3	3.0	1.5
10. Ill-Defined Symptoms	79	2.0	16	171	3.1	15	10	11	12.7	6.4
11. Well Child Exam	124	3.2	12	189	3.4	12	0	0	0	0
12. Urinary Tract Disease	120	3.0	13	193	3.4	11	5	5	4.2	2.6
13. Eye Diseases (Conjunctivitis)	119	3.0	14	183	3.3	13	3	3	2.5	1.6
14. Digestive Tract Disorder	99	2.5	15	145	2.6	17	4	6	4.0	4.1
15. Accidents Injuries	298	7.6	3	545	9.7	2	10	10	3.4	1.8
16. Supplementary Care (Exams)	262	6.6	5	324	5.8	6	0	1	0	0.3
17. Viral Infections	61	1.5	17	68	1.2	20	2	0	3.3	0
18. Well Infant (Exams)	53	1.3	18	78	1.4	19	0	0	0	0
19. School Child (Exams)	46	1.2	19	180	3.2	14	0	0	0	0
20. Genital Disorders	43	1.1	20	46	0.8	21	2	1	4.7	2.2
21. All Others (Neoplasms, Mental, Neurological, Venereal, and Tuberculosis)	80	2.0	21	179	3.2	16	4*	1	5.0	0.6
Total Problems Diagnosed	3949	100%		5602	100%		128	86	3.2	1.5

*For Neuro (2) Mental (2)

Need for communication from the mobile unit is not the same for each health problem category. The observed use of communications is greater than the expected use for metabolic, nitritional and blood disorders; for disorders of skin; and for injuries. The observed use of communications is less than the expected values for enteric and diarrheal diseases; mental and behavioral disorders; respiratory diseases, and musculoskeletal disorders.

The use of the video system by the staff on the mobile clinic consultation followed a similar pattern for most disease categories (See Table 2-12)

Video-consultations were used for 12.7% of all accidents and injuries, 12,3% of all skin diseases, 7.8% of metabolic and nutritional problems, and 6.4% of ill defined conditions. However, the other categories which accounted for high rates of communications need did not rate high for video use. (e.g., mental disorders, genital disorders and urinary tract disorders.) Almost all video consultations were between the remote CHM and the physician at the primary care hospital. In Table 2-12, 82.5% of the total 263 video consultations could be linked to one or more diagnostic categories. In the event that the patient for whom a video consultation was held had more than one diagnosis or health problem, it is not possible to be sure for which problem the video was used, unless the original health record had been studied. For example, there is no obvious reason why the category of metabolic and nutritional disorders should account for 21.4% of the cases to need communications. Since diabetes mellitus with or without obesity accounts for almost all the diagnosis in this category, and patients with these later diagnosis also have a high incidence of skin infections, the rate of 21.4% could very well include many of the patients with skin disorders which had a higher rate of communication needs (27.9%). Therefore, data in Table 2-12 can only be suggestive of the types of health problems for which the field staff thought video would be useful.

Table 2-12 also compares the relative frequency of health problems diagnosed at the health center with those for which the CHM initiated a video consultation with a physician. The relative use of the television systems by health problem categories varied from the rates for the mobile unit. Ill-defined conditions had the highest rate (6.4%) followed by digestive trace disorders (4.1%), urinary tract disease (2.6%), and skin disease (2.4%). Accidents and injuries diagnosed at the health center had a low rate for video consultations, 1.8%, compared with the mobile unit rate of 12.7%. The health records printouts do not distinguish the degree of severity within each category, so the reason for this difference is not readily explained. There was a striking age difference, however. School age children, 5 to 14 years, accounted for 40% of the accidents and injuries seen at the health center, and for only 17% of those going to the mobile clinic. Therefore, the health center probably saw proportionately more minor cases of injury due to the large boarding school nearby.

Other reasons may also account for the differences between these two sites. The health center is only 32 miles (40 minutes) from the hospital and the mobile clinic stops are from 45 to 75 miles away (50 to 90 minutes).

Also, the Health Center supplies several services that the mobile unit does not. Physicians, dentists, public health nurses, physical therapists, and optometrists hold speciality clinics once or twice a month at the health center. Several different CHMs rotate assignment to the health center, while the one CHM was usually assigned to the mobile unit and saw about 65% of all the patients during the time period studied. The different rates for video consultation for these two sites are shown in Table 2-13. In the total of patient visits and patient problems for the health center, only visits to the CHMs on days when they worked alone (i.e., without physicians present), were counted. Total visits also exclude those who used the dental services. The result is surprising because one would have expected the higher usage rates should be from the mobile clinic because of the greater distances from primary care physicians. The mobile unit might also be expected to generate higher uses of video consultations because of the differences in relative proportion

Table 2-13

USE OF VIDEO CONSULTATIONS BY REMOTE CHM WITH PHYSICIANS BY SITE OF HEALTH CENTER
(12 Months: Feb 1976 Through Jan 1977)

	Site of Health Center						
	MHU			Santa Rose Clinic			
Number of Problems Diagnosed by CHM	Number of Visits	Number of TV Consultations	Percent of Total	Number of Visits	Number of TV Consultations	Percent of Total	Percent of TV Consultations to Visits
3373	81	2.40	4597	157	3.42	2.99
4179	81	1.94	5277	157	2.98	2.57

*Visits – Encounters with patients by CHM or LPN on days when neither MD nor dentist (at Health Center) were present.

of visits by disease categories as shown in Table 2-12. For example, patients for preventive services were not expected to need visual consultations as much as those for curative services. Preventive diagnosis at the mobile unit accounted for 13.4% of all diagnosis as compared with 19.5% for the health center.

The use of videoconsultation by level of CHM experience was studied for only those days when the CHM was working without physicians present during a period of 12 months. See Table 2-14. Patients who visited only the dentist at the health center were also subtracted from the number of visits.

There is a statistically significant difference in rates ($P \Rightarrow .01$, Chi Square test) by the experience of the CHM. The least experienced used video consultation for 8.2% of their patients, and the most experienced used television for less than 2%. The same rank order resulted when physicians at Sells were asked to rank the 5 CHMs by their clinical competence. However, other factors such as sex could account for the same degree of statistical significance. Three female CHMs (1, 2A) show as much difference compared with the two (2B,3) males for use of video consultations.

Language differences is another variable because the two CHM trainees spoke fluent Papago, while the others did not. Statistical associations occurring during evaluation of field trials are often subject to multiple interpretations.

Reasons for initiating communications from the mobile unit and the health center were tabulated for a 12-month period. The results are shown in Table 2-15. The wide band system was most often used for the remote physician's help in either diagnosis or treatment.

When the video was used for "other" reasons, it was due to the desire of the remote CHM or nurse on the mobile unit to be able to speak with the medical records staff via interactive television. In other words, the clinical situation did not require the use of the video systems from the mobile unit in these instances.

Table 2-14

USE OF VIDEO CONSULTATIONS WITH PHYSICIAN (BY DEGREE OF CHM EXPERIENCE)

Level of CHM Experience		Santa Rosa Clinic			Mobile Clinic			Both		
	Number of CHMs	Number of Visits	TV Use	Percent of TV	Number of Visits	TV Use	Percent of TV	Number of Visits	TV Use	Percent of TV To Visits
1. Least (trainees)	2	N/A	N/A	N/A	316	26	8.23	316	26	8.23
2. Moderate										
A.	1	2507	91	3.83	472	8	1.69	2979	99	3.32
B.	1	1046	18	1.72	259	6	2.32	1305	24	1.84
3. Most	1	774	11	1.42	1858	37	1.99	2632	48	1.82
TOTALS	5	4327	120	2.77	2905	77	2.65	7232	197	2.72

Visits – Number of patient encounters when CHM was alone (without either physician or dentist)

Table 2-15

USE OF VOICE/VIDEO AT THE MHU AND AT THE SANTA ROSA CLINIC

Mode Reasons	Mobile Health Unit				Santa Rosa Clinic				Health Center & MHU			
	Voice		Video		Voice		Video		Voice		Video	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1. For help in diagnosis or therapy	70	33.0	59	67.1	16	69.6	59	78.7	86	36.6	118	72.4
2. At patient's request	15	7.1	2	2.3	0		2	2.7	15	6.4	4	2.5
3. For CHM education	9	4.2	3	3.4	3	13.0	5	6.7	12	5.1	8	4.9
4. By MD instruction	0	0	1	1.1	0	0	4	5.3	0	0	5	3.1
5. Other (Information from lab, records, appointments, etc.)	118	55.7	23	26.1	4	17.4	5	6.6	122	51.9	28	17.1
Total Answered	212	100.0	88	100.0	23	100.0	75	100.0	235	100.0	163	100.0

On the other hand, the video consultations from the health center were almost exclusively received by physicians or dentists at the request of the CHM. As noted before, the health center used the regular telephone system for almost all their needs that could be handled vocally.

The trends as shown in Table 2-15 are only approximate because this information was not available for at least 20% of all known video consultations from the mobile unit, and for 60% from the health center. About 60% of all calls using only voice modalities from the mobile unit to Sells did not report the reason for initiation.

Almost all those not reported were probably calls made by the nurse to medical records, pharmacy, or laboratory for patient information, to make appointments, or to arrange for patient travel. The use of television for medical purposes varied greatly by equipment function (Table 2-16).

The reasons for low utilization of some of these video or audio equipment are explained by the nature of the health system operations plus the dissatisfaction of the users. Too much time was needed by the CHM to prepare the specimens for transmission over the microscopic system. Since the number of patients far exceeded the desk load, priority of the "providing services" time was given to patient encounters (within the limited service time). Not all the CHMs working at the health center were trained in the use of this subsystem, and lack of time there was also a factor. The nature of the type of infections presented also limited the need. For example, intestinal parasites are very rare in this population (except for pinworms whose manifestations are usually visible to the unaided eye). This system was dismantled at the health center and brought to the primary hospital for research purposes utilizing the slow scan video system. Results of these experiments are reported in another section. Briefly, the video microscope image transmissions via slow scan for blood disorders and exfoliative cytology were successfully diagnosed. There is no reason to believe that wide-band transmissions would have had any less valid or reliable results.

Table 2-16

USE OF BROAD BAND COMMUNICATIONS BY TYPE FOR PATIENT-RELATED PURPOSES 18 MONTHS OPERATIONS FROM TWO REMOTE LOCATIONS

Type of System	Purposes				Both	
	Medical Administration		Clinical Consultation		Med. Adm. and Clinical Consult.	
	Number	Percent	Number	Percent	Number	Percent
1. Television (7.5 GHz)						
• Color TV: Viewing Patient	35		307		342	84.9
• Color TV: Microscope	1		5		6	1.5
• Color TV: Endoscope	0		8		8	1.9
• B&W TV (X Rays)	1		46		47	11.7
Total	37		366		403	100.0
2. Audio:						
• Wide Band: Voice	7		4		11	1.2
Heart Sounds (7.5 GHz)	0		9		9	0.9
• Narrow Band (1.8 GHz) MUX System	517		405		922	97.9
Total	524		418		942	100.0

The video endoscope was thought needed to obtain views of oral pathology, but the functional design of the instrument was cumbersome and time consuming for the CHM. A satisfactory degree of magnification, for most purposes, was achieved more easily by attaching a close up lens to the color camera used for viewing the patient. In addition, the fiber-optic bundle on the mobile unit instrument became damaged by excessive dust, and rather than be replaced, the system was removed after six months because of the low usage and high cost of repair.

The black and white video system was satisfactorily used as needed to transmit pictures or roentograms, mostly from the mobile unit, to be read by physicians at Sells. However, there was rarely a need to perform this function. A patient with obvious symptoms that needed immediate referral to the hospital would not need to be detained at the remote site for the time needed to take, develop, dry, and transmit the x-ray picture. This time period could be as much as one hour. Therefore, the x-rays transmitted were usually for the purpose of ruling out a fracture or serious chest disease in a patient without severe symptoms. In these patients, the remote provider was uncertain about the need for referral. Additionally, not all the CHMs assigned to the mobile unit had adequate skill to take an x-ray that was of a high enough quality to transmit. The transmission of selected, high-quality x-ray films by the slow scan system resulted in as high an index of reliable diagnostic interpretation by a radiologist as the reading of the original films. There is not reason to believe that wideband transmission would have been any less satisfactory.

The low use of the wideband audio channel is explained by the high use and high reliability (i.e., fail 1.1%; poor 1.8%; fair 7.6%; good to excellent 87.5% of 1,056 uses over 18 months) of the MUX system which was the primary carrier. The VHF system was the usual backup for the MUX. The low use of the transmission of heart sounds can be explained by both the low evidence of heart disease in the population plus the dissatisfaction of the receiving physicians with the transmitted sounds. The system produced too much additional noise from the examining room, clothing, or movement of the patient, and the sound of the stethoscope upon the skin and hair of the patient. However, the system

was responsible for a correct diagnosis of heart failure by the monitoring physician when the remote immediate provider was considering pneumonia as the possible diagnosis.

Value of Teleconsultations. The users of the communications systems were asked to give their impression of the value of each consultation at the conclusion. During a 12-month period, 829 statements of value were analyzed by category of provider and by whether the consultation used voice or voice plus television. A consultation was considered to have used television only if transmissions were coming from the field to the primary hospital, regardless of whether the outgoing signal was televised. The small number of instances where only voice was incoming and the television image of the staff member at Sells went to the field sites were considered as voice "only" consultations. The great majority of video consultations were interactive (two way video), except when the return link was inoperative. Of the 829 statements made by health providers, 356 were matched for the same transmission (i.e., these represented 178 patient consultations). The remaining statements represented opinions of either the field staff or the primary care hospital staff for a single patient consultation. Therefore, this information was received for 651 of the 834 known consultations or 78% of the total. The majority of those consultations without ratings were voice only from the mobile unit.

Table 2-17 presents these opinions. The voice mode included all carrier bands, since the health provider was not always cognizant of whethe he RF, VHF, or MUX systems were operating.

The opinions of the value of the only voice mode, cannot be compared to the voice plus video mode. It must be remembered that the latter opinion relates only to those consultations where television was used, not to the use of the television as a separate system. The circumstances under which voice only or voice plus television consultations occurred were entirely different. The CHMs usually initiated television consults only when they felt uncertain as to the proper course of action. When they were certain of the need for referrals to the physician, they initiated, usually, only a call to the physician or

Table 2-17

VALUE OF TELECONSULTATIONS

Value Statement Mode	Health Providers										Totals All			
	CHM		MD		LPN		MR		Other		Number of Voice	Percent of Total Voice	Number of TV Consults	Percent of Total TV Consults
	V	TV	V	TV	V	TV	V	TV	V	TV				
1. "Critical for Proper Care"	15	28 (17.5%)	0	8 (5.1%)	1	2	67	7	1	1	84	18.06	46*	12.64
2. "Important or Useful"	150	121 (75.6%)	29	115 (73.2%)	39	7	129	14	6	11	353	75.92	268*	73.63
3. "Little or No Value"	3	11 (6.9%)	9	29 (18.5%)	4	0	8	2	0	2	24	5.16	44	12.09
4. "Confusing or Harmful"	2	0 (0.0)	2	5 (3.2%)	0	0	0	0	0	1	4	0.86	6	1.65
Totals Mode (V or TV)	170	160	40	157	44	9	204	23	7	15	465	100	364	100

KEY

V = Voice from and to the field, with or without television from Sells
TV = Voice and video from the field, with or without return video from Sells
CHM = Community Health Medics (N = 6)
MD = Physicians (N = 9)
LPN = Licensed practical nurse N = 2
MR = Medical Records staff N = 3
O = all others (Dentist, Physical Therapist, Lab plus 8 unspecified)

*Note: In 86.3% of the video teleconsultations the providers indicate that TV is "critical, important, or useful" for proper care.

medical records staff for notification purposes. The physicians received voice communications, through a telephone coupler, at any station in the hospital, but had to walk to the console room to receive video consultations. This data does show a difference of opinions about the value of consultations where television was used between the CHM and physicians. This data is shown in Table 2-18.

Physicians rated these consultations much lower in value than the CHMs. Explanations for this difference follows:

When the opinions of the CHM and physician are matched for the same consultation, there is only 54% agreement for 84 patients. The CHMs rated 20 video consultations as "critical for the proper care of the patient", but physicians concurred in only two instances. They both agreed that 43 consultations were "important or useful", but differed upon 11 other consultations where the CHM felt the result of "important....", but the physician thought it was "of little or no value".

Perceived values by the CHM also varied significantly, depending on which facility was being used. These variations may very well have been related to the physician perceived competence of the CHM, e.g., the least experienced CHM was serving the Santa Rosa Health Center and the largest difference in perceived value between the CHM/Physician is recorded for that location.

Some further light is brought to this complex situation by analysis of the users' opinions about the nature of the impact of the video consultation. (See Section 2.4.6).

Several impact areas are usually checked for each consultation which compounds interpretations. However, a trend seems to be discernable during our preliminary analysis. It seems that if the physician in consulting with a less experienced CHM, and his impression of the impact is "great" on reassurance of the CHM's initial impression of either the diagnosis or treatment, "some" or "great" on educational value to the CHM, "some" or "no change" in treatment plan and a trip to Sells is not eliminated for the patient, then the physician

Table 2-18

PERCEIVED VALUE OF PATIENT VIDEO CONSULTATIONS BY CHM AND PHYSICIANS FOR THE HEALTH CENTER AND MOBILE CLINIC

Value Statement	Mobile Clinic TV Consultations				Difference in Percent CHM/MD	Health Center TV Consultations				Difference Percent in CHM/MD
	CHM		MD			CHM		MD		
	Number	Percent	Number	Percent		Number	Percent	Number	Percent	
1. "Critical"	18	23.4	3	5.6	17.8	10	14.7	5	4.9	9.8
2. "Important"	57	74.0	45	83.3	9.3	57	83.8	70	67.9	15.9
3. "No Value"	2	2.6	5	9.3	6.7	1	1.5	24	23.3	21.8
4. "Confusing – Harmful"	0	0	1	1.8	1.8	0	0	4	3.9	3.9
Total Reported	77	100	54	100		68	100	103	100	

is likely to consider the consult of "little or no value". This judgement is more often made when video signal quality was rated as "good" than when it was rated as "fair" or "poor".

The physician is especially likely to rate the value of the video consultation as "important or useful" when he thinks that the treatment plan has been changed, a trip to Sells has been eliminated, and a more definite assessment of the patient's problem resulted. On the other hand, CHMs judge that the video consultation has been "critical to the proper care of the patient", or important or useful" when the "great" impact has been on "reassurance", more definite problem assessment, and upon his own educational needs. The competency of the CHM also affected the physician judgment. If the CHM was believed to be highly competent by the physician, then his judgment of the teleconsultation as having "little or no value" was given with the physician's perception that the contact only furnished reassurance to the CHM.

There is some similar evidence regarding the value judgment of specialist physicians in Phoenix who are consulted by younger general physicians at Sells via the slow scan television link.

The specialist rated 3 of 7 coincident consultations "of little or no value" with his perception that the main result was "reassurance" of the initial diagnosis. However, he rated 4 as "important or useful" when he thought a change in either treatment plan or diagnosis resulted.

These trends are supportive of data collected by interviews with the users conducted by a behavioral scientist. Direct questions were asked of 47 health providers (including 21 physicians) about the perceived value of television for the remote diagnosis or treatment of patients visiting CHMs. All providers rated the value of television least as compared with other communications systems for voice and data. Twelve physicians noted that it was "inconvenient" for them to leave their hospital patients for a teleconsultation; pictures rarely offered more important information than they believed could have been

received by telephone (5 MDs, 1 CHM, 1 pharmacist); and that the cost (i.e., as they perceived it) of television system was not worth the benefits. However, seven physicians recalled video consultations where the proper diagnosis or treatment plan had resulted, at least in part, due to their opportunity to "see" the patient or the x-ray. Cases of skin and eye disease, and injuries were mentioned.

Generally, the 5 CHMs rated the communication systems in the same order of value as the physicians, but were much more in favor of using video teleconsultation for their patients (4 of 5), possibly because of the greater reassurance they felt while under observation of the remote physician. The CHM providers did not value the return video link except occasionally when they believed the patient better understood the physician's directions when the speaker was also viewed (1 MD, 1 CHM, 1 Physical Therapist).

When asked to rate the value of "real time" video compared with slow scan video (i.e., pictures without motion), 8 providers thought that motion was important. Color television was rated slightly higher than black and white transmissions from the field.

Some physicians stated that they rated some consultations as "confusing or harmful" when they felt that they were called away from a patient at the hospital who had a more serious health problem than the one presented over television by the CHM. In other words, their judgment did not always apply to the teleconsultation but to a completely different situation. Six physicians, one CHM and the physical therapist thought that a video consultation did not convey as much needed information as a personal encounter. Eight of the 12 providers with one year or more experience in video consultations thought that equipment failures and problems of color balance and resolution sufficient for diagnosis were problems.

A third study attempted to understand the value of video consultation in a relatively objective fashion. All available records about patients whose problems received a video consultation during a two-month period were collected and correlated. Reviewers attempted to make judgements about the appropriateness of the treatments received, referrals made, and the use of television. They attempted to relate the role of television to the outcome of the relevant condition, the amount of travel saved, and the quality of care received. Such an approach during a field trial can only compile examples of the use and misuse, or of the appropriateness and inappropriateness of video consultations by applying a variety of assumptions based only upon existing documentation.

To date, only 116 patients have been studied where wide band television had been used for a total of 133 consultations. In the judgment of physician reviewers, the initiation of the television mode for help in diagnosis, assessment, or therapy was thought to have been appropriate for 112 (84%) patients. For 2 additional patients, the return link seemed to be important, not the incoming transmissions. For 21 others (16%), the records did not show any health problems where television could have been presumed to have been more useful than the use of the telephone.

The 112 patients for whom television consultation was appropriately initiated were further analyzed. For 86 patients, the video consultation was judged to have been helpful (76.8%). Their health problem was apparently diagnosed correctly, treatment properly rendered, 3151 miles of travel was eliminated for 37 patients and their problem was resolved. For 12 other persons, the final result was either of no value, negative value, or at least questionable. The remaining 14 patients did not return for followup visits and therefore the results could not be evaluated. Only one of the 12 patients who were judged to have had teleconsults of little value was related to a poor quality of transmission, an x-ray in this case that resulted in an unnecessary trip to Sells to obtain a negative reading. For the other 11 patients, the value of the teleconsult was compromised by either incorrect diagnosis or treatment plan, as judged in this retrospective study.

These instances in which the initiation of the teleconsultation was thought to have been inappropriate were so classified for a variety of reasons: The complexity of the health problems known or suspected was such that a personal referral to a physician was preferred to a video consult; the delay in hospitalizing the patient (plus the 30 to 45 minute delay in serving others who were waiting) was occasioned by setting up the video consultation and should have been avoided because pictures could not have helped clinical diagnosis (e.g., rattlesnake bite, renal failure, peritonsillar abscess, upper respiratory infection). It is entirely possible that the video consultation was initiated to resolve problems that were not documented in the records for the above patients. Therefore, the results of this study can only be illustrative of some problems associated with the use of television in clinical settings.

There was no doubt that video consultation had resulted in many hundreds of miles of patient travel saved under circumstances where a physician's participation in diagnosis or treatment was needed, but the patient did not need to be personally referred. During a 12-month period, in which 170 video consultations were reported, 49 medical or dental referrals were eliminated. This saved 76 to 150 miles individual round trips. Forty-three referrals were requested.

The appropriateness of these decisions regarding referrals can only be judged by detailed study. It is clear that the value of a video consultation depends upon the complex processes of a health care system; not only upon the adequacy of transmitted information.

Medical Evaluation of Slow Scan Television. The evaluation of Slow Scan Television for remote medical consultations was carried out for three areas: (1) Radiology, (2) Skin Tones Orbital Pictures, and (3) Microscopy. The general purpose of the radiology evaluation was to transmit selected test films from the primary care hospital at Sells to an expert diagnostic radiologist at the Phoenix Indian Medical Referral Center and compare his readings (upon special reporting forms) with the originals. The general purpose of the skin tones/orbit picture evaluation was to determine the adequacy of transmitting patient images in color. The purpose of transmitting microscopic slide data was to test the usefulness, feasibility, and the overall capabilities of televised microscopy for interpreting smears of peripheral blood and bacterial specimen.

Radiology.

Four specific experiments were carried out to evaluate the radiographic quality of the transmitted x-rays and to determine the diagnostic validity of interpreting transmitted chest x-rays by an expert diagnostic radiologist.

Experiment 1. (Whole Chest Disc Readings). The three objectives established for the experiment were to determine if:

- o Single transmissions of one televised view of the whole chest would be a reliable method for interpreting chest x-rays.
- o The size of film was related to the reliability.
- o The radiographic quality of the film was related to reliability.

Eighty-six roentograms were randomly selected from a group of 121 test films for transmission. The transmitted images were stored on a VAS recorder disc in the first experiment.

Sixty-five large chest film sizes (14 x 17 in.) and twenty-one small chest film sizes (less than 14 x 17 in.) were transmitted.

"Radiographic quality", established to evaluate the transmission of the x-ray images, was defined as adequate or inadequate in the judgment of the physicians. All films agreed upon by at least two of the three physicians were classified as either adequate or inadequate quality. Twelve large and three small-size inadequate films were transmitted, while 53 large and 18 small adequate films were transmitted.

The radiologist reader at the Phoenix Indian Medical Center was instructed to report whether each film or televised image was either "negative" or "positive" for pathology. If the film or image was considered "positive", then the reader was asked only to check the tissue, or tissues involved, and mark the location upon a grid diagram. Analysis of the televised positive/negative pathology readings by the radiologist were compared to the positive/negative pathology interpretations given to the original films. Comparisons were made on a first and second reading of the original films.

Results of Experiment 1 indicated that:

- o Reliability is not acceptable for one televised view of the whole chest.
- o Increasing the perceived resolution from 500 to 1,000 lines per square inch by using the smaller size film did not seem to improve the reliability of the interpretation and may have made them worse.
- o Films of inadequate radiographic quality seem to be as reliably read on television as in the original form, but percent agreement in both cases is low.

It should be noted in the experiment that 71 adequate quality X-rays, and only 15 inadequate quality x-rays were transmitted.

Experiment II. (Whole Chest Disc/Videotape Readings). The objective of this experiment was to measure reliability of interpretation of the readings for the TV disc storage with those from the videotape storage, and with original films. The methods were the same as for Experiment I, except for the reduction from 86 transmissions to 57 due to transmitting or recorder malfunctions.

Results of Experiment II were in agreement with those of Experiment I and the conclusion is that reliability is not acceptable for either disc or video tape readings, when compared with dual readings of the original films.

Experiment III. (Whole Chest Disc/Disc Videotape Readings). The objectives of this experiment were to:

- o Measure reliability of the interpretation using different transmission techniques from those used in Experiments I and II.
- o Compare the above objectives for both disc and videotape readings.

The transmission instructions for Experiment III are as follows.

- o Three pictures of the same film transmitted.
- o One whole chest view transmitted as in Experiments I and II.
- o One view of the upper one-half of the film.
- o One view of the lower one-half of the film.

Fifty-two films were transmitted; however, due to a failure to videotape only 37 of the films transmitted were available for reading all 3 views on videotape.

The reliability of the interpretations of the videotape and disc readings compared with the first reading of the original film was 100% for the 32 films from the first two experiments. Of these 32 films, both original readings agreed 30 times (19 negatives and 11 positive pathology readings).

The videotape and disc readings compared with the original readings perfectly and with each other. The reading of five out of the nine true positive pathology films (proven by tissue examination) was also 100% reliable for both videotape and disc readings as far as the positive and negative pathology readings; however; both the video tape and disc readings missed the same lesions and/or location of the tissue involved. From densitometer analysis of the lesions on original films, there seems to be no consistent explanation for the missed diagnosis. During the case conference with the radiologist following the experiment, all nine films and television images were re-read and discussed. Lesions were seen on the monitor, but the radiologist stated "were not appreciated when the film images were mixed in with normals during the transmission sequence".

This experiment resulted in highest reliability indices of the three experiments.

Experiment IV. (Transmission of Whole, Upper and Lower One-half, and Enlargement of Specified Portion of Chest Films). The objectives of this experiment were to:

- Measure the impact of enlargement of specified portions of chest film upon accuracy and reliability of interpretation.
- Pretest another methodology that more closely simulates the physician and consultant interactive mode of transmission, and measure effect upon accuracy and diagnosis.

A sample of 22 films to be transmitted was selected from the 54 films used in Experiment III. The enlarged view of a specified portion of the large chest film did not increase the accuracy of interpretation over the previously transmitted three views for each chest film.

Skin Tones and Orbit Pictures.

Specific experiments were carried out in twelve days to determine the effectiveness of the color TV system to transmit adequate skin tones and orbital structure over the slow scan TV from Sells to Phoenix. The experiment objectives were to identify/distinguish:

- o Papules or macules of 3 mm diameter or less upon dark skinned individuals
- o Scars as either raised or depressed areas
- o Pupillary size and detail.

Limitation of camera capabilities resulted in inadequate color differentiation within the skin tone range of hue for diagnosis of dermatological lesions. The real time color system does not show papules or macules of 3 mm diameter or less upon dark skinned individuals. The color system also fails to distinguish 4 to 5 mm diameter or less red lesions in dark skinned subjects, but does transmit down to 3 mm lesions in fair skinned subjects. Streaks of cellulitis (simulated with red flow tip markers) 4 to 5 mm wide could not be distinguished in dark skinned individuals.

Scars could not be conclusively identified as either raised or depressed areas, unless verbal clues were also given.

Close-up views of skin and mucoral surfaces (i.e., magnifications of 5 to 7 times) showed highlighted areas with a green yellowish tinge. This problem was greatly reduced by using filters, but persisted.

Similar difficulties were encountered in the use of slow scan color transmissions for ophthalmologic problems. The best color transmissions needed to use 500 watts of light. This amount was not tolerated by the subjects and excessive eye tearing resulted. Each tear was highlighted and the same green-yellow hue artifact was introduced.

The detail of eye lids, lashes, iris and scleral vessels was good, but more easily achieved using the black and white system. Both color and black and white failed to distinguish pupillary size and detail in subjects with pigmented irises. Pupillary contours were easily visualized in blue-eyed persons.

The difficulty of obtaining patients with skin and eye problems, plus the time needed to transmit pictures in a room not designed for this function, the recognized discomfort to the patients, and the known shortcomings of the system led to the decision to curtail non-interactive diagnostic research in these areas.

Both color and black and white slow scan systems, however, are available for direct, interactive use between Sells physicians and Phoenix specialists for diagnostic problems as the need arises.

TV - Microscopy.

Three specific experiments were carried out to evaluate the quality of transmitted microscopic slide images and to determine the diagnostic validity of interpreting transmitted slide images of blood smears, mixed flora and a variety of other slides by a microbiologist.

A modified Wilde-Heerburg microscope was used equipped with a high-intensity quartz, iodine light source multiple light filters, and a special photo tube for the color television camera, in conjunction with Slow Scan transceivers.

Experiment 1.

The objectives established for this experiment were to learn the full capabilities and operating procedures for the TV microscope color control unit and the TV monitor and to determine the optimum microscopic positions for a particular objective lens.

Eighty-seven slides of blood smears and some mixed flora were transmitted from Sells to the Phoenix Indian Medical Center via Slow Scan TV. A number of different slides were furnished by NASA-JSC that contained tissue sections, fleas, blood smears, nematodes, and a variety of others.

A variety of slides were initially transmitted to establish light settings, color adjustments, filters to be employed, focal planes to concentrate on, and objectives best suited for observation. The experiment would result in determining the optimum microscopic position for each particular objective being used for observation.

The microbiologist at Phoenix was to evaluate and make recommendations on how to improve the quality of the transmitted images.

The information on Table 2-19 shows that for objectives 3X and 10X the color quality and the receiving and transmitting for the slides were usually the best. This is because the amount of light needed is low and the details of the specimen being observed are usually gross in size. The color is usually representative of the specimen being viewed. The filters can all be utilized depending on what colors need to be enhanced or deleted. The IRE level, which is a video standard, read 100% most of the time at these magnifications. This level should always be maintained for good transmissions to be received at the Phoenix Referral Center. The information also shows that the settings for the microscope and camera equipment fall well within the limits of the equipment's capabilities.

For the objectives 50X and 100X the quality of the transmissions falls off slightly because the problem of resolution begins to have effects on the quality of the pictures being transmitted to Phoenix. Also the color quality begins to show a little deterioration due to the decrease in the amount of light that can be used and the amount of light that reaches the camera lens. The IRE level drops considerably which shows a loss of information from the microscope to the camera. The color representation is close but not high quality. Much adjusting and readjusting of the color control unit and the television monitor controls are necessary to bring about good color quality. The light settings have to be increased to the limit which puts a strain on not only the observer but also on camera equipment and microscopic filters which are both heat and light sensitive.

Table 2-19

OPTIMUM MICROSCOPE POSITION

Objectives (×)	3	10	50	100
Oculars (×)	10–15	10–15	10–15	10–15
Filters	Clear, Frosted, or Blue	Clear, Frosted, or Blue	Clear, Frosted	Clear
Condenser	Wide Open	Wide Open	Wide Open	Wide Open
Knurled Disc	1 or 2	1 or 2	1 or 2	2 or 3
Light Setting (Volts)	6–7	7–9	11–12	11–12
IRE (Percent)	100	100	85–90	60-75

NOTE: The 40× objectives were not used because additional equipment for the microscope is needed for phase contrast and dark field.

Color TV Camera and Microscope

As was noted the 40X objectives were not used because they are for phase contrast and dark field microscopy which need additional equipment to be utilized.

Experiment 2.

The second experiment was an extension of the first experiment in that the optimum microscopic position was utilized to conduct a laboratory diagnostic study for the evaluation and observation of the reliability and feasibility of reading laboratory slides accurately over the television screen.

The slides used in this experiment were blood smears and mixed flora which are two types of slides that are commonly seen in the laboratories at Sells and in Phoenix.

The microbiologist read each transmission using the following criterion for blood smears and mixed flora:

CRITERION FOR BLOOD SMEARS	CRITERION FOR MIXED FLORA
(1) Basophile	(1) Gram Positive
(2) Eosinophile	(2) Gram Negative
(3) Neutrophile	(3) Cocci
(4) Lymphocyte	(4) Rods
(5) Monocyte	

The data collected revealed certain performance qualities such as the system availability, system reliability and reading reliability. The system availability is the total number of days available to transmit versus the number of actual days transmitted to Phoenix. Also a system reliability was noted which is the number of transmissions received in Phoenix versus those that are acceptable. This also included those transmissions that had to be retransmitted because they were unacceptable. Finally a reading reliability is established based on those there were acceptable versus those that are correctly read and those that are missed. From these figures the overall performance could be seen.

In the system availability data collection, the weekends were not counted because neither of the system operators were present to transmit or receive pictures over the Slo-Scan equipment. The rest of the days between June 1, 1976 and September 31, 1976 were counted, including holidays that fell in the testing period, because the system was operable and available for use.

Number of Days (A)	Number of Days System Was Available (B)
81	96

$$\frac{A}{B} = \text{SYSTEM UTILIZATION} = 84\%$$

In the acceptability of transmission, a total of 110 slides of blood smears and 56 slides of mixed flora were transmitted to the Phoenix Referral Center.

	Total Transmissions	Number of Readable Slides
Blood Smears	110	98
Mixed Flora	56	50

$$\frac{\text{NUMBER OF READABLE SLIDES RECEIVED}}{\text{TOTAL TRANSMISSIONS}} = \text{SYSTEM ACCEPTABILITY}$$

System Acceptability

Blood Smears: = 89%

Mixed Flora: = 89%

A total of 98 slides of blood smears and 50 slides of mixed flora were transmitted to assess the accuracy of reading the slides on a TV screen. Accuracy as shown below was 89% correct of the total 98 blood smear slides, while accuracy of only 58% was obtained for the mixed flora.

	TOTAL TRANSMISSIONS	CORRECT	INCORRECT
Blood Smears	98	87	11
Mixed Flora	50	29	21

$$\frac{\text{NUMBER CORRECT}}{\text{TOTAL TRANSMISSIONS}} = \text{READING ACCURACY}$$

Reading Accuracy

Blood Smears = 89%

Mixed Flora = 58%

Results from Experiment 2 show that for blood smears and larger specimens, the System Acceptability, System Reliability and the System Reading Accuracy all fall within the limits and capacity for this system to function accurately. There is a limit, though, that should be noted and that is the mixed flora test. The size of the cells were very small and the morphology and color of the cells over the television screen were difficult to read. The percentage correct for the reading reliability test were less than 60% correct, which may be well below the acceptable level.

Experiment 3.

This experiment employed external camera and microscopic equipment to find the best way to transmit information to Phoenix and also to enhance the capabilities of the microscope. The following is a list of what was acquired during the experiment to increase the capabilities of the television microscope.

(1) 15X CAMERA [illegible] - this increased magnification from 1000X to 15000X for the purpose of revealing fine details in the cells.

(2) MICRO-LOCATER - this device was used to relocate cells previously transmitted for further diagnosis.

(3) PETROFF-HAUSER BACTERIAL COUNTER - This device was used because there were no commercially available resolution charts for the aligr ng of equipment under evaluation.

(4) GRID :'ACHINE - this device was acquired to aid in the locating of specific cells on the television screen by putting a grid system on the screen.

Evaluation of Slow Scan Television Summary.

The use of slow scan television for the transmission of x-ray images has indicated that the hardware performance seems to be reliable enough and the results achieved valuable enough to justify continued experimentation.

The use of slow scan television for the transmission of patient examination images has demonstrated that the existing system requires considerable improvements in equipment, lighting, and space.

The feasibility of televised microscopy from the technical viewpoint has been proven; however, it requires considerable experimentation. The combined problem of optics, alignment, and color quality must be resolved. Resolution of this problem is the same as for patient examination - selection of quality color cameras. System performance in terms of acceptability and reading accuracy were judged excellent for all tests except for the mixed flora transmission which, due to the small cells, the morphology and color of the cells were found not acceptable.

2.4 SUBSYSTEM ASSESSMENT

The five STARPAHC subsystems as illustrated in Figure 2-3 represent; 1) the required telecommunication equipment (TCE) to perform two-way communication for voice, video, and data, 2) the computer for storage and access to health information and health aid programs, 3) six facilities for communication and relay centers, 4) health care personnel, patients, and technicians, and 5) logistic support for maintenance and calibration.

For assessment purposes TCE has been broadly grouped into five categories that reflect the function that the equipment performs:

Wideband - Transmission/Reception of Color and B&W TV images via microwave links plus a high fidelity voice channel for heart/lung sounds.

Narrowband - Transmission/Reception of voice/data.

VHF - Transmission/Reception of voice/data

Slow-Scan - Transmission Reception of Color and B&W TV images via standard telephone lines.

Emergency (PAM) - Emergency medical transmission/reception of medical data.

Figure 2-3 illustrates a further breakdown of the five TCE categories. This breakdown into 24 equipment types was organized to take advantage of the usage logs, trouble reports, and maintenance records for evaluation purposes. This section will present utilization and performance of the TCE at the subsystem level in terms of usage, purpose, and quality. Next each major element comprising the subsystem will be assessed as to its overall performance.

Assessment of the remaining four subsystems as illustrated on Figure 2-3 was accomplished from statistical programs that compiled operation/downtime on the computer, system records on the facilities, interviews with the patients, providers, and technicians for personnel assessment, and from maintenance records and trouble reports.

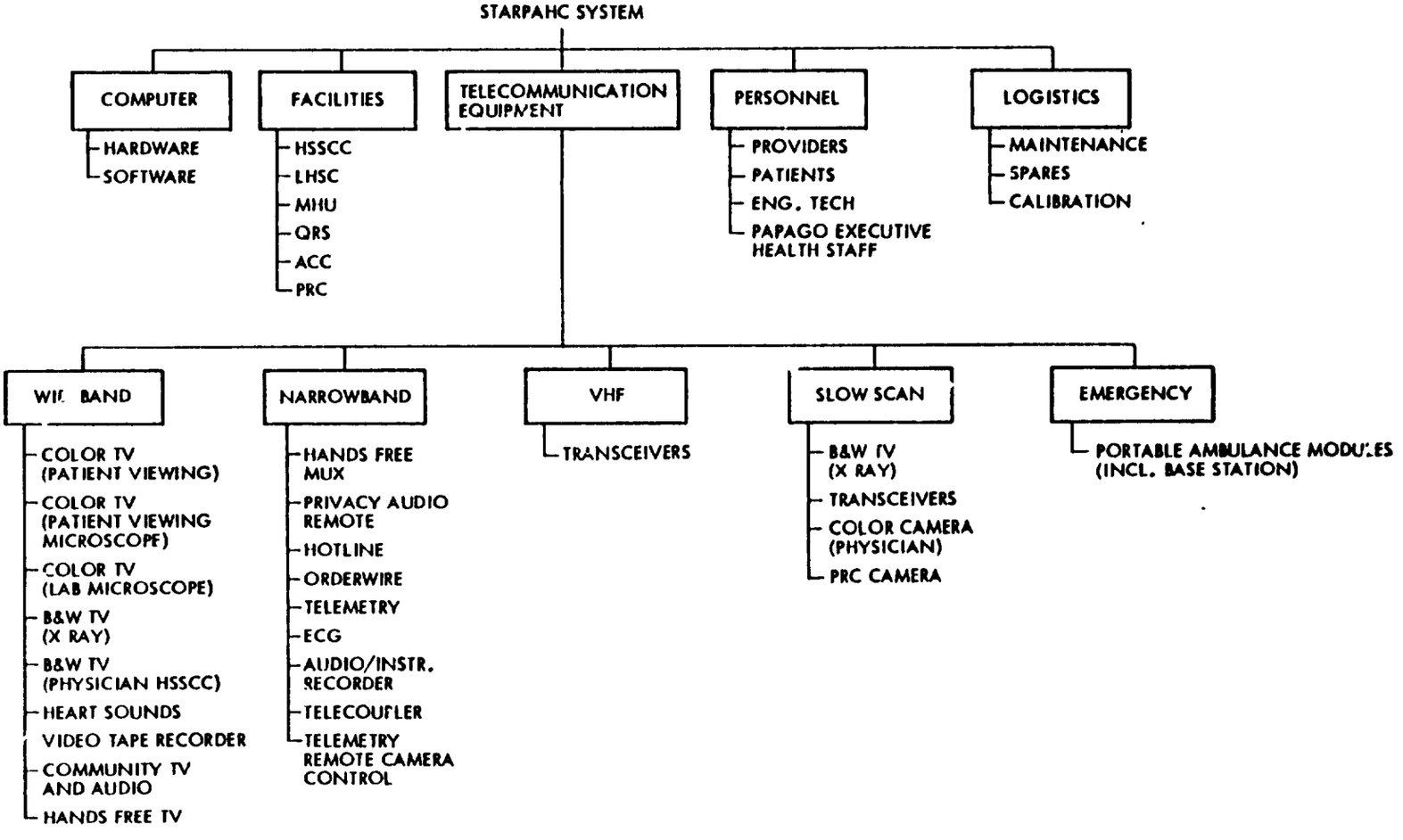

Figure 2-3 STARPAHC System - TCE Breakdown

2.4.1 Utilization and Performance of the Telecommunication Equipment Subsystem The utilization of system equipment with emphasis on monthly trends, failure rates, reasons for failure, high low usage and ratios between medical use and communication for other purposes (usage not directly related to health care) has been analyzed and is presented in summary form.

Three major data sources were available for analyzing and determining the utilization and performance of the system equipment: (1) the Telecommunication Equipment (TCE) usage log (contains performance data on 24 TCE types -- see Table 2-20 (2) usage Data on equipment at QRS, MHU Vehicle, Computer and supporting peripheral equipment and power equipment and (3) STATS-On-Line Terminal Statistics Program report on the computer software/terminal usage.

Monthly data are presented covering the last 6 months and are compared to the first 6 months and the overall two (2) year period. Two (2) year totals are also given on a month-to-month basis for an overview of the operation from start to the end of the two year operational period.

Telecommunications are defined in accordance with the purposes that they serve. Engineering telecommunications are used for checkout, trouble-shooting, communications, (between engineering personnel and/or engineering personnel and health care personnel) and control signal transmissions. Medical telecommunications contacts between the CHM/Physician and Medical and Administration personnel. Teleconsultation contacts are specific medical communications between the CHM and the Physician.

Medical Telecommunication/Teleconsultation Contacts (CHM/Physician and MED/Administration). Table 2-21 summarizes the total number of telecommunications for the four 6-month periods and the number used by the CHM/PHY (teleconsultations), the number used by the Med/Administration, and the combined Medical Telecommunications. The most significiant factors are that medical telecommunications accounts for 58% of the total use, and the relatively equal use by the CHM/Phy (26%) and the Med/Admistrator (32%). The remainder (42%) of the telecommunications were used for engineering purposes.

Table 2-20

GLOSSARY OF TELECOMMUNICATION EQUIPMENT TERMS
(Elements and Types)

Telecommunication Equipment Element/Type	Description
Wideband	
Color TV, Patient View	Patient viewing color TV system which includes the camera, monitor, and local camera control unit
Color TV, Patient View Microscope	Surgical microscope for endoscopic examination which includes color camera, fiberoptics viewing bundle, light-source microscope, and ceiling-mounted track
Color TV, Lab Microscope	Laboratory microscope which includes binocular microscope, light source, light filters, camera adapter, and color TV camera
Black and White TV, X Ray	Black and white x-ray viewing system which includes black and white TV camera, x-ray viewer, local camera control unit, and camera mount
Black and White TV, Physician (HSSCC)	Black and white camera in physician's console used to transmit the physician's image for viewing by the patient at the remote facility
Handsfree, TV	The TV handsfree intercom generally used as backup for the MUX handsfree intercom
Heart Sounds	The "Tonoscope" or battery-powered stethoscope used primarily to transmit heart sounds
VTR	The Video Tape Recorder located in the communications rack (HSSCC) used to record incoming video from a remote facility or local from the physician's room
Community TV and Audio	HSSCC consoles equipped to transmit community/educational video to the MHU, which displays it on externally located monitors
Narrowband	
Handsfree, MUX	The handsfree intercom used for communication between the remote facility and HSSCC. Includes intercom units and audio multiplexer unit
Telemetry (QRS)	The control and telemetry system used to remotely control the QRS Relay Station from HSSCC
ECG	The Cardiostat T single-channel electrocardiogram unit including the transmitter (oscillator)

Table 2-20 (Cont.)

Telecommunication Equipment Element/Type	Description
Narrowband (Cont.)	
Telecoupler	The telephone acoustical coupler located at the physician's console-used to patch the handsfree intercom into the dial telephone for calling the lab, medical records, etc.
Telemetry Remote Camera Control	The Remote Camera Control Units located at both the operator's and physician's console at HSSCC used to remotely control TV cameras at either remote facility
Privacy, Audio, Remote	The privacy audio channel used for private conversations between CHM and the physician. Includes the CHM hand/headset at the remote facility
Hotline	The hotline is the communication link between the operator's console, and the CHM is the link in a remote facility. When one handset is removed from its cradle, the unit at the other end rings until it is answered.
Audio/Instrumentation Recorder	The audio recorder located in the communication rack (HSSCC) used to make audio recordings and to record ECGs
Order Wire	A special audio channel within the microwave system used primarily for maintenance and troubleshooting
VHF	
VHF Transceiver	The VHF radio system used when the MHU is enroute or when the microwave system is not operational
Slo-Scan	
Slo-Scan Transceivers	The Slo-Scan units at HSSCC and PRC used to transmit/receive x-ray images, photographic, and graphical data
Color Camera Phy (HSSCC)	Color camera in physician's room to record color image of patients, etc., primarily from Slo-Scan transmission
Black and White TV, Slo-Scan (HSSCC)	Black and white camera located near the physician's console used to transmit x-ray images as part of the slo-scan system. Includes black and white TV camera, mount, x-ray viewer, and local camera control
PRC Camera	B&W camera installed in the Phoenix Indian Medical Center. Used for transmittal of images to Sells via Slow-Scan TV
Emergency	
PAM	Portable Ambulance Module (MHU and Sells Emergency Room)

Table 2-21

TOTAL TELECOMMUNICATION/MEDICAL TELECOMMUNICATION COMPILATIONS

Month	Total Telecommunications	Medical Telecommunications*	
		CHM/PHY	Med/Admin.
1975			
May	216	37	94
June	240	27	69
July	342	64	86
August	4[illegible]5	145	91
September	484	138	127
October	229	62	28
November	275	78	60
December	308	63	98
1976			
January	359	106	137
February	269	45	119
March	386	88	186
April	425	150	113
May	256	67	72
June	438	129	140
July	325	135	91
August	287	133	74
September	287	113	63
October	279	33	116
November	221	41	81
December	250	45	104
1977			
January	363	84	139
February	228	23	121
March	261	57	90
April	197	35	62
	7,390	1,898	2,361

*Total 4,259

The graphic illustration of Figure 2-4 shows the fluctuating changes during each 6 month period of the medical telecommunications. Percentage of the medical telecommunication remained high for the first three 6-month period. The CHM/PHY teleconsultation decreased sharply in the last 6-month period.

The monthly fluctuations in the use of medical telecommunications is attributed to several factors. During the first 5 months of operation the increase in medical telecommunications is attributed to increasing familiarity of the health care personnel with the STARPAHC equipment, but may be slightly inflated by the August and September sudden increase of teleconsultations caused by a directed response to achieve a specified number of CHM/PHY teleconsultations per week. The fluctuations in the second 6 month period is seen as an occasional medical telecommunication reduction resulting from CHM personnel assigned to the LHSC being reassigned to the Sells Hospital early in February 1976. Replacement personnel had been trained in STARPAHC equipment operation and had demonstrated high proficiency in it's use, but had fewer teleconsultations - because Sells physicians did not encourage teleconsultations as previously indicated under physician's attitudes. Consequently, CHM's were somewhat reluctant to use the system. It should be noted also that a large discrepancy exist between the number of STARPAHC teleconsultations between Sells and the MHU and Sells and the LHSC. This is because STARPAHC teleconsultations over regular telephone lines were not logged and the telephones account for most contacts between the LHSC CHM and the Sells physician. (It is easier to use the telephone calling the OPD directly rather than calling the Sells system operator and having him contact the physician or medical record personnel).

The monthly fluctuations in the third 6 month period is attributed to several factors. Two dependent CHM's replaced the regular independent CHM and LPN on the MHU during June, July, August and September 1976, for one to two week periods. The relatively inexperienced replacement team found the need to communicate with the Sells Physician on a more frequent basis. The two MHU CHM's were subsequently monitored by the independent CHM who was assigned

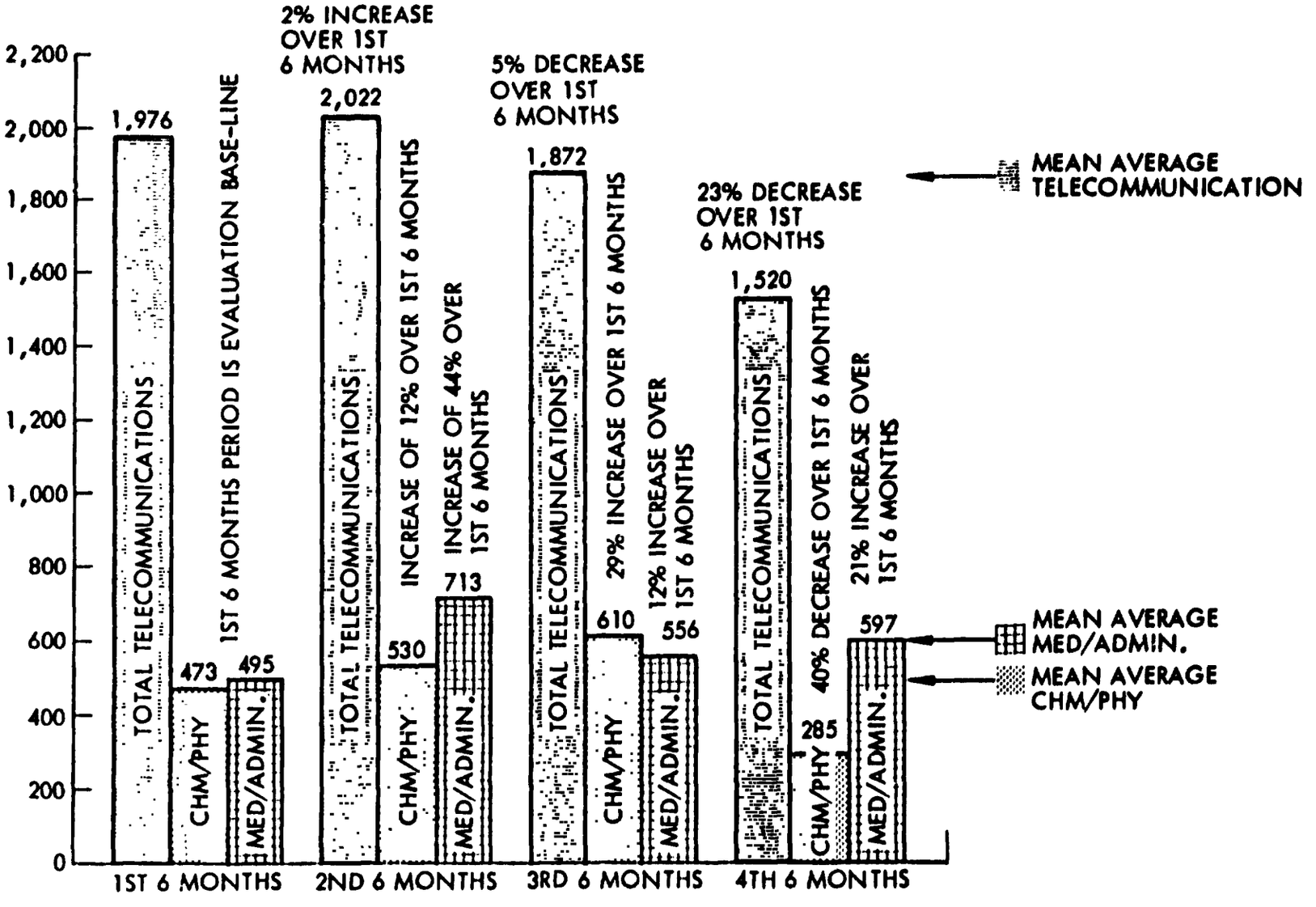

Figure 2-4 Total Telecommunications vs Medical Use

to the Sells hospital, which further affected the number of telecommunications. Other factors that affected the number of telecommunications were the two 2-day and the one 4-day out-of-service period for the MHU.

During the last 6 month period a substantial decrease in CHM/PHY teleconsultation occurred. This decrease was approximately 50% of the previous 6 months of teleconsultations and was a definite reversal of the indicated trend of increasing medical usage.

Telecommunication Usage Analysis.[1] Table 2-22 presents the usage by comparing each of the four 6 month periods. Table 2-23 summarizes, on a monthly basis the usage in terms of use, quality and purpose for the entire two year operational period. Comparison on a month-to-month basis (May 1975 vs May 1976) one sees that fluctuations in the number and types of telecommunications do not correspond on a monthly basis - variations are primarily random but are also affected by personnel assignment/locations, availability of equipment and unique situations, e.g., immunization requirement increases. Table 2-24 shows the usage by TCE type for the full two year operational period. Table 2-25 through 2-28 show TCE usage for each of the four 6 month periods for comparison purposes.

As was expected, the two most used TCE were the hotline and hands-free MUX audio capability and remained as such throughout the two year evaluation period. Use rate of the remaining TCE fluctuated in the most used list from month to month. TCE items of interest in regards to its usage rating as the program progressed was the patient viewing color TV camera which changed from third most used item during the first 6 months to the eighth most used item in the final 6 months. The use of the telephone coupler (21) continued to increase usage throughout the two years, the QRS control telemetry (13) steadily decreased in use as did the patient viewing color cameras and handsfree MUX audio usage. The twelve most used TEC over the two year period has been tabulated in Table 2-29. Section 2.4.3 discusses each of the TCE regarding its functions, major characteristics, and a brief discussion of maintenance and problems.

[1] Refer to Pages 2-98 through 2-112 for major characteristics and descriptions of the TCE.

Table 2-22 Telecommunication Usage and Performance Summary

Period: 01 May thru 31 Oct 1975
01 Nov thru 30 Apr 1976
01 May thru 31 Oct 1976
01 Nov 1976 thru Apr 1977

	Use			Quality					Purpose					
Equipment Type	Try	Fail	Percent PAR (*)	Exc	Good	Fair	Poor	Not Acc	C/O	Trbl Shoot	Comm	Cont	CIIM/ Phy	MED/ Adm
All STARPAHC (1st 6 months)	1,976	43	97.82 00.04	33	1,764	95	41	43	177	26	611	194	473	495
All STARPAHC (2nd 6 months)	2,022	33	98.36 88.82	3	1,793	149	44	33	121	12	458	188	530	713
All STARPAHC (3rd 6 months)	1,872	19	98.98 92.30	7	1,721	107	18	19	88	1	472	146	610	556
All STARPAHC (4th 6 months)	1,520	25	98.36 90.20	4	1,367	93	31	25	81	11	437	109	285	597
Totals	7,390	120	98.38 (a) 90.55 (b)	47	6,645	444	134	120	467	50	1,978	636	1,898	2,361
													Medical Use	4,259

• Performance Acceptability Ratio

(a) Gross PAR
(b) Net PAR
See definition in text

Table 2-23

TELECOMMUNICATION USAGE AND PERFORMANCE SUMMARY

(MONTHLY)

(Period: 01 May 1975 Thru 30 Apr 1977)

	Try			Quality					Purpose					
	Try	Fail	Percent PAR*	Exc	Good	Fair	Poor	Not Acc	C/O	Trbl Sheet	Comm	Cont	CEM/ Phy	MED Adm
May 1975	216	4	98.15 96.76	1	206	2	1	4	9	2	87	17	37	94
Jun 1975	240	4	98.33 93.33	2	222	9	3	4	25	4	110	5	27	69
Jul 1975	342	6	98.25 88.89	8	296	25	7	6	40	1	119	32	64	86
Aug 1975	485	6	98.71 84.73	5	389	44	21	6	51	7	113	58	145	91
Sep 1975	494	14	97.11 94.83	16	443	9	2	14	33	12	132	42	138	127
Oct 1975	229	9	96.07 90.39	1	206	6	7	9	19	0	80	40	62	28
Nov 1975	275	3	98.91 94.55	0	260	11	1	3	10	5	90	32	78	60
Dec 1975	308	5	98.38 96.36	0	266	26	11	5	31	2	81	33	63	96
Jan 1976	359	6	98.33 87.19	0	313	32	8	6	6	0	83	27	106	137
Feb 1976	269	4	98.51 86.99	0	234	21	10	4	16	1	61	27	45	119
Mar 1976	336	7	98.19 86.01	0	332	38	9	7	32	3	54	23	88	186
Apr 1976	425	8	98.12 92.00	3	388	21	5	8	26	1	89	46	150	113
May 1976	256	2	99.22 92.97	0	238	10	6	2	23	0	69	25	67	72
Jun 1976	438	5	98.86 90.64	2	395	34	2	5	22	0	106	41	129	140
Jul 1976	325	5	98.46 87.69	2	283	30	5	5	15	1	57	26	135	91
Aug 1976	287	0	100 97.21	0	279	6	2	0	7	0	96	17	133	74
Sep 1976	287	6	97.91 92.68	3	263	13	2	6	14	0	77	20	113	63
Oct 1976	279	1	99.64 94.27	0	263	14	1	1	7	0	107	16	33	116
Nov 1976	221	1	99.55 96.83	1	213	6	0	1	5	0	76	18	41	81
Dec 1976	250	3	98.80 93.60	1	233	8	5	3	9	3	70	19	45	104
Jan 1977	363	2	99.45 93.94	1	340	17	3	2	24	4	84	28	84	139
Feb 1977	228	8	96.49 81.58	0	186	22	12	8	11	0	58	15	23	121
Mar 1977	261	8	96.93 84.67	1	220	23	9	8	17	3	78	16	57	90
Apr 1977	197	3	98.48 88.83	0	175	17	2	3	15	1	71	13	35	62
Total:	7,390	120	98.38 (a) 90.55 (b)	47	6,645	444	134	120	467	50	1,978	636	1,898 (4,259) Medical Use	2,361

*Performance Acceptability Ratio

(a) Gross PAR
(b) Net PAR

See definition in Table 2-22

Table 2-24

USAGE TABULATION/TCE TYPE-TWO YEAR PERIOD

Period: 01 May 1975 thru 30 Apr 1977

		Use			Quality					Purpose					
		Try	Fail	Percent PAR*	Exc	Good	Fair	Poor	Not Acc	C/O	Shoot	Comm	Cont	CHM/ Phy	MED/ Adm
1	Color TV, Pat View	627	17	97.29 (a)	10	478	97	25	17	201	3	18	2	365	38
2	Color TV, Pat View Mic	18	2	88.89	0	9	4	3	2	9	1	0	0	8	0
3	Color TV, Lab Mic	36	4	88.89	1	25	4	2	4	25	2	3	0	5	1
4	B&W TV, X Ray	95	4	95.79	0	78	9	4	4	34	0	4	0	56	1
5	B&W TV, Phy (HSSCC)	528	4	99.24	1	512	9	2	4	30	0	14	0	264	220
6	B&W TV, Phy X Ray (HSSCC)	0	0	–	0	0	0	0	0	0	0	0	0	0	0
7	Handsfree, MUX	1,321	18	98.64	7	1,140	120	36	18	33	7	136	0	490	655
8	Handsfree, TV	20	2	90.00	0	17	0	1	2	5	1	3	0	4	7
9	Privacy Audio (Remote)	397	5	98.74	5	330	45	12	5	7	1	66	0	89	234
10	Hotline	2,134	21	99.02	5	2,083	22	3	21	19	12	890	0	366	847
11	VHF	678	7	98.97	4	635	20	12	7	8	9	608	1	5	47
12	Orderwire	116	2	98.28	0	113	0	1	2	1	5	109	0	0	1
13	Telemetry (QRS)	560	7	98.75	5	537	5	6	7	4	2	27	524	3	0
14	ECG	8	0	100	0	5	3	0	0	4	0	0	1	3	0
15	Heartsounds	19	3	84.21	0	7	5	4	3	8	2	0	0	9	0
16	VTR	50	3	94.00	1	30	11	5	3	7	0	5	0	19	19
17	A/I Recorder	2	0	100	0	2	0	0	0	2	0	0	0	0	0
18	Slo-Scan, X Ray, & Data	79	2	97.47	1	55	21	0	2	43	0	9	1	18	8
19	Color Camera, Phy (HSSCC)	23	0	100	0	23	0	0	0	4	0	0	0	2	17
20	PAM	0	0	–	0	0	0	0	0	0	0	0	0	0	0
21	Tel-Cplr	425	8	98.12	5	341	59	12	8	4	1	82	0	80	258
22	Telemetry Remote CC	253	11	95.65	2	224	10	6	11	18	4	4	107	112	8
23	TV RC Camera	0	0	–	0	0	0	0	0	0	0	0	0	0	0
24	Community TV & Audio	1	0	100	0	1	0	0	0	1	0	0	0	0	0
	Totals	7,390	120	98.38 (a) 90.55 (b)	47	6,645	444	134	120	467	50	1,978	636	1,898	2,361
														4,259	

*Performance Acceptability Retro

(a) Gross PAR
(b) Net PAR

See definition in Table 2-22

Table 2-25

USAGE TABULATION/TCE TYPE - 1st 6 MONTHS

Period: 01 May Thru 31 October 1975

	Use			Quality						Purpose				
	Try	Fail	(%) PAR*	Exc	Good	Fair	Poor	Not Accept.	C/O	Trbl Shoot	Comm	Cont	CHM/ Phy	MED/ Adm
01 Color TV, Pat View	203	7	96.55	(a)6	151	27	12	7	85	2	8	1	96	11
02 Color TV, Pat View Mic	17	2	88.23	0	9	3	3	2	9	1	0	0	7	0
03 Color TV, Lab Mic	19	1	94.73	1	13	3	1	1	12	1	1	0	5	0
04 B&W TV, X-Ray	29	2	93.10	0	22	2	3	2	16	0	1	0	11	1
05 B&W TV, Phy (HSSCC)	157	1	99.36	0	155	1	0	1	9	0	4	0	68	76
06 B&W TV, Phy X-Ray(HSSCC)	0	0	-	0	0	0	0	0	0	0	0	0	0	0
07 Handsfree, MUX	367	4	98.91	6	322	30	5	4	11	2	44	0	127	183
08 Handsfree, TV	7	1	85.71	0	5	0	1	1	2	0	1	0	3	1
09 Privacy, Aud, Remote	88	1	98.86	5	67	11	4	1	3	0	6	0	26	53
10 Hotline	505	6	98.81	5	491	1	2	6	12	6	298	0	73	116
11 VHF	194	3	98.45	3	186	1	1	3	0	8	181	0	1	4
12 Orderwire	36	2	94.44	0	33	0	1	2	0	1	34	0	0	1
13 Telemetry (QRS)	182	1	99.45	4	176	0	1	1	0	2	23	154	3	0
14 ECG	4	0	100	0	3	1	0	0	1	0	0	1	2	0
15 Heartsounds	5	0	100	0	3	1	1	0	0	0	0	0	5	0
16 VTR	21	0	100	1	19	0	1	0	3	0	0	0	12	6
17 A/I Recorder	1	0	100	0	1	0	0	0	1	0	0	0	0	0
18 Slo-Scan (X-Ray)	0	0	-	0	0	0	0	0	0	0	0	0	0	0
19 Slo-Scan (Data)	0	0	-	0	0	0	0	0	0	0	0	0	0	0
20 PAM	0	0	-	0	0	0	0	0	0	0	0	0	0	0
21 Tel-Cplr	66	2	96.96	0	49	11	4	2	0	0	9	0	17	40
22 Telemetry Remote CC	75	10	86.66	2	59	3	1	10	13	3	1	38	17	3
TOTALS	1976	43	97.82 (a) 90.94 (b)	33	1764	95	41	43	177	26	611	194	473	495

* PAR - Performance Acceptability Ratio
(a) Gross PAR
(b) Net PAR

See definition in Table 2-22

Table 2-26

USAGE TABULATION/TCE TYPE - 2nd 6 MONTHS

Period: 01 November 1975 Thru 30 April 1976

	Use			Quality					Purpose					
	Try	Fail	(%) PAR	Exc.	Good	Fair	Poor	Fail	C/O	Trbl. Shoot	Comm.	Cont.	Chm/ Phy.	Med/ Adm.
01 Color TV, Pat View	166	8	95.1	2	114	32	10	8	48	1	3	0	97	17
02 Color TV, Pat View Mic	0	0	–	0	0	0	0	0	0	0	0	0	0	0
03 Color TV, Lab Mic	10	2	80.00	0	6	1	1	2	8	1	0	0	0	1
04 B&W TV, X-Ray	29	2	93.10	0	24	2	1	2	9	0	0	0	20	0
05 B&W TV, Phy (HSSCC)	176	3	98.31	0	168	5	2	3	12	0	5	0	77	84
06 B&W TV, Phy X-Ray (HSSCC)	0	0	–	0	0	0	0	0	0	0	0	0	0	0
07 Handsfree, Mux	354	6	98.31	0	298	39	11	6	6	2	21	0	135	190
08 Handsfree, TV	5	1	80.00	0	4	0	0	1	1	1	0	0	1	2
09 Privacy, Audio, Remote	77	0	100	0	61	15	1	0	0	0	9	0	26	42
10 Berline	607	4	99.34	0	594	9	0	4	1	3	214	0	108	281
11 VHF	191	1	99.48	0	174	9	7	1	3	0	157	0	1	30
12 Orderwire	41	0	100	0	41	0	0	0	1	2	38	0	0	0
13 Telemetry (QRS)	155	1	99.35	0	151	1	2	1	3	0	0	152	0	0
14 ECG	2	0	100	0	1	1	0	0	2	0	0	0	0	0
15 Heartsounds	9	1	88.89	0	3	2	3	1	4	2	0	0	3	0
16 VTR	12	3	75.00	0	3	2	4	3	0	0	0	0	4	8
17 A/I Recorder	0	0	–	0	0	0	0	0	0	0	0	0	0	0
18 Slo-Scan (X-Ray)	26	0	100	0	18	8	0	0	13	0	1	0	9	3
19 Slo-Scan (DATA)	14	1	92.86	1	10	2	0	1	10	0	1	0	1	2
20 PAM	0	0	–	0	0	0	0	0	0	0	0	0	0	0
21 Tel-Cplr	83	0	100	0	62	21	0	0	0	0	7	0	24	52
22 Telemetry Remote CC	63	0	100	0	61	0	2	0	0	0	2	36	24	1
Totals	2022	33	98.36	3	1793	149	44	33	121	12	458	188	530	713
			88.82											(1243)

*Performance Acceptability Ratio (PAR)

Table 2-27

USAGE TABULATION/TCE TYPE - 3rd 6 MONTHS

Period: 01 May 1976 through 31 October 976

	Use			Quality					Purpose					
	Try	Fail	PAR[a] (%)	Exc.	Good	Fair	Poor	Fail	C/O	Trbl-shoot	Comm.	Cont.	Chm/ Phy.	Med/ Adm.
01 Color TV, Pat View	145	0	100.00	1	114	27	3	0	23	0	1	0	114	7
02 Color TV, Pat View Mic	1	0	100.00	0	0	1	0	0	0	0	0	0	1	0
03 Color TV, Lab Mic	7	1	85.71	0	6	0	0	1	5	0	2	0	0	0
04 B&W TV, X-Ray	25	0	100.00	0	22	3	0	0	7	0	3	0	15	0
05 B&W TV, Phy (HSSCC)	132	0	100.00	0	129	3	0	0	8	0	2	0	88	34
06 B&W TV, Phy X-Ray (HSSCC)	0	0	–	0	0	0	0	0	0	0	0	0	0	0
07 Handsfree, MUX	335	2	99.40	1	297	32	3	2	7	0	41	0	143	144
08 Handsfree, TV	7	0	100.00	0	7	0	0	0	2	0	1	0	0	4
09 Privacy Audio (Remote)	113	2	98.23	0	107	1	3	2	1	0	27	0	20	65
10 Hotline	528	6	98.86	0	519	3	0	6	2	0	179	0	131	216
11 VHF	154	0	100.00	1	141	9	3	0	1	0	141	0	2	10
12 Orderwire	31	0	100.00	0	31	0	0	0	0	1	30	0	0	0
13 Telemetry (QRS)	127	1	99.21	0	122	3	1	1	0	0	2	124	1	0
14 ECG	2	0	100.00	0	1	1	0	0	1	0	0	0	1	0
15 Heartsounds	5	2	60.00	0	2	1	0	2	4	0	0	0	1	0
16 VTR	15	0	100.00	0	6	9	0	0	4	0	4	0	3	4
17 A/I Recorder	1	0	100.00	0	1	0	0	0	1	0	0	0	0	0
18 Slo-Scan, X-Ray & Data[c]	32	1	96.97	0	23	8	0	1	17	0	6	1	5	3
19 Color Camera, Phy (HSSCC)[c]	1	0	100.00	0	1	0	0	0	1	0	0	0	0	0
20 PAM	0	0	–	0	0	0	0	0	0	0	0	0	0	0
21 Tel-Cplr	120	3	97.50	4	108	3	2	3	1	0	32	0	21	66
22 Telemetry Remote CC	90	1	98.88	0	83	3	3	1	2	0	0	21	64	3
23 PRC Camera	0	0	–	0	0	0	0	0	0	0	0	0	0	0
24 Community TV & Audio	1	0	100.00	0	1	0	0	0	1	0	0	0	0	0
Totals	1,872	19	98.98[a] 92.30[b]	7	1,721	107	18	19	88	1	472	145	610	556

(a) Performance Acceptability Ratio (Gross)
(b) Performance Acceptability Ratio (Net)
(c) NEC slo-scan receiver and camera installed during this period.

Table 2-28

USAGE TABULATION/TCE TYPE - 4th 6 MONTHS

Period: 01 Nov 1976 thru 30 Apr 1977

		Use			Quality					Purpose					
		Try	Fail	Percent PAR	Exc	Good	Fair	Poor	Not Acc	C/O	Trbl Shoot	Comm	Cont	CHM/ Phy	MED/ Adm
1	Color TV, Pat View	105	2	98.24	1	99	10	1	2	37	0	6	0	58	4
2	Color TV, Pat View Mic	0	0	–	0	0	0	0	0	0	0	0	0	0	0
3	Color TV, Lab Mic	0	0	100	0	0	0	0	0	0	0	0	0	0	0
4	B&W TV, X Ray	12	0	100	0	10	2	0	0	2	0	0	0	10	0
5	B&W TV, Phy (HSSCC)	61	0	100	1	60	0	0	0	1	0	3	0	31	26
6	B&W TV, Phy X Ray (HSSCC)	0	0	–	0	0	0	0	0	0	0	0	0	0	0
7	Handsfree, MUX	265	6	97.74	0	223	19	17	6	9	3	30	0	85	138
8	Handsfree, TV	1	0	100	0	1	0	0	0	0	0	1	0	0	0
9	Privacy Audio (Remote)	119	2	98.32	0	95	18	4	2	3	1	24	0	17	74
10	Hotline	494	5	98.99	0	479	9	1	5	4	3	199	0	54	231
11	VHF	139	3	97.85	0	134	1	1	3	4	1	129	1	1	3
12	Orderwire	8	0	100	0	8	0	0	0	0	1	7	0	0	0
13	Telemetry (QRS)	98	3	95.84	0	88	0	1	3	0	1	0	96	0	1
14	ECG	0	0	–	0	0	0	0	0	0	0	0	0	0	0
15	Heartsounds	0	0	–	0	0	0	0	0	0	0	0	0	0	0
16	VTR	2	0	100	0	2	0	0	0	0	0	1	0	0	1
17	A/I Recorder	0	0	–	0	0	0	0	0	0	0	0	0	0	0
18	Slo-Scan, X Ray, & Data	21	1	95.24	1	14	5	0	1	13	0	2	0	4	2
19	Color Camera, Phy (HSSCC)	12	0	91.67	0	12	0	0	0	2	0	0	0	1	9
20	PAM	0	0	–	0	0	0	0	0	0	0	0	0	0	0
21	Tel-Cplr	158	3	98.08	1	122	24	6	3	3	1	34	0	17	103
22	Telemetry Remote CC	25	0	100	0	20	5	0	0	3	0	1	12	7	2
23	PRC Camera	0	0	–	0	0	0	0	0	0	0	0	0	0	0
24	Community TV & Audio	0	0	–	0	0	0	0	0	0	0	0	0	0	0
	Total	1,520	25	98.36	4	1,367	93	31	25	81	11	437	109	285	597

Table 2-29

USAGE TABULATION/TCE TYPE - HIGHEST USAGE

		Use			Quality					Purpose					
		Try	Fail	Percent PAR	Exc	Good	Fair	Poor	Not Acc	C/O	Shoot	Comm	Cont Count	CHM/ Phy	MED/ Adm
0.01	Hotline	2,134	21	99.02	5	2,083	22	3	21	19	12	890	0	366	847
0.02	Handsfree, MUX	1,321	18	98.64	7	1,140	120	36	18	33	7	136	0	490	655
0.03	VHF	678	7	98.97	4	635	20	12	7	8	9	608	1	5	47
0.04	Color TV, Pat View	627	17	97.29	10	478	97	25	17	201	3	18	2	365	38
0.05	Telemetry (QRS)	560	7	98.75	5	537	5	6	7	4	2	27	524	3	0
0.06	B&W TV, Phy (HSSCC)	528	4	99.24	1	512	9	2	4	30	0	14	0	264	220
0.07	Tel-Cplr	425	8	98.12	5	341	59	12	8	4	1	82	0	80	258
0.08	Privacy Audio (Remote)	397	5	98.74	5	330	45	12	5	7	1	66	0	89	234
0.09	Telemetry Remote CC	253	11	95.65	2	224	10	6	11	18	4	4	107	112	8
0.10	Orderwire	116	2	98.28	0	113	0	1	2	1	5	109	0	0	1
0.11	B&W TV, X Ray	95	4	95.79	0	78	9	4	4	34	0	4	0	56	1
0.12	Slo-Scan, X Ray, & Data	79	2	97.47	1	55	21	0	2	43	0	9	1	18	8

Note: TCE with less usage than 74 times (1% of total use) is deleted from this list.

Number of Telecommunications. Figure 2-5 presents a telecommunications summary for the two year period on a month-to-month basis. Average monthly telecommunication for the first 6 months (May-October 1975) were 329, for the second 6 months (November 1975 - April 1976) were 337, for the third 6 months (May - October 1976) were 312 and for the fourth 6 months (November 1976 - April 1977) were 253 and an average of 307.75 per month over the entire two years. High and low variations between the first three 6 month periods showed fairly good correlation but the fourth 6 month period was significantly low (17.8 percent below the mean average). The highest number of telecommunications occurred during the first 6 month period, in August - September time period with the next highest in the third 6 month period, June 1976.

The lowest was the last month of the two year period, April 1977 (197). The two lowest telecommunication months were the first and last months and may be attributed to startup characteristics of the program. The low average of the fourth 6 month period is perhaps due to the CHM/LPN becoming very proficient over the years and no long duration change in staffing on the MHU or at the LHSC. The low in the second 6 month period occurred in February 1976 (269), attributed to an influenza epidemic that curtailed teleconsultation. The lowest number in the third 6 month period occurred in May 1976 (256), attributed to having the most experienced medical personnel assigned to the MHU and shorter monthly work periods (16 days vs 18 days).

The mean gross PAR for the two year operational period was 98.38 percent with the mean net PAR at 90.50 percent. (See Performance Accept. Ratio subsection).

Quality of Transmission. Quality was judged by the health providers and by the system operator. The system operators judgement of telecommunications quality for audio functions almost always agreed with the users perceptions. However, this was not the case for the quality of video transmissions, as reported by the physicians. These results, therefore, are suggestive that the users seem to be more critical of signal quality than the operators. The users were undoubtedly responding to a much broader range of expectations than the operators.

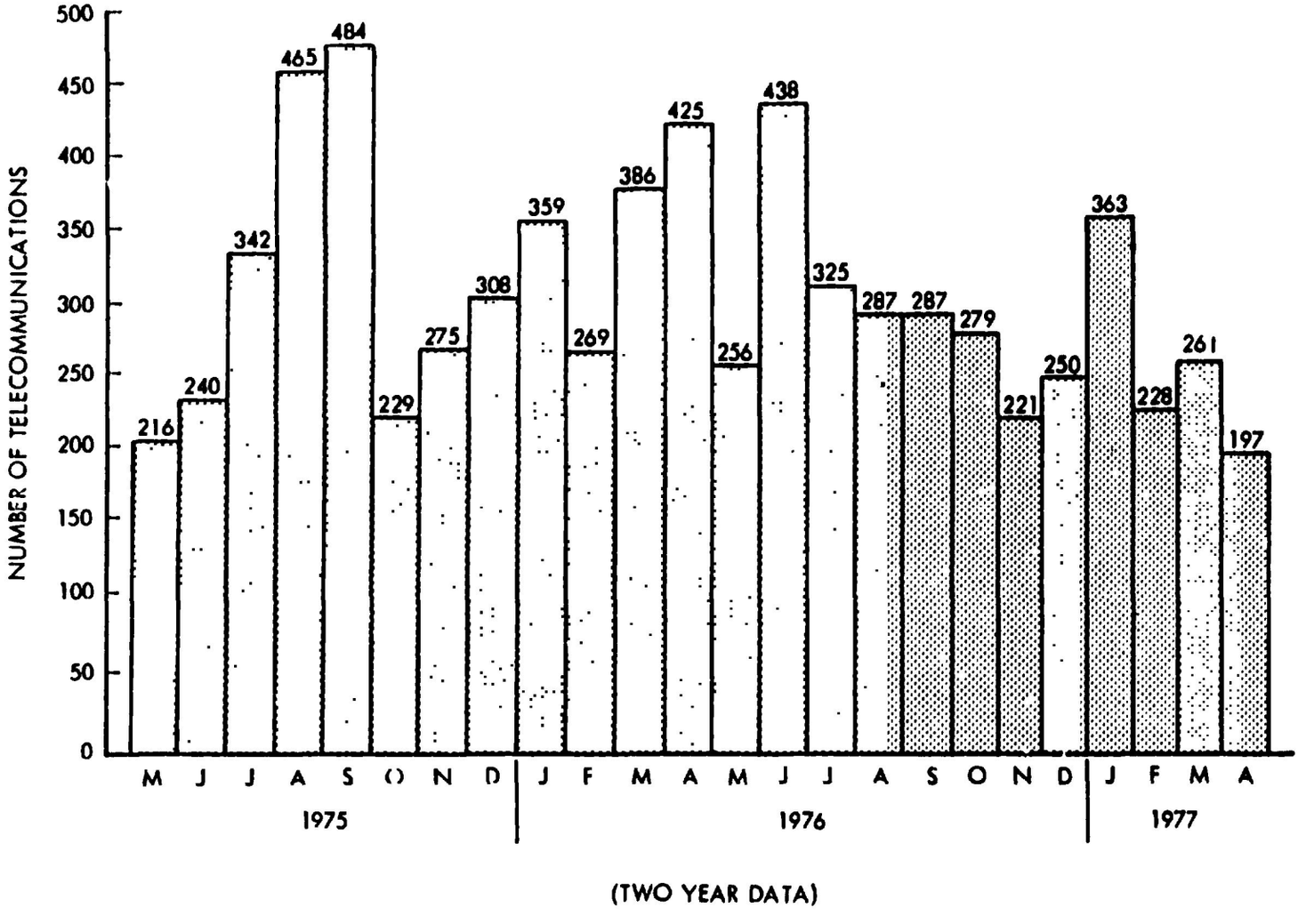

Figure 2-5 Total Telecommunications (Month by Month) (Two Year Data)

The perceptions of all telecommunication quality by the health providers is presented in Table 2-30. If two evaluation forms had been completed for every patient consultation between the mobile unit and Sells, then 1,268 forms would have been the maximum available. However, only 600 forms had been returned (47.3%). For the health center, 400 forms would have been the maximum possible, and 244 (61%) were returned.

Several reported "failures" or "poor" rated video consultations were investigated further. Many were verified by recreating the problem identified by the physician under simulated conditions. These are listed in Table 2-31. Other reported defects that could not be simulated may have been related to improper lighting of the patient's lesion, camera angle, focusing, or other errors in the sender's technique or the receiver's ability to operate the remote camera controls.

Figure 2-6 shows a two year summary of the system operator's judgement on the quality of telecommunications. The quality rating did not vary percentage wise over the two years, with the quality "Good" predominantely highest (89.9%). The ratings of Good and Fair tend to follow the curve of the total telecommunication which implies that when the total number of telecommunications increase that the system is more available and operating more reliably.

During the third 6 month, there were a total of 1872 telecommunications, with 1728 transmission of Excellent/Good quality netting a 92.30 percent PAR. The lowest 6 month period net PAR occurred in the second period with 1796 Excellent/Good transmissions out of a total of 2022 (highest total telecommunication). The fourth period had an average net PAR of 90.2 percent and had the least amount of telecommunication (1520) with 1371 Excellent/Good transmission, (explanation is in prior subsection).

Excellent ratings were reserved for transmission of exceptional quality such as excellent contrast, color, brightness, lighting and observations of minute detail in the case of video transmissions.

Table 2-30

PERCEPTION OF SIGNAL QUALITY BY USERS FOR PATIENT CONSULTATIONS
(12 Months, STARPAHC Project)

Sites Involved	Health Provider Category and Site	Number of User Evaluations for Patient Consultations	Number Rated for Any Signal as "Failed" or "Poor"	Percent Consultations Where Any Signal Rated "Poor" or "Failed"
1. Between Mobile Unit and Sells (Primary Hospital)	<u>On Mobile Unit</u>			
	• CHM	234	21	8.97
	• Nurse	60	27	45.00
	<u>At Sells</u>			
	• MD (at Sells)	71	11	15.49
	• Medical Records	223	11	4.93
	• Others* and Unspecified	123	2	16.67
Subtotal		600	72	12.00
2. Between Health Center and Sells	<u>At Health Center</u>			
	• CHM	97	18	18.56
	<u>At Sells</u>			
	• MD	132	31	23.48
	• Others and Unspecified	15	4	26.67
Subtotal		244	53	21.72
Both Sites	TOTALS	844	125	14.81

*Others: Dentist, Laboratory, Physical Therapist, Pharmacist.

Table 2-31

QUALITY VERIFICATION (SIMULATED VIDEO TRANSMISSIONS)

Clinical Conditions	Possible Reason for Defect (Simulated)	Possible Corrective Methods
1. <u>Exanthems Skin</u> • Varicella • Pityriasis rosea • Herpes Zoster • Scabies • Allergic rashes	A. • Poor transmission of red hues on tan to brown pigmented skin	a. Better color fidelity as with studio cameras and lighting
	B. • Lesions less than 3mm diameter not seen, even on less pigmented skin	b. Above, plus better close-up lens and tangential light direction
2. <u>Localized Skin Conditions</u> • Celluitis • Lymphangitis • Evaluation of rattlesnake bite • Exudative wounds • Identification of tendon injury	• Same as above (A&B)	c. Extent of erythema better seen on B&W TV with negative reversal image
	C. • Highlighs from reflections of tissue fluid add greenish hue to image, obscuring reflection of tendon sheath and suggesting pseudomonas infection.	d. Use of camera filters reduced green hue by 75%. Polarized filters reduced highlights.
• Evaluation of scars, keloids, chronic papules, etc.	D. • Angle of tangential light on lesion gave erroneous perception of elevation or depression, especially when magnified.	e. Training of staff. Sender to specify direction of light on lesion. Do not magnify more than 2.5 times.
3. <u>Mucous Membranes</u> • Enanthems • Dental abscess • Lacerations • Exudates of pharyngitis, tonsillitis, etc.	• Same as A (except red hues on pink background) • Same as C above. Highlights give false perception of exudates.	• Same as a. (above) • Same as d. (above)
4. <u>Conditions of Eye</u> • Identification of pupillary defects, reflexes to light • Acute trachoma papules • Conjunctivitis • Retinitis • Iritis • Trauma	E. • Hard to distinguish pupillary border from dark pigmented (brown) iris	f. Use B&W video only. (Not entirely satisfactory) g. Use B&W video only plus blue filter on light or freeze frame mechanism on camera synchronized with white light for color. (Not tried)
	F. • Muscle spasm from amount of light needed for color – prevents examination • Same as C above	

QUALITY	MAY-OCT 1975 TELE-COMMUNICATIONS	NOV-APR 1976 TELE-COMMUNICATIONS	MAY-OCT 1976 TELE-COMMUNICATIONS	NOV-APR 1977 TELE-COMMUNICATIONS	TOTAL TWO YEARS
EXCELLENT	4	7	3	33	47
GOOD	1,367	1,721	1,793	1,764	6,645
FAIR	93	107	149	95	444
POOR	31	18	44	41	134
NOT ACCEPTABLE	25	19	33	43	120
TOTALS	3,392 (1ST YEAR)		3,998 (2ND YEAR)		7,390

DEFINITIONS OF QUALITY

EXCELLENT – EXCELLENT CONTRASTS; MINUTE DETAIL OBSERVED
GOOD – NOISE PRESENT; NO PRACTICAL DEGRADATION
FAIR – SOME DEGRADATION; NOISY BACKGROUND, BUT FULLY HEARD AND SEEN
POOR – TRANSMISSION; BUT STRAINING TO SEE AND HEAR
FAILURE – NO TRANSMISSION; NOT ACCEPTABLE

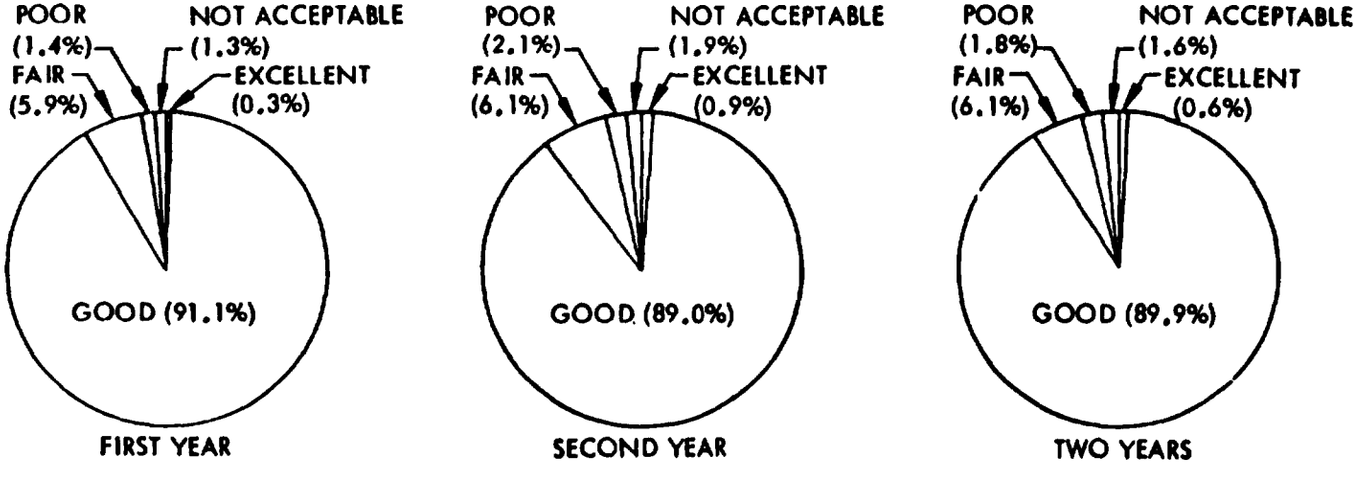

Figure 2-6 Quality of Telecommunications

Performance Acceptability Ratio (PAR). The PAR has been defined as the ratio of success as measured by taking the ratio of failures to total telecommunication and applying a percentage to the result. Gross and Net PAR terms will be used and are defined as follows:

Performance Acceptability Ratio

$$\text{Gross PAR} = \left[1 - \frac{\text{Not Acceptable}}{\text{Telecommunications}}\right] 100 = \%$$

$$\text{Net PAR} = \left[1 - \frac{\text{Anomalies (Fair, Poor, Not Acceptable)}}{\text{Telecommunications}}\right] 100 = \%$$

Tables 2-22 and 2-23 lists the PARs for each month and their 6 month averages. (Gross PAR) for the four 6 month periods shows a low of 97.82 percent to a high of 98.98 percent. The low occurred in the first period, and the high occurred in the third period. Net PAR for the four 6 month periods shows a low of 88.82 percent to a high of 92.30 percent. The low occurred in the second period while the high occurred in the third period.

The improvement in Net Par during the third period was due to a concentrated effort to correct equipment deficiencies and upgrade equipment performance. Reviewing the PAR on a monthly basis, Table 2-22 shows the highest Gross PAR occurred in August 1976 (100%), while the lowest Gross PAR occurred in February 1977 (96.00%). This low PAR is attributed to the relatively high number of Not Acceptables (8 vs a monthly average of 5), combined with a relatively low number of telecommunications (228 vs a monthly average of 308). The high and low net PAR's also occurred in those same months.

Purpose of Telecommunications. Six categories (Figures 2-7) were established to determine the specific purpose of each transmission over the two (2) year period of operation. Figure 2-7 also shows the percentage breakdown by each 12 month period of the six categories by the Purpose of telecommunications. Also shown is the mean average of each category for the two years. During the two years medical purposes accounted for 57.7 percent of all telecommunications compared with the low of 49 percent, occurring during the first 6

PURPOSE	MAY-OCT 1975 TELE-COMMUNICATIONS	NOV-APR 1976 TELE-COMMUNICATIONS	MAY-OCT 1976 TELE-COMMUNICATIONS	NOV-APR 1977 TELE-COMMUNICATIONS	TOTAL TWO YEARS
CONTROL	194	188	145	109	636
CHECKOUT	177	121	88	81	467
TROUBLESHOOT	26	12	1	11	50
COMMUNICATION	611	458	472	437	1,978
CHM/PHYSICIAN	473	530	610	285	1,898
MED/ADMINISTRATION	495	713	556	597	2,361
TOTALS	3,998 (1ST YEAR)		3,392 (2ND YEAR)		7,390

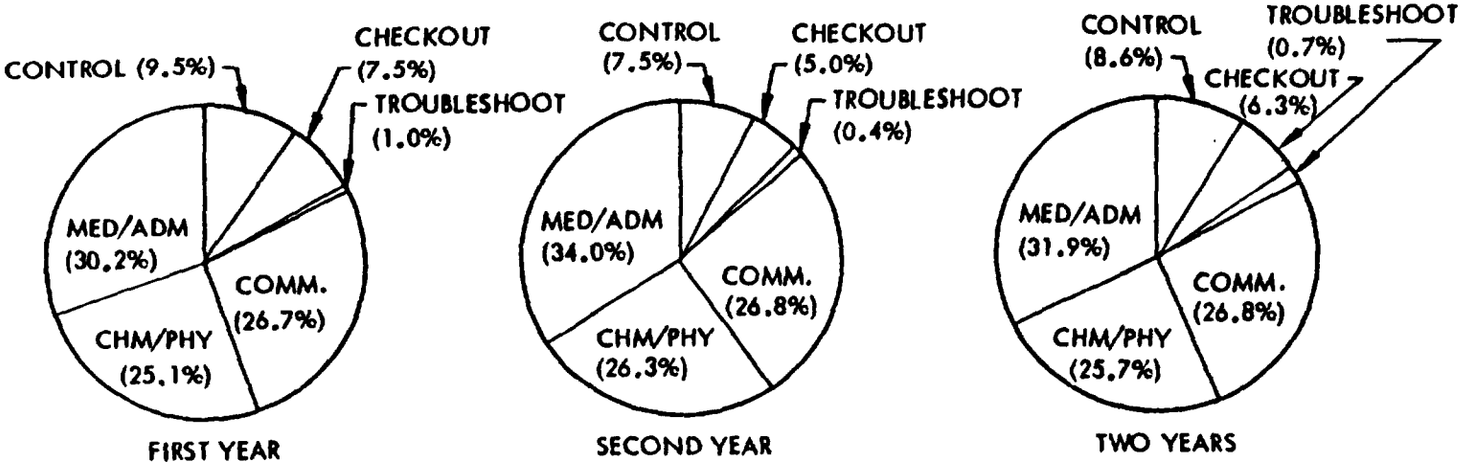

Figure 2-7 Purpose of Telecommunication

months and a high of 62.3 percent which occurred in the third six month period. Medical/Administration indicate an increasing trend while Control and Checkout were generally decreasing. The decrease occurred as a direct result of the reduction in equipment failure which resulted in fewer checkout and troubleshooting.

Total telecommunication time over the two year period was 1390:18 hrs:min. Figure 2-8 shows the trend of reduced transmission time as the operation proceeded. Figure 2-8 also shows the comparison between total and medical telecommunication time month-by-month. The average time over the two year period for total telecommunications was 57:56 hrs:min. while medical telecommunications required 29:20 hrs:min. or 50.6 percent of the total time. The average time of one telecommunication was 11.3 minutes while the average time of one medical telecommunication was 9.9 minutes.

It is interesting that medical vs engineering times are practically equal for the last year of operation, whereas for the first year, engineering exceeded medical times (435 hrs. vs 422 hrs). The equalization of time is attributed to decreasing checkout and troubleshooting and greater participation between the CHM/Physician and Medical/Administration.

2.4.2 Reliability Evaluation

Failures-Cause and Action Taken. The Trouble and Corrective Maintenance Report supports the Usage Log and is used to analyze degradation, deficiencies, failure rate and trends. Data was entered daily by site personnel as problems occurred and/or were reported by users/providers. The data was used to:

- o Set work priorities/schedules
- o Establish satus of open items
- o Evaluate spares requirements
- o Analyze as part of evaluation process

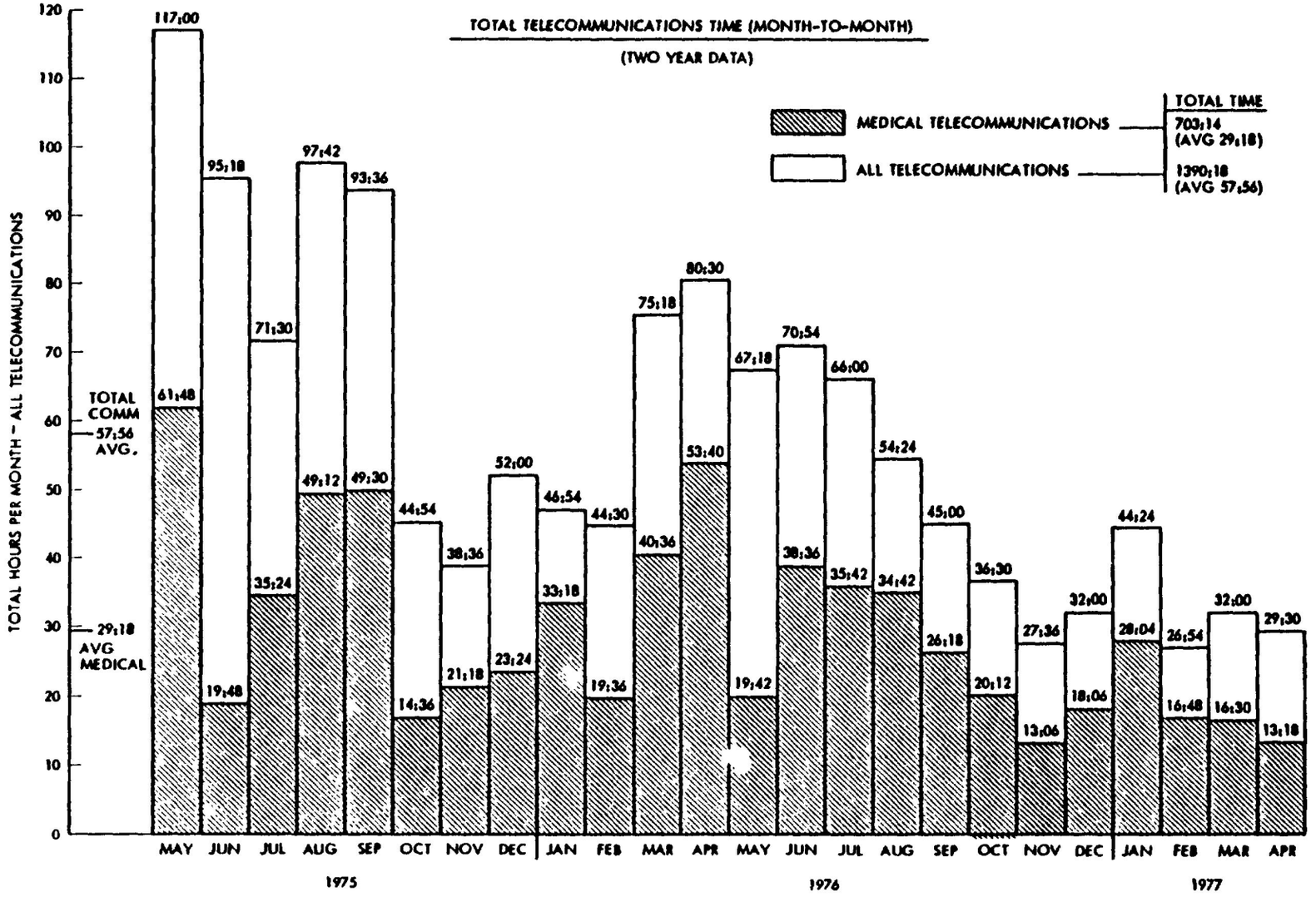

Figure 2-8 Telecommunication Time Comparison Between Medical & Total

Subsequent t· t explores the criticality of failures as reported in the trouble reports with respect to health care delivery. (See Appendix D for more detai).

A total of 748 Trouble Reports were recorded during the two years of operation. These were carefully reviewed and screened for validity, i.e.: blo•n fuse, burned-out indicator/pilot lamp not effecting operation were excluded. The resulting valid trouble reports totaled 688.

Classification of Trouble Reports. Figure 2-9 illustrates the trouble report analysis for the two (2) year period. Shown are (1) trouble report distribution, (by the type of trouble) for the two year period (2) the number of trouble reports in each 6 month period (by the type of trouble) and the percentage of type of trouble reports.

The last two 6 month periods indicate a reduction in average number of trouble reports per month (20.4) while the first 6 month period was the highest (40.5) as one would expect due to beginning operations of a new system. Of significance interest is the high percentage of the trouble reports of the computer/terminals and MHU vehicle and related equipment.

Operator errors showed a steady decline indicating an improving proficiency by the providers, (25 during first 18 months down to 3 for last 6 months). The problem with the computer was considerably reduced with the addition of the Uninterruptable Power Source (UPS) during the third 6 month period.

The majority (54.4%) of the trouble reports (as defined in 5 categories shown in Figure 2-9) were in the "failure" category as would be expected. The second highest was "degradation" with "deficiencies", "modification" and "others" trailing.

Failure Trend Analysis. Figure 2-9 illustrates the declining trend, for 2 years, of the trouble reports which reduced at a faster rate than the decline in telecommunications. Additionally, the number of failures per

INCIDENT CLASS	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	TOTAL
FAILURES	23	16	29	33	29	25	19	14	26	20	14	15	10	15	9	9	13	9	11	10	9	1	5	10	374
DEGRADATION	3	11	11	7	9	13	4	7	8	16	11	9	14	10	11	6	13	7	5	7	3	8	1	8	202
DEFICIENCIES	4	3	1	0	5	4	1	3	3	1	4	3	–	1	2	1	1	–	1	2	–	2	–	–	42
MODIFICATIONS	1	2	1	1	6	0	1	3	1	1	1	2	1	1	–	2	1	1	2	–	–	2	1	–	31
OTHER	0	1	2	2	1	0	2	4	2	1	2	2	–	–	–	–	–	–	4	2	4	5	3	2	39
TOTALS	31	33	44	43	50	42	27	31	40	39	32	31	25	27	22	18	28	17	23	21	16	18	10	20	688
	1ST PERIOD TOTAL = 243						2ND PERIOD TOTAL = 200						3RD PERIOD TOTAL = 137						4TH PERIOD TOTAL = 108						

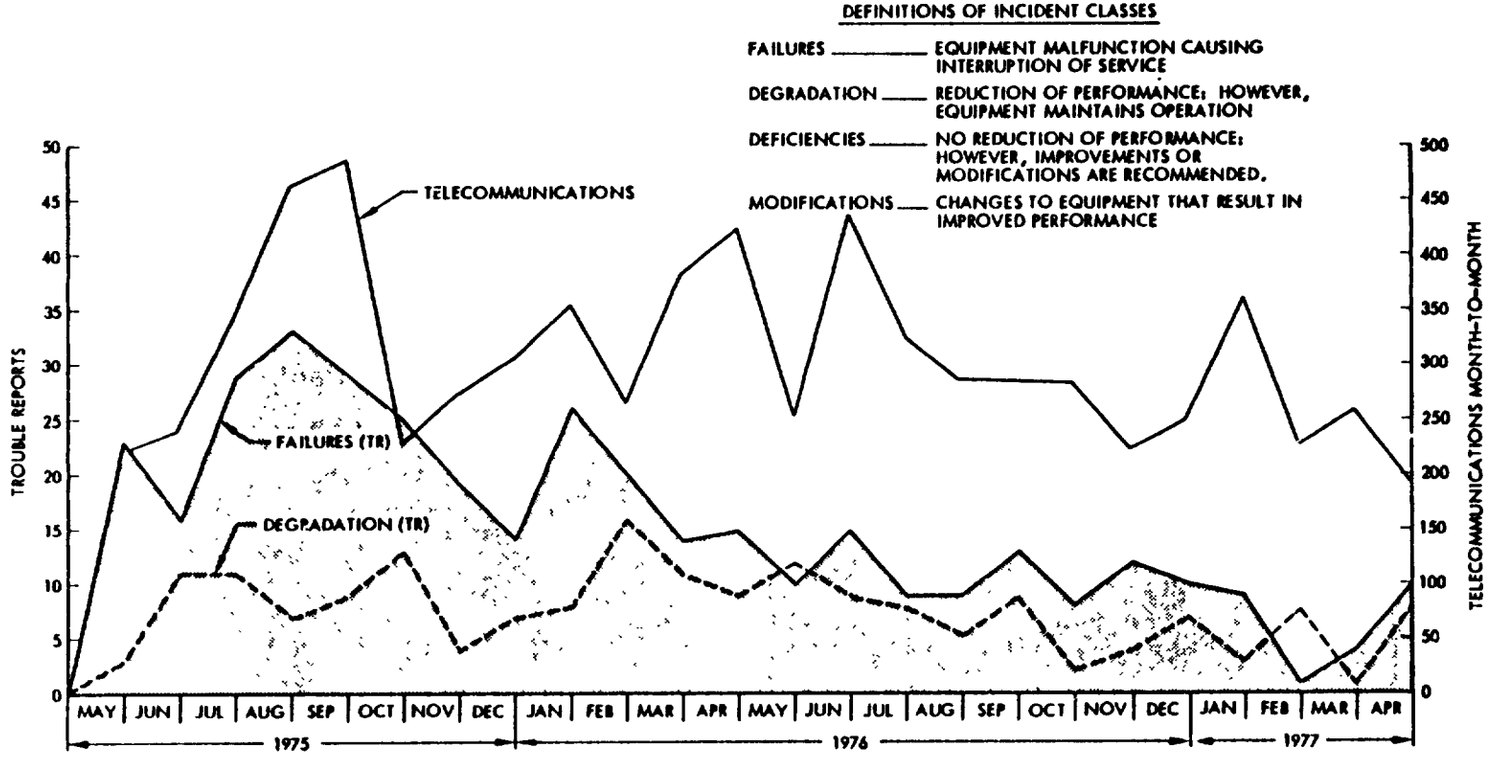

Figure 2-9 Distribution of Trouble Reports (By Effect & Type)

month was declining faster than the degradations per month which is a favorable situation, as degradations do not take the elements or subsystem down.

System Reliability. The TCE system reliability (defined as the probability of delivery of health care at any given moment) of STARPAHC was at a very impressive level of 98.38%. This figure is derived from trouble report logs and the raw usage log which indicate that over the two year period, only 120 (1.62%) "Not Acceptable" events occurred out of a 7390 telecommunication. The first 6 month period showed the lowest reliability indicator of 97.82% with the third period the highest of 98.98%.

The TCE system reliability is actually higher than that shown above because of redundant system capabilities. A "Not Acceptable" voice transmission via the handsfree, utilizing the multiplex radio link could easily be overcome by switching to the handsfree, using TV audio link, the hotline or VHF link.

The STARPAHC system was designed with adequate redundacy and fail-safe features there was never a "system down" situation during the entire two year period. Almost all "Not Acceptables" were actually inconveniences and posed a work around, or reconfigured operational mode.

2.4.3 Telecommunication Subsystem

STARPAHC telecommunication subsystem consist of five (5) subsystems (refer to Figure 2-3) that reflect the function that the equipment performs. (Refer to Table 2-20 "Glossary of TCE definitions" for explanations of the 24 TCE.) The design of the TCE subsystem allows a great degree of flexibility in various configurations. Redundancy and alternate path configuration prevented most failures from disrupting a telecommunications.

Most of the equipment is commercially available off-the-shelf and is of solid state design. (See Equipment List - Appendix C).

The wideband element is principally associated with Video, both Color and Black and White and extended response audio transmission. Narrowband is for audio, telemetry, data and ECG transmission. VHF is a liaison and backup communication capability. Slow-Scan allows the transmission of video images, B&W and color, from the Sells hospital to the PRC via commercial unconditioned telephone lines. The emergency element is in support of the hospital and MHU on an as needed basis.

A summary of the telecommunication subsystem follows which will provide a description of its function, major characteristics, and a brief discussion of maintenance and problems.

Wideband. Wideband communication equipment contains ten (10) TCE items varying from one item such as a recorder to an assembly such as a TV camera, control and monitor. The heart of the wideband is the RF transmitters and receivers through which most of the information passes. The modular units operate independently, powered by -24 volt direct current, and contain built-in alarm indicators and a built-in test panel. Each unit operates at a specific frequency between 7.1 and 7.9 Ghz with one video channel and one wideband extended low frequency audio subcarrier channel.

Maintenance is easily accomplished as the units are entirely modular constructed and corrective actions consisted of determining the failed module and replacing it with a spare.

Color TV, Patient Viewing

A patient viewing, color TV camera, was provided at the LHSC (emergency room) and MHU (exam room) for normal viewing of the patient and on occasion the provider. The cameras are equipped with a 10 to 1 zoom lens, and the pan, tilt, zoom, focus and iris can be remotely controlled by the Physician, system operator from Sells or CHM/nurse at place of patient contact.

This camera was used for most CHM/Physician teleconsultations. It was relatively easy to prepare for use and was the easiest of all cameras to use for video transmission. An exceptionally good performance for equipment of this type was achieved however, the physicians would not base a diagnostic judgement on sole use of the color camera as it could only provide an approximation of the actual color and hues and not always true reproduction. A green hue persisted in some highlight and all shadow areas at light levels that could be readily tolerated by patients, (as explained in conjunction with the slow-scan TV experiments).

The color TV cameras and camera control units (CCU) were moderately reliable and did not require inordinate adjustment or alignment. At the beginning of the operational period all units were modified by the manufacture to provide improved voltage regulation to the electrical components.

There were seven color cameras required for STARPAHC operations. Early engineering tradeoff studies reviewed all available cameras in the time period of interest. It was recognized that studio-type high quality cameras were available, however, the increase in cost for the program would require approximately $250,000. A further engineering consideration was that maintenance requirements on the three-gun studio-type camera could be well above the capabilities of the site operators which in turn would require expensive maintenance contracts. Another consideration was that since this was a test bed type program it would be valuable to evaluate the performance of commercial equipment under field conditions. On the basis of these considerations the low cost, less quality, cameras were selected. The cameras were acceptance tested and met their specifications.

Color TV, Patient Viewing Microscope

One unit was provided at the LHSC (emergency room) and the other in the MHU (exam room). The basic components were identical but the mechanical support structure differed due to the facility designs. (See Sect. 2.3.3 for details).

Color TV, Laboratory Microscope

A triocular microscope was fitted with a color TV camera. One assembly was provided in the lab at the LHSC and one in the Reception/Lab room in the MHU.

The microscope due to its excellent capabilities was used at the LHSC often, according to the providers, but very few video transmissions were accomplished. The microscope was replaced by a unit not possessing video capability and the TV microscope was located in the HSSCC laboratory where its use is higher since it can be used also for Slow-Scan TV at this location. The MHU-TV microscope was used often for routine lab workups but very few video transmissions were attempted. Lack of video transmissions in both facilities is due to lack of need and nature of lab work done at both clinic locations. The MHU health care personnel did not have specialized training in microscopy which contributed to the lack of transmissions. It was anticipated that specialized laboratory personnel could be made available on a test period basis, however, that did not occur during the two years of operation.

Medical research evaluation of this system was carried out via Slow-Scan TV from Sells to Phoenix. (See Section 2.3.3).

The quality of the video was generally regarded as good with respect to acuity, color saturation, contrast, hue etc. Typical of all the color cameras used in the STARPAHC, the correct hue was not achievable across the color spectrum with the relatively inexpensive color camera. In almost all images, a green hue was present in either highlights or shadow areas. Color differentiation of mute hues were also difficult to distinguish regardless of monitors and reasonable light levels.

Black & White, X-ray

A B&W TV camera was provided at the LHSC (exam room) and in the MHU (X-ray room) that could be remotely controlled by the Physician, system operator or CHM. It could pan, tilt, zoom, focus, and adjust iris in order to 'see' any area of an X-ray film desired. This capability was often used to first view the entire X-ray film then zoom in on a particular area of interest, perhaps of only 2 or 3 sq. in. This enhanced the view of the area by effectively increasing the resolving capability by the viewer. Additionally, it could be used as an auxilliary patient viewing camera, in B&W.

It's use was moderately low (95 with 56 teleconsultations) even though it demonstrated it's ability to transmit a very high quality image. The need to obtain immediate diagnostic assistance on X-ray film was not high but important when needed. This camera was also used to send written data. During installation and checkout, schematics and technical procedure images were transmitted for engineering information as well as written patient data during the operational period.

Black & White TV, Physician Viewing (HSSCC)

A B&W, 525 line, TV camera contained in the HSSCC Physician Console, located such that the image returned to the LHSC or MHU would view the physician in a face-to-face teleconsultation. It has a wide angle fixed focus lens capturing a shoulder and head picture. It's use was high, 528 total, even though it was not used for every teleconsultation (264 CHM/Physician users and 220 medical/administrative). It's reliability was excellent the highest of the high usage TCE with a PAR of 99.24%. The nigh PAR is explained by two major factors. One was the camera was contained in the Physician's console, which is a relatively clean, environmentally controlled area. The other being that the resolution, contrast, lighting, etc. was not critical as the person's image was transmitted to primarily complete the "face-to-face" telecommunication. Additionally during several periods, the physician's or medical/administrative personnel images were not transmitted, but the patients requested their transmissions to be reinstated.

Handsfree, TV

The TV handsfree intercom was generally used as a backup for the MUX handsfree intercom, however the program audio channel did provide an excellent low frequency response needed for transmission of heart sounds. This aspect will be further discussed under that category.

This audio capability for voice transmission was seldom used since the audio capability of the narrowband MUX was highly reliable.

Heartsounds

Heart, chest and abdominal sounds could be sent from the MHU and LHSC via the FM subcarrier audio channel of the wideband RF link. An electronic stethoscope was used at the sensor end operated by the provider.

It's use was low (19 total with 5 medical uses) due to various factors. (See discussion under Section 2.3.3). Most physicians that used or tested this capability did not accept the artifacts and low level background noise heard at the physician's console. It was somewhat difficult to use as it was more susceptible to extraneous noise than the regular stethoscope and required careful placement and handling. For future application, additional development is needed as technological improvements are necessary for physician's acceptance and consistent easy use by the CHM.

Maintenance of the stethoscope was relatively high compared to it's use. This involved primarily battery replacement and repair to the sound transducer located in the electronics package.

Video Tape Recorder (VTR)

A 1 inch helical scan VTR was used to record teleconsultations, in color or B&W, as requested by the Physician or CHM. Additionally real time audio of the CHM, Physician, and time signal could be recorded.

The cleaning of the video head and tracking adjustments was quite critical, and required scheduled maintenance.

Community TV and Audio

An additional requirement was added approximately midway through the two year period to present video and audio to an audience outside the MHU. This requirement was easily accommodated within the existing design. It's anticipated use was to play video tapes and transmit these images with audio to audiences in the villages at which the MHU was visiting. This will expand the telemedicine concept to include educational TV.

The benefits to education and welfare programs that STARPAHC capabilities afford as spinoffs are just beginning to be realized. The capability to communicate periodically (over video and audio links) with the people in remote villages will enable teaching and instruction of all kinds to support such vital education programs and environmental health, sanitation, nutrition, disease control, and many more. In addition, this capability accommodates general community discussions (with the control center area) and provides for transmittal of other information such as news and coordination of community, State, and national activities.

Narrowband. The Narrowband element contains nine (9) TCE items varying from one item such as a ECG recorder to ten assembly such as the telemetry remote camera control units.

The major items are the narrowband FM/FM multiplex transceivers. Each transceiver operates on 24 vdc at a specific carrier frequency between 1.7 to 1.85 Ghz. They have the capability of providing up to 24 channels of audio bandwidth information with each channel possessing an out of band E&M (leads) signaling capability. In addition each transceiver has an orderwire, (a special audio channel) used primarily for maintenance and troubleshooting. An alarm system is provided in the Quijotoa Relay Station (QRS) that it activated by eight (8) sensors providing audio (pretaped) alarms that are transmitted over the orderwire audio channel.

Like the wideband equipment, some TCE listed under the narrowband category may operate independently or in conjunction with other equipment but principally support narrowband telecommunications, (for example, the audio channels were used during TV transmission). Maintenance is accomplished by card replacement in the multiplex chassis. Capacitor and diode failures were experienced which required component disassembly, repair and reassembly resulting in a little higher maintenance repair time than the wideband transmitters and receivers. Spare modules permitted quick return to service.

Handsfree, MUX

Handsfree, MUX, provided an audio communication mode allowing the health care providers to hear each other without the use of hands to operate buttons, or switches.

The handsfree audio was used in conjunction with video telecommunications and many times as the sole communication mode. Medical/Administration audio telecommunication with the MHU were normally conducted over the handsfree audio channels, while only limited use of this capability was used by the Santa Rosa clinic personnel. This was due to the easy availability of telephone service between the clinic and the Sells hospital. Most of the medical/administration telecommunications were with Medical Records in obtaining prescription information, laboratory results, and recent medical summaries.

Privacy Audio, Remote

In situations at both clinics where the CHM did not wish the patient to hear the audio during telecommunications, the privacy mode could be selected by either using a telephone handset or a lightweight small headset. The headset was most often used as it leaves both hands free and provides good audio in both directions, reducing extraneous noises such as crying babies, wind noise, air conditioning noise, etc. The audio reception/transmission is similar to a good normal telephone conversation.

At both clinics, the CHM could ensure video privacy by disabling the monitors in each room including the data communication room at the Santa Rosa clinic. At the Sells Hospital, the physician could ensure both video and audio privacy by disabling the monitors and speakers on the system operator's console.

Hotline

The hotline provided the fastest and easiest means of obtaining audio communication during clinic hours between personnel at the LHSC and MHU and system operator at the HSSCC. Lifting the handset at either end automatically causes the set at the opposite end to ring.

The hotline was the most used TCE with a total of 2134 usages of which 366 with CHM/PHY contacts, 847 medical/administrative and 890*engineering telecommunications. Most medical/administrative telecommunications were by Medical Records and the CHM regarding medication, treatment, prescriptions, and lab results.

It's PAR was 99.02 percent indicating excellent reliability.

Orderwire

The orderwire is a built-in feature of a special audio channel in the narrowband transceivers allowing audio communications from set to set and audio signaling. The use was mostly by maintenance/engineering personnel to accomplish system management. This audio capability is in addition to the regular multiplexed channels allowing point to point communications without disrupting data or communication of the regular channels.

A PAR of 98.28 indicated an excellent reliability, and maintenance was easily accomplished.

*Approximately 450 of the 890 contacts were for the purpose of setting up teleconsultations between the CHM Physician but are shown as engineering telecommunications.

Telemetry, QRS

The control and telemetry system was used to remotely control the QRS Relay Station from the Sells hospital. Control and override capability was provided by tones through one of the FM/FM multiplex channels. A touch tone encoder was used by the system operator and decoded at the QRS to accomplish TV-on/off antenna rotations, generators on/off or auto etc.

Corrective maintenance of this TCE was relatively easy. The design is simple and packaged modularly for accessibility and maintainability.

ECG

An electrocardiograph signal can be transmitted from either the MHU or LHSC to the HSSCC for display on a 2 channel cardioscope or recording on a 3-channel cardiograph recorder in the Physician's room. Additionally, the signal is recorded at the transmitting end and when directed can be recorded by the system operator on a wideband FM channel of the audio/ instrumentation magnetic tape recorder, at the operator's station.

The use of the ECG transmission capability was very low but very important when used due to several factors such as (1) the low incidence of heart diseases, (2) relatively easy referral to a hospital with a cardiologist, and (3) lack of a cardiologist at the HSSCC. The equipment performed flawlessly during all operational uses, tests, checkouts and demonstrations.

The PAR was 100% and was one of the best performing, maintenance free TCEs in the subsystem.

A/I Recorder

An Audio/Instrumentation recorder was provided to record audio communication, on separate tracks, of the CHM, Physician and standard time signals. Additionally the ECG signal could be recorded on a wideband FM channel.

The PAR was 100 percent but the recorder was never used by the medical staff. The only audio recording made was on the video tape recorder and ECG's were recorded directly on the cardiograph recorder.

Telecoupler

The telephone coupler was used to patch the handsfree intercom into the dial telephone so that people in the field such as the MHU personnel, (without telephones), could contact the lab, and medical records. It saw increasing use as the personnel became aware of its value. Tribal programs, other than health care, also used the telephone coupler as well as other STARPAHC communication modes to effect contacts with the different villages. The telephone coupler was also used by relatives of patients in outlying villages who made inquiries to Sells as to the patient's status and well-being. Other than health care usage of the telephone coupler was for the dissemination or gathering of information concerning disease control, alcoholism, mental health, and personnel travel coordination related to community programs.

Telemetry, Remote Camera Control

The patient viewing and X-ray viewing cameras are remotely controlled from the HSSCC Physicians and Operators console via tone encoding/decoding equipment located at each end, and using one of the multiplexer's channels.

The use of this TCE was good with a total of 253, uses. 120 of them were for medical purposes and 107 by support personnel assisting the provider.

The reliability of the remote camera control equipment was reasonably good with a PAR of 95.65. Most of the failures that did occur were in the power supply section of the receiver in the MHU and LHSC.

Maintenance was relatively difficult due to the packaging design and manner in which the units were mounted at the facilities.

VHF. The VHF radio element was provided at each facility and used as a liaison communication capability primarily for microwave antenna alignment and maintenance/operations personnel communication. The MHU provided an external VHF handset, which initiated an alarm at the HSSCC when lifted from the hanger, for non-clinic hours for emergencies.

The VHF radio was used 678 times with 52 uses for medical purposes.

Reliability was very good with a PAR of 98.97 percent and maintenance was accomplished easily.

Use of the VHF radio link was actually much higher than recorded. Many communications were accomplished point-to-point without communicating directly with the system operator (who recorded the usage data).

An additional capability of the VHF radio equipment was a computer data back-up mode in which data would be transmitted between the HSSCC computer and remote facilities, in a half duplex mode (which provides for the transmission of signals alternately in two directions over the same circuit as contrasted with simultaneous transmission in full duplex). This data backup mode was used when the Traveleze trailer was substituted for the MHU on several occasions and provided a very important service. The VHF could also be used for audio communications between the trailer and other facilities.

Slow-Scan. The Slow-Scan category contains four (4) TCE groups varying in complexity. The color transceivers are supported in operation by B&W and Color cameras, monitors, and recorders.

By use of "dial-up" telephone lines, single-frame color and black-and-white video are transmitted to the Phoenix Referral Center for study of the subject matter by medical specialists. In routine use, X-rays, microscopic slides, and views of patients are transmitted on real-time TV from the mobile and fixed clinics to the control center at Sells Hospital (or originated at Sells), where they can be transmitted via the dial-up Slow-Scan video link

to Phoenix for additional study and consultation. When received at Phoenix, the video images are displayed on monitors and/or recorded on a disk and video tape recorder for later playback and study, if required. This capability is proving to be an extremely valuable tool for consultation (and teaching) and one that gives the patient in the most remote area, direct, timely access to some of the finest physicians and specialists available. The medical research evaluation for transmission of X-ray, microscopic slide images, and patient examinations has been previously discussed under Section 2.3.3.

The Slow-Scan transceivers are solid-state, digital pulse code modulation units capable of sending and receiving color and B&W video images using unconditioned (commercial) telephone facilities, (dial up). The incoming composite, NTSC standard, video signal is converted from analog to digital data, stored in an IC memory and clocked out at a rate allowed by narrow bandwidths for transmission over telephone lines. The receiving end stores the digital data in memory and presents the video image on a monitor as it is received. The video display will remain constant until new data is written into memory. Transmission time per image is 2½ minutes.

The Slow-Scan transceivers operated for over one year without failure. Failures in the system were exclusively those involving telephone couplers (4).

A B&W TV camera is situated in the HSSCC Physician's room for primarily viewing X-ray film illuminated by a high intensity variable brightness light box viewer. These, and other, video images may be recorded on the VTR, in the system operators room, or transmitted directly to PRC or one of the remote facilities. The camera is operated from the Physician's console control panel and can be panned, tilted, zoomed, focused and iris varied while viewing the selected monitor in the console.

The TCE usage tabulation table indicates no usage of the B&W camera, however most of the Slow-Scan transmissions were accomplished using this camera and when usage was recorded it was inadvertently assumed to include the B&W camera.

The maintenance on this camera was a little less than on other camera and controls attributed to a relatively clean and more closely controlled environment.

Color TV, Physician's Room

A color TV camera was installed on a moveable arm in the Physician's room as part of a test program in evaluating the Slow-Scan and ancillary equipment. There were a total of 23 usages with 19 of them for medical purposes over a 6 month period. Many of the usages included many individual images transmissions and would last over several hours.

The PAR for this TCE was 100 percent attributed to the more favorable environment and testing associated with the numerous transmissions.

PRC Camera.

The Slow Scan system is capable of transmitting and receiving data at both terminals. It was believed that transmissions from Phoenix to Sells could be useful for educational and training purposes, therefore color transmissions to Sells hospital was verified.

Emergency. The emergency element consists of a Portable Ambulance module (PAM) in the exam room of the MHU and emergency room (ER) at the HSSCC. A base station is located in the physician's room at the Sells hospital which contains a receiver, waveform monitor, recorder, and audio communications capability.

The unit located in the ER contains equipment to provide medical procedures for oxygen administration, fluids aspiration, respiratory resuscitation, blood pressure measurement, ECG monitoring and defibrillation. Additionally, audio communication capability is provided as well as vital sign transmissions back to the HSSCC.

No usage had been recorded by the system operator as transmission through the telecommunication subsystem did not occur except during installation and checkout early in the program. The PAM in the hospital was used at least six times with satisfactory results according to discussions with clinical staff personnel.

One life-saving feature of the emergency unit is the defibrillator. Lethal energy levels are stored in the defibrillator when charged. In typical operation, the health care personnel removes the paddles from their storage area. They are connected to the defibrillator. The defibrillator is charged simply by pushing the CHARGE/DRAIN toggle forward until the desired energy level is reached as indicated by the front panel meter. This takes approximately 12 seconds. Paddles are placed on the patient and both paddle discharge switches are simultaneously depressed to discharge the defibrillator.

Minimal maintenance is required and was limited to canister exchange and battery charging.

2.4.4 Computer and Peripheral Equipment Subsystem

The computer subsystem consists of hardware and software. The hardware was comprised of the computer mainframe, peripheral equipment and various CRT and hardcopy terminal, located at 4 locations, and supporting interfacing modems and cable. (See Inventory List - Appendix C). The software element contained several programs and data bases in direct support of the HSSCC computer. A support computer and associated software, Health Information System (HIS) was located in Tucson (Tucson Computer Center, TCC), however during August 1976 the HIS was relocated to the IHS computer center in Albuquerque, New Mexico. During December 1976 and January 1977 the HIS information retrievals were changed from the STARPAHC computer to a Time Division Multiplexer (TDM), while the STARPAHC computer supported only the schedule data base and program activities. Operation is now direct to Albuquerque through the TDMs.

Hardware. As illustrated in Table 2-32 the computer was a major maintenance problem during the first year, decreasing sharply in the third 6 months but with some increase in the last 6 months. The problems with hardware maintenance during the earlier operational period is attributed to new hardware design of the computer and problem created by power interruptions and fluctuating voltage. This situation improved in the third 6 month period primarily due to the installation of an Uninterruptable Power Source (UPS) in June 1976. The increase in downtime during the fourth 6 month period can not be determined as the failures occurred in several different areas of the mainframe and disc drives electronics and could not be correlated to any particular event other than use. However, delays by the service contractor in providing service and parts added more down time to this period than in prior periods.

Software. The computer software was divided into two major functions: (1) Data Concentrator and (2) Medics Application Software. Generally, the MEDICS (See Table 2-32) Application Software usage reflected about 30 percent of the total computer usage and the Data Concentrator function utilized approximately 70 percent.

Table 2-32 Computer Usage/Failure Summary

	May 1975 thru Oct 1975	Nov. 1975 thru April 1976	May 1976 thru Oct 1976	Nov 1976 thru April 1977	TOTAL
Total Operation Time (hrs)	1126	1126	1377	1377	5006
Total Operation Downtime (hrs)	130	214	32	108	484
Percent Operational Downtime	11.54	19.0	2.32	7.8	9.7
Total Failures (100% System Down During Clinic Hours)	8	14	5	10	37
Total Varian Service Calls (Corrective Actions)	6	7	4	9	26
No. of Operational Days Between Failures	16.3	9.3	26	13	N/A
No. of Operational Hours of Each Failure	16.3	15.28	6.4	10.8	N/A

Reference

10% is considered normal operating downtime in the computer industry.

The usage of the Data Concentrator, MEDICS and the terminals was related to the number of requests recorded. There were approximately three lines of input associated with each request for the Data Concentrator. These inputs averaged between 1200 and 1500 per month.

All terminals within the STARPAHC network have the capability of retrieving Health Information Service (HIS) medical summaries from the Albuquerque computer. The HIS medical summaries provide detail medical histories on all Papago patients. Identification, location, histories, and medication records are provided.

The MEDICS software usage was divided into three categories: (1) Users, (2) Program Usage and (3) Data Base Usage. Relationship between Program and Data Base is illustrated in Figure 2-10 with the Programs and Data Base definition in Table 2-33.

MEDICS.

The eight main users of MEDICS were Sells Medical Records, Programmer, LMSC, HPSC OMIS, Paramedics, Santa Rosa Medical Records, Nurses, and Others. Sells Medical Records, LMSC Programming, and the Santa Rosa Medical Records accounted for 87 percent of the total usage. There were five main programs available to the users: (1) RETRVL, (2) INPUTP, (3) SCHEDULE, (4) UPDATE, and (5) OTHERS. The RETRVL, INPUTP, HIS, and SCHEDULE accounted for 48 percent of the total usage.

There were 3 main data bases: (1) Schedule, (2) Equipment Records, and (3) Active Medications. The Schedule and Equipment Records data bases accounted for 93 percent of the total usage. The lack of usage for the remaining data bases was attributed to the size of the hospital which is a 50 bed hospital. The less used data bases were tested for use by the applicable hospital staff but in most cases it was found that manual record keeping and aids programs were less time consuming with the number of patients and encounters involved. If the same software and computer capability were available to a larger hospital, the use of the data bases and programs may increase appreciably.

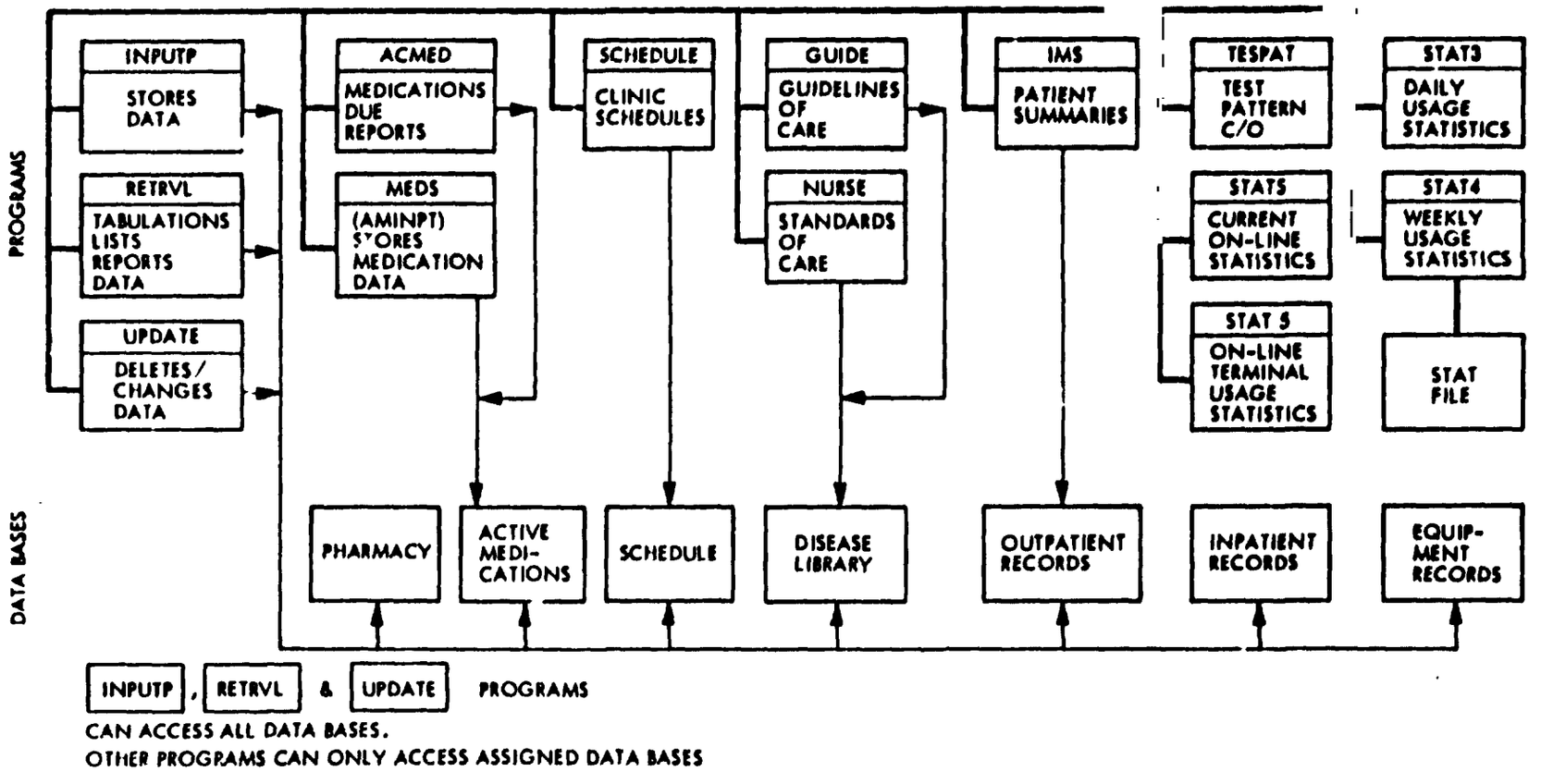

Fig. 2-10 Programs/Data Bases Relationship

Table 2-33 Computer Data Bases and Programs

Data Bases.

An organized collection of data. Organization of each data. Organization of each data base is directly related to the data to be stored; i.e., numberic data is filed in numeric order, time related data is filed chronologically, or alphabetic data such as patient names, is filed alphabetically. The MEDICS data bases can be accessed by several application programs. Users use these programs to store, report, or change data in the data bases.

- o PHARMACY - This data is a collection of patient data regarding medications for outpatients. This data base is used primarily by the Pharmacy at Sells Hospital.

- o ACTIVE MEDICATIONS DATA BASE - This data base is a collection of data regarding physician for inpatients at the Sells Hospital. In general, this data includes hours due, medication, dosage, physician's name, patient name, and room number. This data base is primarily used by the ACMED and MEDS programs.

- o SCHEDULE - This data base is a collection of patient data regarding scheduling patients for the specialty clinics. This data base is primarily used by the Schedule program.

- o DISEASE LIBRARY - This data base is a collection of reports used by the paramedics and nurses. The Guidelines of Care reports are used by the paramedics to guide them in diagnosing diseases. The Nurses Standards reports are used by the nurses to remind them of tasks needed to be accomplished in their care of the patient. These reports are filed by Disease Name.

- o OUTPATIENT RECORDS - This data base is a collection of patient exam data such as blood pressure, pulse, temperature, weight. This data base is used primarily by the IMS program.

- o INPATIENT RECORDS - This data base is a collection of hospital census information, such as admissions, discharges, and disposition in case of fatality.

- o EQUIPMENT RECORDS - This data base is used to collect data regarding the STARPAHC equipment. Preventive maintenance schedules and procedures along with Trouble Reports and Usage Reports are maintained in this data base.

- o NURSE - This MEDICS application program is used to report Nurses Standards to a terminal. The program utilizes the Disease Library Data Base.

- o IMS - This is a MEDICS application program that summarizes patient exam data. This program utilizes the Outpatient Records data bases.

Table 2-33 (continued)

- o TESPAT - This MEDICS application program types a test pattern onto the screen (in the case of CRT's) or on paper (in the case of hard copy). This program is used for check-out purposes only.

- o STATS - This MEDICS application program reports statistical data to the terminal; it provides the number of users in the system and the terminals being used. This program is available to the user at the terminal.

- o STAT5 - This software programs provided data on the number of times that a data base, user, program or terminal was utilized. Additionally, it provided the number of HIS inputs and outputs for each terminal and indicated the quantity of NAKS transferred over the BSC line.
- o STAT3 - This software program provides daily statistics of the computer usage giving user name, program(s) used, data base used, etc. This program reports these statistics at 5:00 each afternoon.

- o STAT4 - This software program summarizes the total daily statistics contained in the computer file. This program is usually executed weekly, summarizing the week's computer usage. Data reported is the same as STAT3.

- o DATA CONCENTRATOR - The Data Concentrator is a software program that compacts data to be sent to the Indian Health Service Computer in Tucson. Another function of the Data Concentrator is to unpack compacted data from the computer in Tucson and transfer it to the terminal. The program also maintains the BSC line discipline for the outgoing and incoming messages.

Medics Application Programs.

These are programs that are designed to interact with a user at his terminal. They store, manipulate, or report data from the data bases to the user or from the user to the data bases. These programs constitute a major portion of the computer usage.

- o INPUTP - This is a MEDICS application program used in storing data into any one of the various data bases. The program uses a question/answer technique where the questions are related to the data base and the answers are typed in (by keyboard) by the user and stored by the program.

- o RETRVL - This MEDICS application program reports data to the user at the terminal. The user can request tabulations, lists, etc., to define the report. Any data base can be used by this program.

Table 2-33 (continued)

- o UPDATE - This MEDICS application program allows a user at the terminal to change or delete any data in any of the data bases.

- o ACMED - A MEDICS application program whose function is to provide reports of medications due for inpatients in the Sells Hospital. This program uses the Active Medications Data Base, and is used primarily by the Nurses at the Nurses Station.

- o MEDS - This MEDICS application program is used to store data exclusively into the Active Medications Data Base. The program is identical to the INPUTP program in structure, but differs in the amount of data stored. Upon completion of a question/answer session, the program interrogates the answers to store multiple data into the data base. If a user stores for ten days, a certain hour that a patient is to receive medication, ten sets of the data are stored - one for eacy day at the given hour.

- o SCHEDULE - This MEDICS application program generates schedules based on data found in the Schedule Data Base. The user can request a schedule for any clinic in the system and for any day.

- o GUIDE - This is a MEDICS application program that types out the Guidelines of Care reports to the user. These reports are used by the paramedics to guide them in diagnosing diseases. There are five reports available now. All reports are designed by the Indian Health Service.

Terminal Usage.

In determining terminal usage, the statistics on both the Data Concentrator and MEDICS Application program usages were reviewed. The terminals devoted primarily to patient health care represent 81 percent of the total terminal usage. These terminals are located in the Sells Medical Records (3), Santa Rosa Clinic (2), MHU (2), San Xavier Medical Records (2), and the Sells Pharmacy (1). The remaining terminals (3) reflect such patient health care usages as the IHS patient summaries, and this usage represents about 10 percent. Thus, a total of at least 91 percent of all terminal usage can be attributed directly to patient health care. The remaining 9 percent is primarily devoted to Equipment Records data base usage and checkout.

2.4.5 Facilities (See Appendix B for detailed description of facilities)

The STARPAHC system includes six (6) facilities as shown in Figure 2-1; three are fixed locations on the Papago Indian Reservation, two (2) are fixed locations off the reservation in Arizona and New Mexico and one, a mobile unit that travels in the western region of the reservation extending modern quality primary health care to this remote area. The New Mexico facility is the Albuquerque Computer Center with which STARPAHC interfaces for patient history records.

2.4.6 Personnel

Evaluation of health care and engineering personnel performance and patients attitude as to health services provided by STARPAHC was accomplished by:

- Five separate sets of recorded interviews by a Behavioral Scientist from outside the Office of Research and Development (IHS).
- Site visits, trouble report analysis, and maintenance ability in terms of turnaround time in repairing and replacing equipment.
- Patient interviews and questionnaires by the Papago Executive Health Staff.

Proficiency assessments came up routinely during operations. Degradation in performance was reported to the Sells Unit Director. Reinforcement training occurred on a scheduled and unscheduled basis.

Personnel performance was judged oy; 1) the patient's acceptability of the providers services, 2) the acceptability of the providers in the utilization of the telecommunication equipment, and 3) the ability of the engineering technicians in operating and maintaining the system.

Providers Attitude. One of the objectives for evaluation of STARPAHC is to test the assumption that health care providers will accept and use the new capabilities if an adequate orientation training discipline is maintained both for individual patient care and for other, broader, applications in the areas of group health education and health maintenance.

The task of this part of the evaluation is to document the reaction of those full time physicians on the Papago reservation having continuous contact with STARPAHC, and other allied health professionals who worked with STARPAHC. The goal was to record and measure attitudes and expectations over time as the project progressed particularly the effects of STARPAHC on physician hours worked, number of patients seen each day, percentage of time spent on various kinds of activities and numbers of patients referred out of the area and looked at either by directly querying the physicians or by a review of the computerized health records for the patient.

One of the compounding problems that effects our ability to understand attitudes towards STARPAHC is that the STARPAHC project itself has several unusual components. It added a mobile unit to provide care to isolated Papago reservation areas not previously served with direct care; it added two way television; it added the ability to transmit medical records to remote areas; it helped provide voice communication to areas of the reservation without telephone lines; and it added sophisticated equipment

such as a new computer and technologically superior diagnostic equipment. Each of these components has its own value. Each person when asked about STARPAHC had therefore to think of the project in its total sense as well as how one or combinations of components effected his/her ability to provide and/or receive good quality medical care. It was shown that acceptance of some parts of STARPAHC does not necessarily mean acceptance of all parts, and trying to understand why certain aspects are more accepted than others was a goal of the interviews and analysis.

One of the major problems, in addition to the small number of physicians involved, is the high turnover rate. The Indian Health Service has always had physician retention problem. Most physicians remain at a site for no more than two or three years. The physicians who were on duty during STARPAHC planning were replaced when the compulsory draft was abolished, three months after STARPAHC went operational. Some positions had turned over twice by the time the research was completed. Because of this rapid turnover some of the physicians did not receive any or cursory training on STARPAHC. Also, the majority of physicians working at the Sells Hospital, the center of STARPAHC activities, are in their first job after internship.

It is important to understand these factors, as well as the organization of medical services on the reservation and the relationship with the Papago tribe, before commencing an evaluation. Indian patients have few alternatives to medical care on the reservation except that provided by the Indian Health Service and traditional healers. The Indian health care is free of charge to the patients (by law) and most physicians are kept very busy treating patients in an environment isolated from the medical mainstream in which they have recently been trained. Most surgery and other specialty care is available either in Tucson, 70 miles by car from Sells, (or up to 140 miles from outlying villages), or at Phoenix, some 150 miles by car from Sells. Both preventive and curative medical services are available from Sells and the field clinics, as well as an extensive outreach program provided by both the tribe and Indian Health Service.

Methodology

The methodology, then, for this study of provider attitudes toward and expectations for STARPAHC must constantly involve the consideration of these factors: the small population to be studied, the high turnover rate of providers and the difficulty in obtaining the needed information.

The major areas of interest are: the type and frequency of training each provider has, proficiency assessment rationale, their experience with advanced technology, how they feel the STARPAHC equipment will affect certain areas of medical care in general, what they feel are the major benefits and problems caused by STARPAHC, what areas they feel are important to evaluate in STARPAHC and some of their feelings about the equipment and its utility. A questionnaire was designed to be used in structured interviews. The questionnaire has a great many open ended questions to permit the maximum flow of information from the providers to the evaluator. After STARPAHC became more fully operational, several additional questions were added in order to learn how the providers feel about using television and other equipment, whether they find its use harmful or critical to patient care, whether the information received is adequate for diagnosis, and to get feedback from providers regarding what parts of the STARPAHC operation they give highest priority and what parts of the system they feel are worth keeping.

As stated before, the structured interviews were held with providers who were or would be actively involved in STARPAHC. This includes all physicians, and those CHM's, nurses, administrators and other allied health professionals working with STARPAHC equipment. An attempt was made to interview all such persons at the beginning of their involvement with STARPAHC or at their start of work with the Indian Health Service, then every four to six months thereafter and before they left the project site for whatever reason. In practice this was not always possible since rapid turnover sometimes prevented an exit interview.

In general, most people in contact with STARPAHC were interviewed. There have been a total of 89 interviews, representing 47 individuals since

STARPAHC began. This includes 21 physicians (four Indian Health Service administrators of STARPAHC, 12 practicing physicians at Sells and five specialists at Phoenix, some had received cursory training on STARPAHC), five CHM's (Physician assistants), six nurses and 15 other allied and administrative personnel. Of the 12 M.D. users interviewed, four were interviewed four times, one was interviewed three times, four twice, and three only once. Of the five CHM's interviewed, two were interviewed all five times and the rest one time only. Many of the staff interviewed before STARPAHC became operational were not inteviewed a second time as their involvement with STARPAHC turned out to be negligible. There is at present a core of about 15 people, mostly physicians and allied health personnel, who have daily contact with STARPAHC.

There have been five sets of interviews. The first set took place in January 1975, before STARPAHC went operational in April 1975, completed by 24 individuals; and the second set in June and July 1975, given to 21 individuals; and the third set in November 1975, given to 15 individuals. The fourth set in March 1976, was given to 15 people and the last set in September 1976, was given to 14 people. All interviews were held during working hours whether in the Sells Hospital or at the field location of STARPAHC and took from 30 to 40 minutes to complete. The interviewer madeevery effort to note responses to all questions.

After each set of interviews, some of the data was coded and placed on coding sheets so that a quick review of the answers to several questions could be obtained to help in tabulation.

Most respondents were very receptive to being interviewed, but due to busy schedules some of the interviews were interrupted. None of the interruptions resulted in postponement and hence the interviewer feels that they did not interfere significantly with the quality of the interview, as the answers provided seemed clear and the providers wanted their opinion properly recorded. By scheduling interviews over a reasonable period of time and in advance, the author was able to maximize the coverage and minimize the disruption. In the

busy hospital and clinic setting that exists at Sells Indian Hospital this is an important point since the presence of the interviewer at the facility means time taken from the providers in a busy day. No one refused to be interviewed. On the contrary all staff seemed willing to have their opinions recorded so that problems and benefits could be shared by all and so that decision makers and other planners may avoid repeating in the future mistakes that they feel have been made with STARPAHC in the past.

Training

Almost all personnel, including the physician, had some form of training regarding the STARPAHC equipment. In the beginning the STARPAHC training was regular and formal, with weekly or daily seminars held to explain various technical aspects of the equipment. Some physicians who arrived after STARPAHC went operational had no training at the time of their initial interviews, almost a month after arriving. Official training for new physicians occurred sometime after the physician was called to the consultation room to assist in a medical problem in the field. Six physicians mentioned that the training in many cases was not enough and that retraining is needed if constant use of the equipment doesn't take place. More training was requested by one of the CHM's in the field who felt that this would help to better understand how the equipment is supposed to be used to get more effective use from STARPAHC.

Prior Experience

In response to a question about prior experience with technology similar to that used in STARPAHC, ten physicians said they had not used computers before coming to the Indian Health Service, but only three had not worked with a physician's assistant or CHM and only two had some experience with television. It is interesting to note that two of the physicians without prior experience with a CHM were cautious about accepting, and apprehensive about the success of STARPAHC. The physicians with experience with television seemed more open and enthusiastic about STARPAHC initially, although over time they had apprehensions similar to those of the other physicians.

Attitudes on Technical Capacity of STARPAHC

In response to a question as to whether the clinical information obtained from a teleconsultation was enough to substitute for a face to face encounter, it was reported in 15 interviews out of 65 interviews that it was not. Six physicians users, one CHM, and the Physical Therapist reported (in at least one and in some cases three separate interviews) that the telecommunications did not give enough information. Reasons given included: "the television doesn't substitute for a face to face encounter because medicine is still an art;" "television doesn't subsitute for good medical history and the CHM should be doing that," "if CHM needs help he can call on the phone;" "skin problems couldn't be diagnosed on TV in two cases;" the physical therapist could not diagnose a problem on TV because he needed patient in the hospital to be able to study the case more carefully and finally some providers mentioned "equipment failure in early stages of STARPAHC as being a problem" or as one provider put it, "I can not pinpoint why I say TV doesn't give enough information but I know it is so after six months."

When providers were asked if the use of teleconsultation was considered critical, 17 interviews out of the 65 where the question was asked reported a critical case at some point during the providers experience. Some of the 17 were reports by one person in different interviews or by two people about the same case. Four physicians users, two physicians non-users, three CHM's reported such critical cases as the following:

a. Case of a heart failure diagnosis over STARPAHC equipment.
b. Case of a dehydration in an infant.
c. Case of a broken bone.
d. An appendix attack seen over TV not diagnosed by CHM but picked up by the MD.
e. A laceration.
f. Dispatching an ambulance into the field.
g. To get medical records.
h. To help a child with high fever.
i. A case of snake bite.

In all of the above cases cited by providers, the patients were transferred to Sells, and most reported by the CHM and/or MD, could have been handled by voice.

Only two persons, both physicians, said they felt that teleconsultation was harmful but not directly to the patients. They felt that such consultations, in general, took time away from other patients and that in so doing were harmful.

Nine providers felt that in their opinion the telemedicine resulted in some negative effects. Nineteen interviews out of the 65 completing this question reported such negative effects. In the last interview half of those interviewed stated yes there are negative effects from telemedicine. And this included four of the eight MD's users interviewed. The major negative effects mentioned were time lost by physicians when CHM has to set up equipment during consultation, leaving patients in the exam room while having to go to the special teleconsultation room, increased patient waiting while physician teleconsults time lost from equipment malfunctions and being forced to use equipment at one point early in STARPAHC by HEW direction, when it was not indicated medically.

All physicians who have used STARPAHC, except two, said the teleconsultation has resulted in change of treatment plans either by requiring additional laboratory tests, changing of drug therapy, or requiring additional referrals.

Only one physician claims to have changed the way he treats patients as a result of STARPAHC. More specifically, this change is in the way he relates to the CHM, in that STARPAHC has given him more confidence in the CHM's ability to deal with patients and consequently gives the CHM more credibility and authority. The CHM and Physician Therapist also claim that the STARPAHC equipment forces changes in the way they treat patients. The therapist says he must be more precise than in face to face enounters. The CHM relies more on MD and can show area of problem of MD over TV.

The major educational value seen as a result of STARPAHC was for the CHM in the field. Both the physician and CHM felt that STARPAHC was useful in helping to learn about difficult cases as they come up. The potential value for education of physicians and community was also mentioned by several respondents.

In the November, 1975 interview, after STARPAHC had been operational several months, a question was added concerning the value of television as opposed to voice communication alone. In the three sets of interviews with this question five physicians, one CHM, and the Pharmacist said they had had no consultation where voice communication alone couldn't have solved the problem The other seven (7) physicians users at Sells said the television was important in helping to make a diagnosis, especially for those cases involving dermatological problems, lacerations, reading of x-rays, eye problems, the one appendix case where the physician could see patient reaction to pain, and the snake bite case where the MD directed tourniquet application and the physical therapist needed TV to see patients doing therapy.

The IHS was also interested in finding out from the providers what priority they would place on various parts of STARPAHC. Although it is too early to make any final statement at this time the evaluators have attempted to stimulate the providers to think about this question. It was interesting to note that almost all the professional staff ranked Data(computerized health records) first, voice communications second, and the MHU (Mobile Unit) third as the three most important features of STARPAHC in all surveys where the question was asked. Only one physician felt no STARPAHC equipment was needed. The general consensus was that data, voice and the MHU were important components to continue. Other components which followed in order of priority were TV from the field in color, then black and white TV from the field, and finally all equipment. TV to the field was not felt to be important and ranked very low.

It will be interesting to follow the patient's opinion on this last, i.e., do they feel that seeing the physician on the TV while being examined is

important? The providers do not see this as a high priority capability, as only three (3) people (one MD, and one CHM and the physician therapist and two CHM's were the individuals reporting a need to see motion, reflect, pain expressions, etc.

Effects of STARPAHC

Providers were asked whether, as an effect of STARPAHC, the following areas would be increased, decreased or not changed. The trends as shown in Table 2-34 have held up over the two year period without major changes.

Benefits and Problems

Starting with the July 1975 set of interviews, an open ended request was made of all respondents to "describe both the major benefits and the major problems of STARPAHC."

The major benefit stressed by all users was that people who did not have access to medical care before STARPAHC and its mobile unit now can get good quality care close to home. Physicians and other users felt that the mobile unit having good CHM staff and voice communication to the hospital was the major asset of STARPAHC. Many providers liked the idea that patient travel could be cut down, that follow-up was more easily done, that people came for care at an early stage of illness and that better patient records were available to field personnel. Some providers felt STARPAHC helped cut down patient loads at Sells Hospital and that patient compliance with orders was improved thru better follow-up. All the physicians and the CHM's felt that the major benefit to provider was to the CHM's whose confidence was improved through knowing that consultation by a physician was close at hand.

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Some of the problems mentioned have already been reported under negative effects of STARPAHC but were repeated in this open-ended question. Most providers reported two or three problems in each interview. The major problem physicians users identified were: "they felt STARPAHC was too expensive," "took too much of their time," and "was overly sophisticated for the population' needs." Several (3) physicians pointed out "that TV could not replace the art

Table 2-34 Trends of Providers Attitudes Concerning Effects of STARPAHC on the Following Areas

		Increase	No Change	Decrease	Don't Know
a)	Cost of medical care	x			
b)	Total work for you	x			
c)	Number of patients seen	x			
d)	Availability of charts	x			
e)	Quality of medical care	x			
f)	Length of hospital stay		x		
g)	Number of hospital admissions		x		
h)	Patient time at clinic		x		
i)	Ease in reaching physician from field	x			
j)	Ease in reaching a physician in Phoenix				x
k)	Physician time per day		x		
l)	Physician travel		x		
m)	Patient/Physician bond		x		
n)	Consultation in general	no trend			
o)	Allied personnel involvement in patient care	x			
p)	Assurance to patients	x			
q)	Communication with administration		x		
r)	Convenience to you	no trend			
s)	Responsibility for you	x			
t)	Scheduled interruption	x			
u)	Waiting lines for use of STARPAHC		x		
v)	Patient apprehensiveness		x		
w)	Patient travel time			x	

NOTE: Trend is defined as having more than 50 percent of respondents in this category in all those (3) sets of interviews.

of medicine or the M.D.-CHM-patient relationship." Some physicians (4) felt "that a major problem existed when they were forced to use the TV even when it was not medically necessary, but required for test purposes." Eight (8) providers (CHM's, physicians and a physical therapist) reported problems with "equipment failure" and "with the ability of the television equipment to give an adequate picture with good color balance and resolution for diagnostic purposes." All physicians and other providers reported that "the length of time it required to set up a consultation" and "physicians having to leave patients in the hospital OPD exam rooms to go to the TV console" were problems. A few physicians (3) felt "a problem with evaluating STARPAHC was that the population was too small on the part of the Papago reservation where STARPAHC was put to make the system cost effective and didn't permit enough use of all equipment since there were not that many serious medical problems to give it a fair test." Half of the physicians (6) felt left out of STARPAHC planning and therefore didn't feel part of the system. Even though most of these physicians came after STARPAHC was operational and planning was done by the previous physicians on duty at the time. It was viewed "as something being imposed from above" and several felt "training was not adequate". One physician felt a major problem was "STARPAHC didn't fit into medical practice of today because it was not available 24 hours a day and it disrupted the routine of practice."

What Should be Evaluated?

The providers' opinion were sought on what areas are important to evaluate as a result of STARPAHC. It was found that "quality of care" always ranked first, that being the only constant area identified in all five set of interviews. "Cost" ranked second in the last three (3) sets of interviews, while "use of care" was ranked third. "Time saved by professional" was ranked fourth. Other opinions on this varied with each set of interviews so that it is difficult to make any statement concerning this question other than to point out that different providers have differing opinions about what areas need to be evaluated first. Some providers tend to be more concerned with professional convenience, other with patient acceptance and convenience. The major areas of agreement

were that "quality of care" and "cost" should be given high priority in evaluations in order to see what effect STARPAHC has had on these two important areas of medical care.

Only one physician was apprehensive about using television and other STARPAHC equipment while eleven said they were either neutral or enthusiastic.

When asked if providers felt STARPAHC would be successful or not, over the five interviews (89 total) there were 48 yes, 15 nos and 26 didn't know. Thirteen of the "no" answers were by physicians, the other two by other providers. Seven physicians users out of 12 felt at one point during the two years that "STARPAHC would not be successful". Two physicians went from negative to positive in their last interview both saying "that the improved access some Papago patient will get to medical care will make STARPAHC a success". Two other physicians changed a positive and a negative attitude to a don't know in their last interview. There were only two physicians who were negative throughout and only one physician interviewed in the first two interviews who was positive in both cases. Most physicians changed attitudes throughout the two year period. Most other providers felt STARPAHC would be successful because the Papago people would like and use it and "because it provides health care to a population not having care available previously."

Summary and Conclusions

Although this study represents responses from only 47 providers including 21 physicians (12 physician users) and many of those physicians associated with the project in the early stages have left, there is evidence the concerns of providers in STARPAHC are similar to those reported by others associated with telemedicine. (Conrath, et al 1974; Bashshur et al, 1975; and Sanders et al 1975). Equipment reliability and time involved in television consultations are most often cited as problems from the provider's point of view. STARPAHC reliability, however, was exceptionally high due to the redundant nature of the telecommunication network.

Based on the five sets of interviews with 47 providers the following major benefits and attitudes that are considered representative are:

- o Providing of health care to a po ·lation not previously receiving such care is highly beneficial.
- o Voice, data, and the MHU provides a high quality and much needed service.
- o Training in the use of telecommunication equipment is important not only in the early stage but through its operational lifetime.
- o Providers should feel part of the system, and be involved in planning and making contributions to the organization of such projects.
- o The physician users were equally divided whether teleconsultations could substitute for face to face encounters.
- o Physicians/CHMs reported critical cases where teleconsultations helped.
- o Major negative effects reported by 19 interviewers out of 65 were; time lost by physician in teleconsultations where CHM would have to adjust or modify the equipment setup, and leaving their hospital patients while having to go to the special teleconsultation room.

Management problems of a service unit or problems in dealing with patients can be translated into frustration and negative attitudes about all aspects of medical care in a service unit. Some of the problems physicians have identified may not be due to STARPAHC equipment per se, but to the way STARPAHC activities are organized at this service unit.

Patient Acceptance. The Papago Executive Health Staff visited the MHU at different villages and interviewed patients to determine the level of acceptance of the health care services provided to the patients of the Papago tribe. This section is limited to a study of those patients who had used the MHU, and included their opinions about the use of telecommunications in place of a personnel consultation with a physician and traveling to/from Sells Hospital.

The Papago Executive Health Staff implemented this study. The questionnaire was designed by Papago health staff members with consultation from staff of the Office of Development (L. Berg), and from a consultant in behavioral studies who investigated the attitudes of health providers reported in the prior section.

Interviewers were members of the Papago health team. Interviews were conducted in either English or Papago language during the last month of the two year evaluation period, April 1977.

The interviews were held at the four scheduled stops for the mobile health unit : the Pisinemo, GuVo, Hickiwan, and Kaka communities). Due to the short time the mobile unit was at each unit (about 6 hours), only a small portion of patients were interviewed each day. No persons refused interviews.

31 interviews were completed during six days, April 13th through the 21st. 107 patient encounters occurred during this period and 28.9% were interviewed. The interview rate varied from 20 to 39% by the stop for the mobile unit. These results are shown in Table 2-35.

11 males and 19 females were interviewed. The age of these patients ranged from 10 to 58 years. The mean age was 40.4 years for males, 32.8 years for the females, and 35.7 years for the total group.

The majority (93.3%) said they liked the service provided, the attitude of the mobile unit staff (100%), and they felt that their questions about their health had been clearly answered (76.6%), and that all other questions had been clearly answered (75%). These responses did not vary greatly by the site of their visits.

Other group responses with little variance by site were that most felt they had waited a short time (30 minutes or less, 61.3%); Most felt that the mobile unit had not been late (74.1%), and that most would prefer to visit the health service at the site of the interview (63.3%) rather than go to either the Sells outpatient department or the Santa Rosa health center.

Table 2-35 Interviews with Patients Using the Mobile Unit by Site, Age and Sex and Percent of Total Visits - April 1977

Community and Site of Clinic	No. of Days	Number of Patients	Number of Interviews	Percent Interviewed
1. Hickiwan	2	32	11	34.4%
2. Kaka	2	23	9	39.1%
3. Pisinemo	1	24	5	20.8%
4. GuVo	1	28	6	21.4%
TOTALS	6	107	31	28.97%

Hickiwan was the location where the largest portion of patients had 10 or more visits to the unit prior to the interview (63.6%), but this greater experience did not relate to any variance of response to questions when compared with the patients at the other sites. These results are tabulated by site in Table 2-36. However, the responses to one question had no majority viewpoint. When asked about the time they had spent receiving services plus the time from leaving their home until returning, only 30% thought this was a "short" interval, 33% thought a "moderate" interval, and 37% a "long" time. This was especially true for those patients from PiaOik that were seen at GuVo, 15 minutes from their home.

Of the total group, only 8 persons (27.6%) said that any of the special telemedicine equipment had been used during their visits. Proportionately more patients had experienced telemedicine at Hickiwan (36.4%) and Kaka (33.3%). than at the other two sites. Seven had experienced a video consultation and one had an roentenogram transmitted.

Most of these seven persons felt that it was important to be able to see themselves on the television monitor as well as to see the image of the consultant from the primary care hospital at Sells. However, all six persons who had experienced a remote consultation and responded, thought it would have been better to have seen the physician consultant in person than via the television. These responses are tabulated in Tables 2-37.

It was thought that certain cross tabulations of questionnaire responses might add to the understanding of patient's attitudes. However, because of the small numbers involved and the lack of variance to certain key questions, generally trying to couple questions as listed below showed no correlations.

1. Would the patient's attitude toward health services in general, the mobile unit staff in particular, the time spent waiting for services; and the time spent away from home vary with the number of visits?
2. Would the patient's attitude about services received vary with their perception of waiting for service?

Table 2-36

Distribution of Responses by Patients to

Questions About Telemedicine

Questions	Sites of Mobile Health Unit Service — No. of Responses				Total Patients Interviewed*	Percent Answering
	Hickiwan	KaKa	GuVo	Pisinemo		
1. Did you like the service?						
Yes	11	8	5	4	28	93.3
No	0	1	1	0	2	6.7
No Response	0	0	0	1	1	-
2. Were you asked if you had any questions?						
Yes	4	5	5	4	18	58.1
No	7	4	1	1	13	41.9
No Response	0	0	0	0	0	-
3. Were your questions clearly answered?						
Yes	5	6	4	3	18	75.0
No	3	2	1	0	6	25.0
No Response	3	1	1	2	7	-
4. If you were given two chances, would you have rather gone to Pisinsoma, Santa Rosa Clinic, Sells, or MHU?						
Pisinemo	0	0	1	0	1	3.2
Santa Rosa	1	2	0	0	3	10.0
Sells Hospital	2	2	2	1	7	23.3
Mobile Health Unit	8	5	2	4	19	63.5
No Response	0	0	1	0	1	
5. How much time was spent at the MHU? Short Time	6	7	2	4	19	61.2
Medium Time	2	2	2	0	6	19.4
Long Time	3	0	1	1	6	19.4

Table 2-36 (continued)

Questions	Sites of Mobile Health Unit Service — No. of Responses: Hickiwan	KaKa	GuVo	Pisinemo	Total Patients Interviewed*	Percent Answering
6. How many times have you used the MHU?						
First Time	0	2	2	0	4	12.9
2 to 5 Visits	3	1	1	3	8	28.5
5 to 10 Visits	1	3	0	1	5	16.1
10 or more Visits	7	3	3	1	14	45.2
7. How long did it take you to get seen, and get back home?						
Short Time	4	3	1	1	9	30.0
Medium Time	3	2	2	3	10	33.3
Long Time	3	4	3	1	11	36.7
No Responses	1	-	-	-	1	-
8. Was the MHU ever late, where you had to wait?						
Yes	2	4	1	0	7	25.9
No	8	4	4	4	20	74.1
No Response	1	1	1	1	4	-
9. What was the attitude of the MHU staff towards you?						
Fine	11	8	6	5	30	100.0
Better	-	-	-	-	-	-
Terrible	-	-	-	-	-	-
No Response	-	-	-	-	-	--
10. Do you feel that your medical problem was explained well enough to you?						
Yes	8	4	6	5	23	76.6
No	3	4	-	-	7	23.4
No Response	-	1	-	-	1	-

*31 patients were interviewed on Questions 1 through 10.

Table 2-37

Distribution of Responses by Patients to Questions About Telemedicine

*31 Patients were interviewed on Question 1.
8 Patients were interviewed on Questions 2 through 4.

QUESTIONS	Sites of Mobile Health Unit Service — No. of Responses: Hickiwan	KaKa	GuVo	Pisinemo	Total Patients Interviewed*	Percent Answering
1. Was any of the special equipment used on you?						
Yes	4	3	1	-	8	27.6
TV	(4)	(2)	(1)		(7)	
X-Ray	-	(1)	-		(1)	
Other	-	-	-		-	
No	7	6	4	4	21	72.4
No Response	-	-	1	1	2	-
2. When you were on TV did you think it important to see the Sells physician or medical administrator on the screen in the MHU?						
Yes	3	1	1	-	5	71.5
No	1	1	-	-	2	28.5
No Response	-	1	-	-	1	
3. When you were on TV did you think it important to see yourself on the screen in the MHU?						
Yes	4	-	1	-	5	71.5
No	-	2	-	-	2	28.5
No Response	-	1	-	-	1	
4. Even if you had to go to the Sells Hospital would you have preferred to see the physician face to face rather than by using TV?						
Yes	3	2	-	-	5	100.0
No	-	-	-	-	0	
No Response	1	1	1	-	3	

3. Would the patient's attitude toward services received vary with their perception of the health provider's attitude toward them?
4. Would those patients who received teleconsultations feel that their health problems had been more clearly explained then those who had not?

Generally, the 31 patients interviewed at the end of the second year of operation were as positive in their responses as the 18 persons queried at the end of the first year. Health services rendered by a Community Health Medic in a mobile clinic are thought to be acceptable and valued. Remote consultation with a physician via television cannot substitute for a direct consultation, but two-way television is preferred.

It is planned for IHS to continue further interviews with patients using the mobile clinic, as well as other sites where service is rendered. Further analysis will either confirm or redirect the trends observed in this preliminary study.

Engineering Technicians Performance. One of the objectives for evaluation of STARPAHC is to test the validity and feasibility of maintaining and operating a complex system in a rugged desert environment. Test results are in the form of maintenance and operators' performance, their ability to keep the system on-line, quick-turnaround on repair, adoptation and flexibility to incorporate design modifications, and incorporation of new equipment.

Four LMSC site personnel, supported by an IHS technician operated and maintained the system during the two years of operation. Maintenance was performed by a maintenance technician knowledgeable in electronics/mechanics and specialized skills such as diesel generators, welding etc. He was supported by the site manager and either of the two system operators. Maintenance of the computer hardware was accomplished by the system operator supported by a NASA furnished maintenance contract with Varian. Software and terminal maintenance was fully supported by the trained system operator. A complete set of calibration equipment was provided at the site which permitted routine calibration and communication equipment alignment.

Services beyond the capabilities of the site personnel were; engine overhaul, microwave communication module repair and repair of some terminal and computer failures. For those specific repairs, the equipment was either sent to a qualified specialist or the vendor field representative would visit the site.

System operation of the console was the sole responsibility of one operator. The operator spoke the native language which was a definite asset in his assignment. The system operator was supported during timeout, vacations, etc by another system operator whose prime duty was operating the computer system. The site manager also supported console operation when needed.

Proficiency checks were carried out by the site manager by inspecting repairs, keeping a system log on daily events, and reviewing daily the maintenance logs and the system operator log.

Assessment of site personnel performance was made by frequent site visits of management and technical personnel from NASA/IHS/LMSC. Six month oral briefings were held at IHS-ORD (San Xavier) during which performance and results of the operation were reviewed with the site manager and a site inspection visit was carried out.

The first months of operation were truly an operational "shakedown" period during which equipment, personnel, and procedure problems were experienced. During the fifth and sixth months, personnel and equipment performance improved and became somewhat stabilized. The second, third and fourth 6-month evaluation periods continued fairly well stabilized with minimal effect upon operations caused by equipment failures, performance anomalies, and personnel changes. During these latter periods constructive improvements in hardware and operational procedures were implemented to reduce maintenance requirements, improve performance, and increase reliability.

Interface with th two government agencies (NASA and IHS) with the Papago Executive Health Staff, and with the residents of the Papago reservation were accomplished as needed.

2.4.7 Logistics (See Table 2-38 for summary of utilization of expendables). Logistic support was primarily provided by site personnel supported when needed by Lockheed Sunnyvale or other vendors. Inventory control was computerized Spare lists were kept on-site. Day-to-day logistics supplies were purchased locally wherever possible, e.g. diesel fuel for generators, oil/gas for the MHU.

The Logistics subsystem consist of three elements: (1) maintenance, (2) spares, and (3) calibration. These three elements were operated, monitored and controlled by the implementation of the STARPAHC Logistic Plan and Operational Support Plan. These provided the plan for maintenance, supply and inventory management and calibration. Additionally, they recognized the areas of responsibility for NASA, IHS and LMSC and aided in the successful coordinated logistics effort.

Maintenance. Maintenance was divided into two categories, which were preventive and corrective. Maintenance was performed per task assignment in which certain areas of responsibility were placed with individuals according to skill, experience and familiarity. These assignments were by individual equipment levels and covered both operation and maintenance. The level of maintenance performed also determined the individual responsible for certain equipment types.

Preventative.

Preventative (first-echelon) maintenance (PM) was accomplished on designated equipment by the system operator and maintenance technician. A set of preventative maintenance instructions (PMI) were written and followed on all applicable equipment and included facility and mobile equipment. Examples of these were:

Table 2-38

GENERAL EQUIPMENT USAGE

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
Primary			
[illegible]	28.2 gal/hr	439.2 gal	[illegible]
[illegible]	Change - 3 qt/2 hr Consumption - 0	19.0 qt 6.3 qt	45.3 qt
[illegible]	1 qt/hr	9.2 qt	
[illegible]	2/3 hr	4 filters	
[illegible]	2/hr	12 filters	
Secondary			
[illegible]	1 gal/hr	24 gal	[illegible]
[illegible]	Change - 4 qt/6 hr Consumption - 0	3 qt 0 qt	3 qt
[illegible]	1 qt/hr	12 qt	
[illegible]	2/6 hr	2	
[illegible]	2/6 hr	2	

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
Potable Water	40 gal/hr	1020 gal	[illegible]
Waste Water	20 gal/hr	510 gal	
Toilet Water	20 gal/hr	510 gal	[illegible]
Wash/Shower Water	35 gal/hr	897.5 gal	
Shower Chemicals			[illegible]
Urine	10,000 hr (hour) 17-20,000 hr (hour)		[illegible]
Gas Consumption	4 hr/gal	1225 gal	[illegible]
Gas Generator (Gas.)	0.5 gal/hr per 10 hr/day	830 gal	
Propane Generator	4.0 gal/hr for 3 hr/day	3060 gal	
Recovery Water (RWS)	1/2 gal/hr	- gal	
Recovery Water (Primary Gen.)	Urine + cooled vent		
Air Conditioner	3 hr/day - 4 days/wk 8 hr/day - 2 days/wk	530 hr 430 hr	960 hr
Oil (Potable Eng.)	Air Breather - 1 qt/hr Oil Change - (26.0 gal) 20 qt - 3 times Oil Consumption - 1 qt/hr	42 qt	
Gas Generator (VRS)	Oil Change - 3 hr/6 qt Consumption - 0.75 qt/hr	30.3 qt	
Primary Generator (VRS)	Oil Change - 6 hr/6 qt Consumption - 1 qt/3 hr	35 qt	
Spark Plugs (VRS)	0/3,000 hr	12 plugs	
Spark Plugs (Primary Gen.)	Once/3 hr (6) plugs	12 plugs	
Spark Plugs (APU)	Once/3 hr (2) plugs	17 plugs	
Propane (VRS)	1 can/3000 hr	2 cans	
Propane (APU)	1 can/hr	6 cans	
Propane (Primary Gen.)	1 can/3 hr	2 cans	

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
Oil Filter (VRS)	1/3,000 hr (3 times)	3 filters	
Oil Filter (APU)	1/3 hr	8.0 filters	
Oil Filter (Primary Gen.)	1/6 hr	4.3 filters	
Air Filter (APU)	1/3 hr	8.0 filters	
Transmission Oil/Brake Fluid	5 qt	5 qt	Transmission oil cooler installed (APU) antifreeze
Antifreeze	7 gal Plus	7 gal + 24 qt	One container flush
Chassis Lubrication	4 hr/180s	12 Hr	Lube period 2 hr
Carburetor Cleaner	1/2 can/hr	3 cans	One 12-oz can lasts 2 hr
Engine Degreaser	2 cans hr	12 cans	16-oz cans
Toilet Paper Chemical.	-	-	[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
CPU	4320	24	
[illegible]	2042	11	[illegible]
Memory Disk	2042	11	[illegible]
Mag Tape Unit	300	2	
Card Reader	1200	10	
Line Printer	300	2	
Card Punch	300	2	
Data Comment Terminals	1250	9	
VRS Terminals	800	6	
TTY	1300	10	

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	1/2-qt/20 hr	0-qt estimated	Generator to standby 1130-hr total
Water	None		
Air Filter	1/0 hr		
Propane	3-gal for [illegible] only	qt	Emergency estimate .0 30 gal for 0 hr

	[illegible]	[illegible]
[illegible]	3 hr/hr estimated	.0 hr
300 Generator		
Primary	342 hr/hr	2052 hr
Standby	12 hr/hr	72 hr
VRS Generator		
Primary	173 hr/hr	1038 hr
APU	350 hr/hr	2100 hr

the MHU engine, chassis and drive train, power and distribution at the QRS and on the MHU and water/waste systems on the MHU. The results, materials used and comments were recorded and maintained in the Preventative Maintenance Report (PMR) by facility. A PM schedule was established by facility and equipment type and coordinated with available personnel. Emphasis was placed on scheduling PMs on equipment so as to reduce travel mileage and time and prevent less important PM from interfering on important PMs. Preventative maintenance on the MHU was scheduled to occur on Friday and Saturday, therefore other maintenance was scheduled on Monday through Thursday.

Corrective.

Corrective maintenance (CM) was performed upon observation of failure, degradation or other anomaly other than minor adjustment or alignment performed during PM's. The logic diagram of Figure 2-11 was used as a very helpful guide in yes/no step to accomplish expedient repairs, replacement or adjustments. When a failure or malfunction was discovered a first line decision was made as to inplace correction of; removal, replace or repair.

Site resources for corrections were assessed as well as skills, outside vs in-house cost of repair, warranty repair or replacement and time involved for subsystem or element restoration. These factors were carefully weighed and appropriate action initiated. Very good repair and turn around was experienced for most of the vendor/manufacture repair. This included the video RF transmission equipment MUX video, TV camera, electronic generating sets, MHU chassis and running gear and VHF radios. Approximately 90 percent of the corrective maintenance was accomplished by site personnel with the remainder performed by outside services, mostly under warranty repair. Most of the non warranty repair that was accomplished by a vendor was due to the fact that a test set was involved and/or the vendor personnel possessed infinitely more familiarity with the component than site personnel.

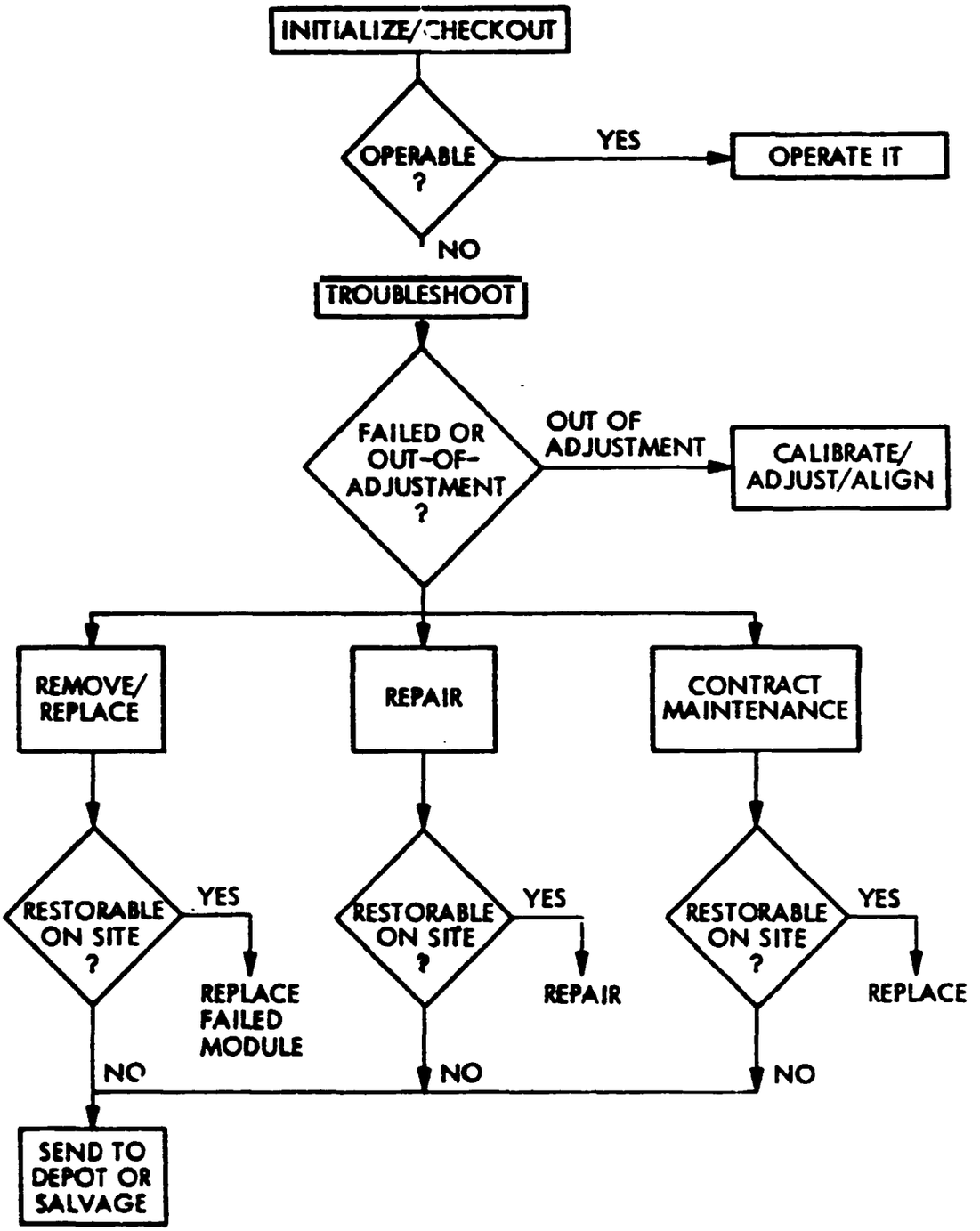


Figure 2-11 Logic Diagram - Maintenance, Calibration, and Repair

Spares. The spares element was comprised of spares control, supply property management and fuel services.

Spares control.

Early in the STARPAHC deployment a critical flow analysis was performed to determine equipments, line replacement units (LRU) and components that if failed would cause the loss of a capability (TCE) or subsystem element. From this analysis a spares list was prepared and those identified parts and equipment were procured and maintained as site spares. Parts were analyzed for cost, delivery lead times, etc. Those necessary to minimize service interruptions and within cost constraints were selected.

A spares list was maintained at the spares location which listed each spare items by nomenclature, part number, manufacture, sparing level, on hand and on order. A monthly inventory was made of the list vs the actual spares for monitoring and ordering purposes. Additionally upon exhaustion or estimated depletion of a spare item the card was entered into the short file and immediate reordering was initiated. Priorities were placed on all spare, critical, consumable or other. These priorities were ranked in categories such as the highest, "Critical operational item, immediate reorder after spares expended", lower category "long lead item in excess of 60 days", to "Available in Tucson Area", to the lowest, "Manufacturing residual - do not reorder".

Consumables that were not of critical nature were inventorized on each month and reordered. Most of these were obtained locally or in Tucson.

Supply and Property Management.

Magnetic tape, video tape, computer paper and other supplies were ordered on a "as-needed" basis by monitoring the level and initiating proper action.

Property management was monitored and controlled by the property inventory listing. This listing identified all major equipment by name, manufacture, serial and model number and the NASA property tag serial number. Each six

months the complete STARPAHC system was inventorized by a property accounting specialist and a report prepared. (See Appendix C).

Scraped or surplused parts were controlled through the property accountant in order that proper records were maintained.

Fuel Services.

Fuel was required for all of the facilities on the Papago reservation. Liquid Petroleum Gas (LPG) was required for the LHSC and for the QRS prior to the 2nd diesel installation. Diesel was required for the QRS after the first diesel set and for HSSCC during the period prior to the UPS installation. Gasoline was required for the MHU and its electric generating sets.

The LPG for the QRS was obtained from local sources in Sells, Arizona and was replenished on a 12 to 14 day basis during the time the LPG was a prime fuel source. Replenishment was on an as-needed basis after the diesel was installed. LPG level for the LHSC was monitored periodically and the IHS notified when low. Diesel for the QRS was replenished on a 30 to 35 day rate with bulk storage at the HSSCC. Fuel was supplied directly from the bulk storage for the HSSCC/computer generator. The bulk storage contained was monitored for level periodically.

Arrangements for the MHU gasoline supply was made through the Sells GSA sub-motor pool. Additionally fuel was required during the week, when the return to Sells was not practical, and services were made available at Trading posts for supply.

Calibration. Calibration and a calibration status report was maintained on the STARPAHC test equipment. Calibration of the test equipment was performed by a Secondary Standards Lab located first in Phoenix and then Tucson to a frequency established by specification and type. Equipment contained in consoles or racks were routinely calibrated using the test equipment thereby ma taining an overall system calibration standard. See Appendix C (Location HG) for list of calibration equipment. Instruments were calibrated every 6 months.

Section 3
DEMONSTRATION COSTS SUMMARY

Cost considerations as evaluating factors must be viewed in the context of the program's principal goal - "to evaluate the value and potential of telemedicine using CHMs for quality health care delivery to people in a remote area." Offering physicians excessive monetary rewards has not been a workable or permanent solution (although in isolated cases it may have been an acceptable temporary stopgap measure). Therefore, when cost is being used as a decision and/or evaluation factor, it must be considered relative to the value and need for a solution to the problem of remote-area health care delivery, and in the context of STARPAHC being essentially a research and development and not a "production" effort.

To provide objective, accurate cost data, STARPAHC conducted a continuous, thorough cost analysis, considering both the recurring and nonrecurring costs for the system and each of its major elements and functions. Existing data reveal that the "cost per outpatient visit" figures are most meaningful and do equate favorably with costs for outpatient visits in comparable facilities without telemedicine capability. Projected IHS costs for the next operational period show a reduction in the cost per outpatient visit (OPV). This will be accomplished by simplifying the data system and a reduction in the number of operational personnel.

Demonstration costs for this, first of a kind, program are provided as reference information to future telemedicine system planners. It is expected this data will be of value to planners when analyzing the most cost effective system details for their respective areas. It is recommended that this data be used in conjunction with the information presented in Section 4, exportability, and appropriate interpolations and extrapolations from prior

sections of this report that indicate potential problem areas. After stringent priortizing of requirements, the planner should carefully screen and select components and determine likely operating procedures, all with some respect to cost - but cost itself should not necessarily be the sole determining factor.

3.1 PROJECT STARPAHC COSTS

Two government agencies (NASA/IHS) and through the primary contractor to NASA, Lockheed Missiles and Space Co., Inc. (LMSC) provided time and material to the project. STARPAHC costs include the acquisition, maintenance and operation of systems and equipment by LMSC. Also included are the costs to the Indian Health Service of providing primary medical services and support at the Mobile Health Unit and the Santa Rosa Center Site and the cost of providing secondary/tertiary telemedicine services at the Sells Hospital and the Phoenix Referral Center (PRC). Minor direct support costs of NASA are covered. Specifically excluded from this cost analysis are the costs and funding of project planning, development, management and evaluation as borne by NASA, IHS, and LMSC, Sunnyvale. However, evaluation funding needed for LMSC site personnel participation are included.

Also excluded from this cost analysis are equipment costs whose functions were discontinued by NASA prior to the close of the two year demonstration period. These include:

Total Recurring Cost	$ 74,000
Total Nonrecurring Equipment Cost*	272,014
Total Recurring and Nonrecurring Cost	$332,014

*Replacement of the Varian 73 computer and its peripherals with the Time Division Multiplexer units when the HIS computer and the data base moved to Alburquerque accounted for $217,025 of the nonrecurring cost of $272,014.

This presentation of STARPAHC costs includes:

Recurring Costs: for operations and maintenance, including labor, parts, expendables, subcontracts, utilities, and transportation.

Nonrecurring Costs: for (a) capital equipment, and (b) design, engineering, labor, consumables, and installation and checkout costs.

Unit Costs: for outpatient visits and per hour of operation.

The period covered is May 1975 through April 1977.

3.2 RECURRING COSTS OF PROJECT STARPAHC OPERATIONS AND MAINTENANCE

The recurring operations and maintenance costs of the agencies involved in Project STARPAHC are described as follows. See Figure 3-1 for cost distribution by agency.

Indian Health Service's costs include medical support and consultation for the STARPAHC system, medical operation of a fixed base and mobile clinic, health records, pharmacy, lab, X-ray services, transportation, maintenance of buildings and grounds, and related field administration. Nine full time persons were employed, six at the fixed base clinic and three on the Mobile Health Unit. Costs are nominal for physicians and support personnel assigned part-time to STARPAHC functions at the Sells Hospital and the Phoenix Referral Center.

Lockheed site costs cover field operations and maintenance of the STARPAHC telecommunication systems and hardware including the central control point at Sells, the Relay Station, the Mobile Unit, the fixed site facility at Santa Rosa, and the Phoenix Indian Hospital referral site. At Sells, Arizona, three full time employees were responsible for day to day operations and maintenance. Support for the evaluation is included. This support consisted of data inputs into the computers.

Lockheed costs at Sunnyvale cover engineering support required to resolve field operational problems. Key personnel were assigned as needed for field support.

RECURRING TWO-YEAR COST OF OPERATION AND MAINTENANCE

	Inflationary Increase During Periods	IHS	LMSC		NASA	Total
			Site	SV		
First 6 Months $	-	112,688	41,188	35,662	6,900	196,438
Second 6 Months $	9.8K	116,645	44,736	32,626	6,900	200,907
Third 6 Months $	10.0K	120,652	55,635	35,993	6,900	219,180
Fourth 6 Months $	10.9K	121,049	57,465	33,484	6,900	218,898
Total $	-	471,034	199,024	137,765	27,600	835,423

NONRECURRING TWO-YEAR COST OF ACQUIRING STARPAHC SYSTEMS

	IHS	LMSC & NASA	Total
Installed Equipment	20,729	756,379	777,108
System Improvements	-	10,305	10,305
Design	-	191,000	191,000
Acceptance	-	95,000	95,000
Installation, Checkout, Training	-	93,968	93,968
Totals	20,729	1,146,652	1,167,381
Amortization 6 Month Rate	1,037	57,332	58,369

Figure 3-1 Recurring and Nonrecurring Two-Year Cost of Operation and Maintenance

NASA provided for the cost of vehicles furnished to Lockheed employees on the site.

Operations and maintenance costs were tracked monthly as incurred by each agency, (see Figure 3-2). Indian Health Service and Lockheed on site operations and maintenance (O&M) costs showed a gradual increase for materials and labor during the two year period. LMSC engineering support fluctuated with demand generated by equipment and support problems, showing a small increase in the second year. Also retroactive changes for rate adjustments, as allowed periodically by the government agency APRO, are reflected in increases especially in the third and fourth 6-month periods of approximately $17,000. In addition, cost increases do reflect the effect of an annual inflationary rise of approximately 10%.

3.3 NONRECURRING COSTS OF ACQUIRING PROJECT STARPAHC SYSTEMS

The nonrecurring costs incurred by the involved agencies in acquiring and installing Project STARPAHC systems and equipment are briefly described in the following paragraphs. See Figure 3-1 for cost distribution by agency for installed equipment system improvements, and development costs.

Indian Health Service (Department of Health, Education, and Welfare) costs include improvements to buildings and sites to house STARPAHC equipment and workspace for personnel.

Lockheed and NASA nonrecurring STARPAHC equipment costs include microwave two-way audio and video communications, VHF radio and telephone voice and data communications, and recording and playback equipment. A control center is provided at Sells Hospital with a Slow-Scan telephone link to the Phoenix Referral Center and VHF/Microwave links via a relay station to the Mobile Clinic and the Santa Rosa Clinic.

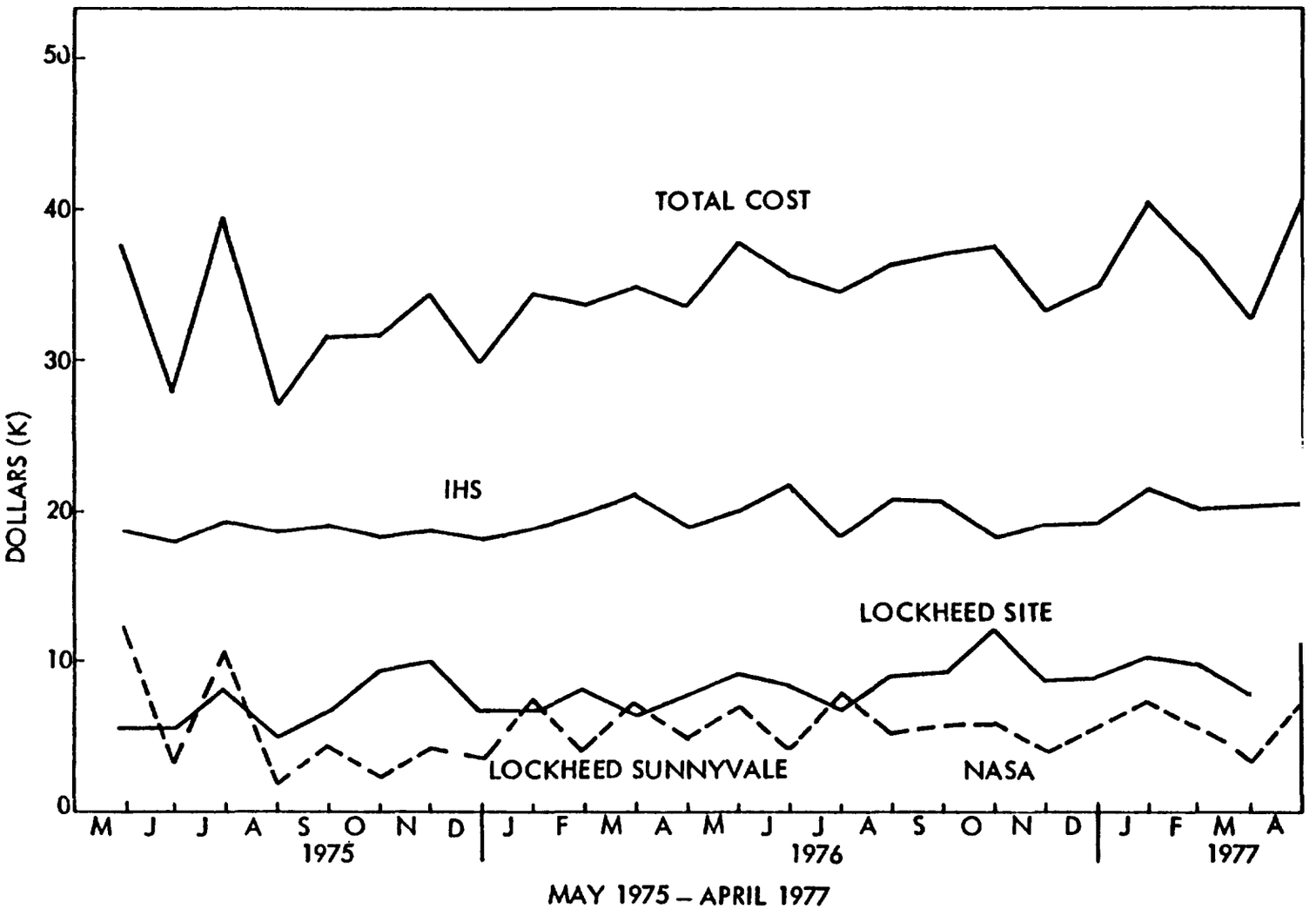


Figure 3-2 Recurring Cost of Operations & Maintenance Distributed by Agency/Month May 1975-April 1977

Excluded are management costs, mockups, site studies, and other non-specific project expenses.

Capital equipment costs and significant system improvements of the types described above are amortized over a ten-year period, without interest. Ten-year amortization has been chosen based on the anticipated life of major system equipments.

3.4 THE NATURE OF STARPAHC UNIT COST CONSIDERATIONS

In developing unit cost under Project STARPAHC, several options were studied. Two are commented upon below.

3.4.1 Cost Per STARPAHC Outpatient Visit (OPV)

This includes the cost of treating each outpatient visit, whether or not the telecommunications system was used for each outpatient. Outpatients involved are those at the Mobile Health Unit and the Santa Rosa Clinic. Fluctuations in the number of such patients' visits have a significant impact on such unit costs from period to period. It is noted that the cost per OPV, as a unit of measure, is flexible, allowing for comparisons between different kinds of facilities. See Section 3.5 for discussion of unit costs per OPV.

3.4.2 Cost Per Hour of Operation

An alternative method of analysis which may be of use to telecommunication planners would be cost per operating hour of the clinics. It is computed separately for each clinic because different hours of operation between the two clinics (20 hours weekly for the Mobile Health Unit and 40 hours weekly for Santa Rosa) make it impossible to develop a common unit cost. This is brought out in 3.5.3.

3.5 COST PER OUTPATIENT VISIT TO STARPAHC FACILITIES (See Table 3-1 and Figure 3-3)

This analysis relates the total number of outpatient visits at the mobile and Santa Rosa Clinics to the total cost of operating these clinics, including the cost of telecommunications and the telemedical referral and consultative services available at Sells and Phoenix, Arizona. Such costs are presented in two versions; the first is based on recurring operations and maintenance costs only and the second is based on a consolidation of recurring and amortized nonrecurring costs. Variations in unit costs are also shown for the mobile versus the fixed site clinic.

3.5.1 Recurring Operating and Maintenance Cost Per Outpatient Visit at STARPAHC Facilities - Summary

Project STARPAHC operations and maintenance includes the overall recurring costs of the government agencies involved (NASA, IHS) and Lockheed as shown in Table 3-1. Between the periods of May 1975 through April 1976 and May 1976 through April 1977, the fluctuations in cost per outpatient visit reflect variations in numbers of patients served and an uptrend in prices and costs. (See below.)

Based on two years operations	$49.69
First year period	48.44
Second year period	50.87

The cumulative two year cost per outpatient of $49.69 is compared with the FY1976 baseline cost per non-STARPAHC outpatient at the Sells Hospital (including patients serviced at the Santa Rosa Clinic) of $34.00 per outpatient visit.

The only telemedicine project with outpatients' costs on which any data is available for a very generalized comparison is the East Harlem Child Health Care Station/Mount Sinai Project*. The cost per patient visit of

*Medical Care, March 1977, Vol. XV, No. 3, "Cost Factors in Urban Telemedicine". Charlotte Muller, Ph.D., Carter L. Marshall, M.D., Melvin Krasner, Nicholas Cunningham, M.D., Edward Wallerstein, and Beatrice Thomstad.

TABLE 3-1

COST PER OUTPATIENT VISIT

	First Year	Second Year	Two Year Summary
Recurring Operations and Maintenance Costs - All Agencies			
Number of OPV's	8,203	8,611	16,814
Agency Cost			
IHS	$229,333	$241,701	$471,034
Lockheed Site	85,924	113,100	199,024
Lockheed Sunnyvale	68,288	69,477	137,765
NASA	13,800	13,800	27,600
Total Recurring Cost	$397,345	$438,078	$835,423
Recurring Cost Per OPV	$48.44	$50.87	$49.69
Recurring O & M Costs Plus Amortized Nonrecurring Costs			
Recurring O & M Cost	$397,345	$438,078	$835,423
Nonrecurring Cost - Amortized*			
IHS	$ 2,074	$ 2,074	$ 4,148
Lockheed & NASA	107,470	114,664	222,134
Total Nonrecurring Cost	$109,544	$116,738	$226,282
Total Cost	$506,889	$554,816	$1,061,705
Recurring & Nonrecurring			
Cost Per OPV	$61.79	$64.43	$63.14

*Equipment costs are amortized over ten year period based on estimated equipment life.

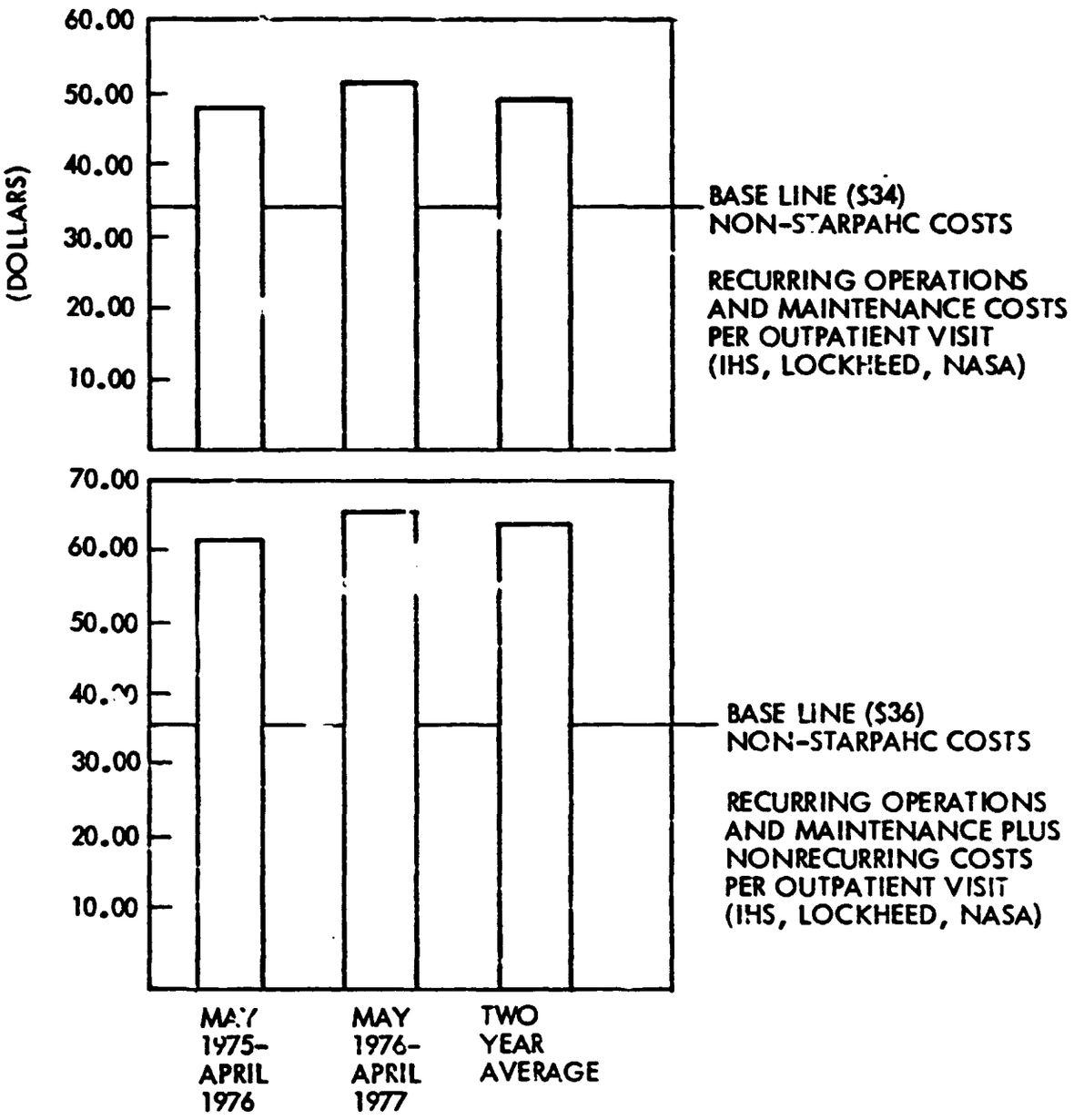


Figure 3-3 Cost per Outpatient Visit by Operating Year

$52 in 1973 and $43 in 1974 using cable TV includes communication, travel, and other costs that may not be directly comparable with similar appearing STARPAHC expenses due to the different mechanisms, nature, and location of the projects.

The STARPAHC and non-STARPAHC cost per OPV may be related to the reimbursement rates per outpatient visit based on the U.S. Government's cost recovery policy published in the Federal Register 29 June 1976 (Vol. 41, No. 126, Page 26767).

AGENCY	RATE PER OPV
DHEW	$25
Veterans Administration	39
Department of Defense	20

Field conditions in the very remote areas served by STARPAHC contribute greatly to the higher cost per patient. This applies to the MHU and the fixed site clinic.

3.5.2 Cost of Consolidated Recurring and Nonrecurring Costs Per Outpatient Visit at STARPAHC Facilities

The unit costs quoted below cover Project STARPAHC recurring operations and maintenance costs for all involved agencies (Section 3.1) and the nonrecurring capital costs of installed equipment, which, with related systems improvements, are amortized over ten years. The year to year increase per outpatient visit is due to an upward trend in costs of personnel, materials and the addition of system improvements to nonrecurring costs.

Based on two years operations	$63.14
First year operations	61.79
Second year operations	64.43

Baseline comparative costs for the Ellis and Santa Rosa outpatient clinics are $35 per OPV including amortization of the clinic facilities.

3.5.3 Comparison of STARPAHC Costs Between Mobile and Fixed Site Clinics

One aspect of the STARPAHC demonstration of interest to health care and delivery organizations is the comparative cost and usefulness of fixed site versus mobile clinics. Two STARPAHC clinics were in operation. The Mobile Health Unit spent a day each week at four villages, where it was effectively available about five hours a day or twenty hours a week. The Santa Rosa Center was a long-established clinic to which the STARPAHC telemedicine features had been added. It normally operated forty hours as week as an IHS class 1.00 clinic, with a Community Health Medic (CHM) in lieu of a physician and capacity of up to 8,860 outpatient visits annually, assuming a basic clinical team.

To make a comparison, the direct allocable costs to the MHU and Santa Rosa clinics have been identified. The remaining costs of the STARPAHC system at Sells, the Quijotoa Relay Station, and the Phoenix Referral Center equipment were divided equally between the two facilities. Comparisons are available on (1) recurring operations and maintenance costs, (2) recurring costs plus nonrecurring costs, and (3) the design capacity versus the actual number of patients served.

3.5.3.1 Comparison of STARPAHC Recurring Costs Between the Mobile and Fixed Site Clinics

Calculations shown below for recurring costs of operations and maintenance indicate the Mobile Health Unit to be more expensive per patient or per hour of operations than a fixed site clinic. Costs to the patient for travel and other personel expenses are excluded. The geographic flexibility of the Mobile Health Unit may provide greater accessibility for service than a fixed site clinic.

The analysis of recurring costs is as follows for the 24-month operating period ending April 30, 1977.

	MHU	Santa Rosa
Number of Outpatient Visits	6,557	10,257
Hours of Operation	2,016	4,032
Direct Costs of MHU and Santa Rosa	$174,497	$258,400
Other Recurring Costs Distributed Equally	$ 201,263	$ 201,263
TOTAL	$375,760	$459,663
Cost per Outpatient Visit	$ 57.31	$ 44.81
Cost per Hour of Operation	$186.39	$114.00

MHU recurring costs per OPV exceed Santa Rosa by 28%. MHU recurring costs per hour of operation exceed Santa Rosa by 64%.

3.5.3.2 Comparison of Consolitated STARPAHC Recurring & Nonrecurring Costs Between Mobile and Fixed Site Clinics (24 months)

When both recurring and nonrecurring costs are considered, as shown below, the cost advantage to fixed site clinic at Santa Rosa remains about the same as for recurring costs only. The MHU cost per outpatient visit exceeds Santa Rosa by 34% for the sum of recurring and nonrecurring costs.

Because of nonrecurring costs of the MHU include the amortized cost of the basic vehicle, the costs of the Santa Rosa Clinic have been expanded to give comparability by including the cost of an $800,000 replacement clinic amortized for 40 years at $10,000 per six month period. This compares with amortization of the MHU vehicle over a ten year period.

	MHU	Santa Rosa
Recurring Costs	$375,760	$459,663
Nonrecurring Costs	131,675	134,607
TOTAL	$507,435	$594,270
Cost per Outpatient Visit	$ 77.39	$ 57.94
Cost per Hour of Operation	$251.70	$147.39

3.6 ANALYSIS OF STARPAHC MOBILE AND FIXED SITE CLINIC CAPACITY COMPARED WITH ACTUAL LEVEL OF OPERATIONS

The extent to which each clinic is operating in proportion to design capacity may indicate the limits to which additional patients may be treated without a similar increase in cost.

3.6.1 Mobile Health Unit

The MHU design was executed in anticipation of processing 16 to 18 pacients over an 8 hour day which is equivalent to approximately 2.25 patients per hour. It is now serving an average of 3.25 patients per hour but limited to a twenty hour week. This appears to be over-capacity of +1.00 on an hourly rate but within a forty hour week potential. To increase operations to a full 40 hour week, it is assumed that the number of MHU personnel would be increased with no increase in system operating staff at Sells. If the number of patients processed were limited to the MHU 40 hour week design capacity, a reduction in cost per OPV may be expected.

3.6.2 Santa Rosa Clinic

The Santa Rosa Clinic design capacity is assumed to be the same as a basic IHS health center with a capacity of up to 8,860 patients annually based on agency resource allocation criteria. This criteria produces a design capacity of 4.26 patients per hour. Actual patient lo at Santa Rosa over the past 2 years was 2.54 which indicates an under-capacity of -1.72 patients per hour. Although the clinic is operating at only 60% of normal capacity, it has the potential of carrying a full patient load with the addition of two employees at most and very little change in other support costs.

3.7 PROJECTED IHS OPERATING COSTS - ONE YEAR

An estimate of Project STARPAHC operating costs for the year ending April 30, 1978 has been made. This estimate provides a basis for computation of costs per outpatient visits for the same period, including both recurring and amortized nonrecurring costs. Table 3-2 gives the estimate recurring operations and maintenance costs. Table 3-3 gives the calculation of costs per OPV and shows cost reduced from (for 2 years) $63.14 to $59.96 (cost per OPV).

Table 3-2

PROJECT STARPAHC

RECURRING OPERATIONS & MAINTENANCE COSTS

ESTIMATED FOR THE YEAR ENDING APRIL 30, 1978

BY SITE

Mobile Health Unit	
3 employees	$ 43,000
Other support costs	36,000
Santa Rosa Clinic	
6 employees	74,000
Other support costs	56,000
Sells Hospital and Control Center	
3 employees - operations & maintenance	74,000
Part-time charges for full time employees	23,000
Administration & support	22,600
Materials for telecommunication system	24,000
Sunnyvale engineering support	42,500
ORD support	25,000
Quijotoa Relay Station	
Fuel, supplies & contractual maintenance	2,700
Phoenix Referral Center	2,200
TOTAL 1st year IHS operations	$425,000

These costs are based on the IHS plan of operations.

Table 3-3

PROJECT STARPAHC

CALCULATION OF COST PER OPV

YEAR ENDING APRIL 30, 1978

Number of OPV's	9,000
Nonrecurring Costs - 10 Year Amortization	$114,664
Recurring Costs	425,000
Recurring & Nonrecurring Costs	$539,664
Cost per OPV/Recurring	47.22
Cost per OPV/Recurring and Nonrecurring	$ 59.96

Section 4
EXPORTABILITY

For purposes of this discussion the definition of Exportability is:

> "The potential for transferring in whole or in part, the STARPAHC concept, data, and information. Purposes may be to utilize for analyses or decision judgements in planning, engineering, and implementing telemedicine systems to meet the needs of specific operational sites."

STARPAHC data includes medical, engineering, management, and cost information that may be used for concept formulation, trade-off analyses, requirements definitions, system synthesis, etc. A decision making technique with which to evaluate alternates and other options, and their associated cost factors are including in this section. Recommendations are made, training and skills are discussed, and supplemental application of the STARPAHC concept in other fields than primary health care are presented.

In examining exportability potential of the STARPAHC concept the following questions were used as catalysts;

1. What have we learned from the project that would be of benefit and significance to future planners of another telemedicine project?
2. Which of the data we have listed in the report would be of value to further system designers/health care planners?
3. What recommendations can be made for specific subsystems and their limiting conditions?
4. What is the recommended process in planning, analyzing and operating a future telemedicine project?

The following sections will address these questions.

4.1 LEARNED AND SIGNIFICANT FINDINGS - In response to question number 1.

4.1.1 General Medical Findings

- o Interaction between CHM and physician using the telecommunication capabilities resulted in high quality of health care administered to patients in the remote areas.
- o Quality of care studies indicates that the CHM working independently in the mobile or fixed clinic achieved a quality of care better or equal to that delivered by physician staffed facilities.
- o There is a positive acceptance, by patients, to health care from non-physicians who are using telemedicine at facilities other than a hospital. (This is partially attributed to excellent preparatory orientation of the community by the Papago Executive Health Staff). The fact that more and high quality health services were provided at facilities closer to the patient's home is the major factor for patient acceptance.
- o A major value of telediagnostic capability by the use of either video or audio links is reassurance to the initiator that the proposed treatment plan is satisfactory, (this effect is equally valuable whether the initiator is a generalist physician consulting with a specialist or a physician's assistant consulting with a generalist).
- o 58% of the telecommunications were for medical purposes. Average telecommunication was 11.3 minutes. Medical teleconsultations average 9.9 minutes.
- o The physicians and CHMs reported that 86.4% of the teleconsultations were, "critical, important or useful," for providing proper diagnosis and/or treatment. Physicians throught that a video consultation with a remote non-physicians provider was valuable when a direct referral was eliminated or a significant change in diagnosis or therapy occurred. There is inconclusive evidence for the superiority of color television over black and white for diagnosis.
- o As rated by providers and patients, the most valuable health capability is the MHU with voice and data communications. The use of a mobile health unit directly effects the increased utilization of all facilities by bringing dependable quality health care services awareness, and accessibility to a remote underserved population.
- o The need for the use of television to support non-physicians as remote primary health providers in making diagnoses seems to be correlated with the specific distribution of diseases in the utilizing population and the amount of training or experience of the providers.

- The costs associated with the patient travel time saved, return of patient to productivity, as well as those costs for getting a patient into a main hospital from a remote location can be a significant tradeoff.

4.1.2 General Engineering Findings

- Complicated communications equipment can be designed so that only minimal experience of health providers is needed to achieve operation. The telecommunication subsystem performed without failure for 98.4% of the total transmission.
- The value of a thorough system engineering approach and follow through is reflected in the fine performance, and high reliability of the system, and the low overall failure rates, (average 15.6/month).
- Establishing a computer health data base, for recall of patient histories and other medical records, is essential for an effective telemedicine project.
- Evaluation of slow-scan television for X-ray transmission indicates the results achieved are valuable. For transmission of patient examination color images it is necessary to provide quality cameras and monitors and adequate lighting. For transmission of televised microscopy system performance in terms of availability, acceptability, and reading interpretation was judged excellent for all tests except for mixed flora with small cells.
- For smooth operations on-site technicians are required supplemented by the systems on-site spares and design to provide modular replacement of defective parts.
- Integrated medical/engineering team is required.
- Detail planning in the areas of logistics, particularly critical spares analysis, maintenance, inventory control and procurement, is essential.
- Safety investigations regarding instruments, electrical grounding and lighting protection must be provided prior to design.
- Contingency planning and potential problem analysis can be initiated based on equipment performance trends.

4.2 REPORT DATA OF SPECIAL VALUE - In response to question number 2. The following provides the reader with a cross-index between report data and its location in this volume that may be of value in telemedicine planning:

Item	Location
Utilization prior to and after STARPAHC	Section 2.3.1 Tables 2-1, 2-2, 2-3
Quality of Care	Section 2.3.2 Tables 2-4 through 2-9
Medical Telecommunication Utilization	Section 2.3.3 Table 2-11, 2-12
Value of Voice and Video Teleconsultations	Section 2.3.3, Section 2.3 Table 2-13 through 2-16, 2-18 through 2-20
Research Evaluation of Slow-Scan TV	Section 2.3 Table 2-21
Equipment Performance	Section 2.3.3, 2.4, 2.4.1 through 2.4.5 and 2.4.7 Table 2-10, 2-23 through 2-31, 2-38 Figure 2-1, through 2-10 and 2-12
High or Low Usage of TCE	Section 2.3.3, 2.4.3
Software Program Value	Section 2.4.4 Table 2-32, 2-33 Figure 2-11
Providers' and Patients' Acceptance	Section 2-4.6 Table 2-34 through 2-37
Operating Costs	Section 3 Table 3-1 through 3-3 Figure 3-1 through 3-3
Exportability	Section 4

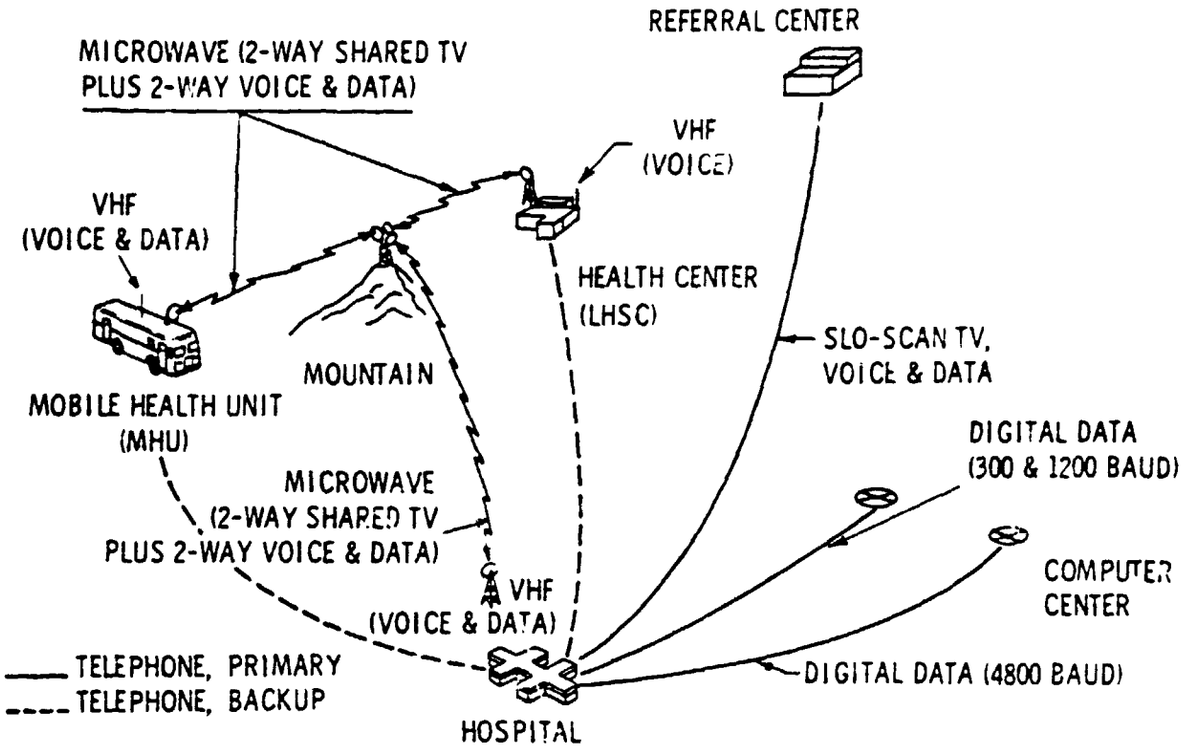
4.3 SUBSYSTEMS RECOMMENDATIONS - In response to question number 3. Selection of subsystems as defined in Figure 2-3 for STARPAHC are highly dependent on specific requirements which involve, capabilities, and cost. Section 2.4.3 through 2.4.7 furnishes an insight into the functions and characteristics of the five subsystems and can be used in a preliminary selection process. A summary of the capabilities of four communication options (Wideband, Narrowband, VHF, and Telephone Link) will be given in this section.

4.3.1 Wideband

Requirements of real-time video dictates the selection of a wideband microwave communication system. Figure 4-1 presents a typical configuration and capabilities. The need for a relay station is dependent upon the line-of-sight capability and the distance between transceivers. As illustrated Slow-Scan TV can supplement the video transmission of the wideband link if the distance and/or mountainous terrain back to a medical referral center is prohibitive and too costly for multiple relay centers. Advantages of the option are; real-time video, hi-fi voice channel, modularity for easy maintenance and privacy control. Disadvantage compared to other options are; high cost, limited multiple voice-grade channels, and higher power consumption.

4.3.2 Narrowband

The selection of narrowband is determined by the requirements for multiple-voice grade channels, and transmission of data. Figure 4-2 presents a typical configuration and capabilities. Again the need for a relay station is dependent on the topography and the distance between the two communicating facilities. Slow-Scan can fulfil the need for delayed video if necessary. Advantages of this option are; easily provided multiple-voice grade channels, all capabilities of telephones, dedicated private audio channels are available privacy control and separate maintenance lines. Disadvantages compared to the VHF and Telephone Link Options are; high cost, more complex antenna dish, and increased maintenance.



REMOTE SITE

CAPABILITIES

- ONE- OR TWO-WAY TELEVISION IMAGES
- ONE- OR TWO-WAY VOICE
- ALL CAPABILITIES PROVIDED BY VHF OPTION

RELAY STATION

CAPABILITIES

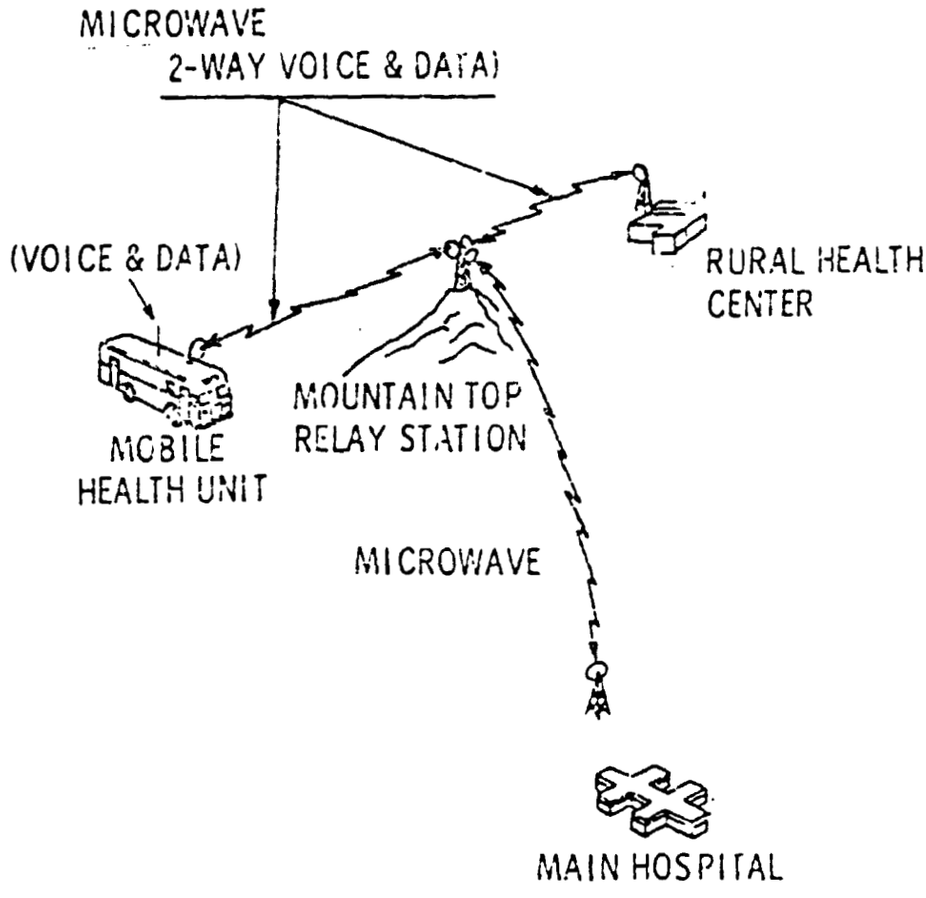
- POWER SOURCE
- TELEMETRY CONTROL
- ALARM SYSTEM
- A/C AND HEATING
- SHELTER
- ANTENNA TOWER

CONTROL CENTER

CAPABILITIES

- ONE- OR TWO-WAY TELEVISION IMAGES
- ONE- OR TWO-WAY VOICE
- ALL CAPABILITIES PROVIDED BY VHF OPTION

Figure 4-1 Wideband Microwave with VHF Backup Configuration



REMOTE SITE

CAPABILITIES

- MULTIPLE-VOICE GRADE CHANNELS
- ALL CAPABILITIES PROVIDED BY TELEPHONE
- PRIVATE/HOT LINES
- SEPARATE MAINTENANCE LINES

RELAY STATION

CAPABILITIES

- POWER SOURCE
- TELEMETRY CONTROL
- ALARM SYSTEM
- A/C AND HEATING
- SHELTER
- ANTENNA TOWERS

CONTROL CENTER

CAPABILITIES

- MULTIPLE-VOICE GRADE CHANNELS
- ALL CAPABILITIES PROVIDED BY TELEPHONE
- PRIVATE/HOT LINES
- SEPARATE MAINTENANCE LINES

Figure 4-2 Narrowband Microwave System Configuration

4.3.3 VHF

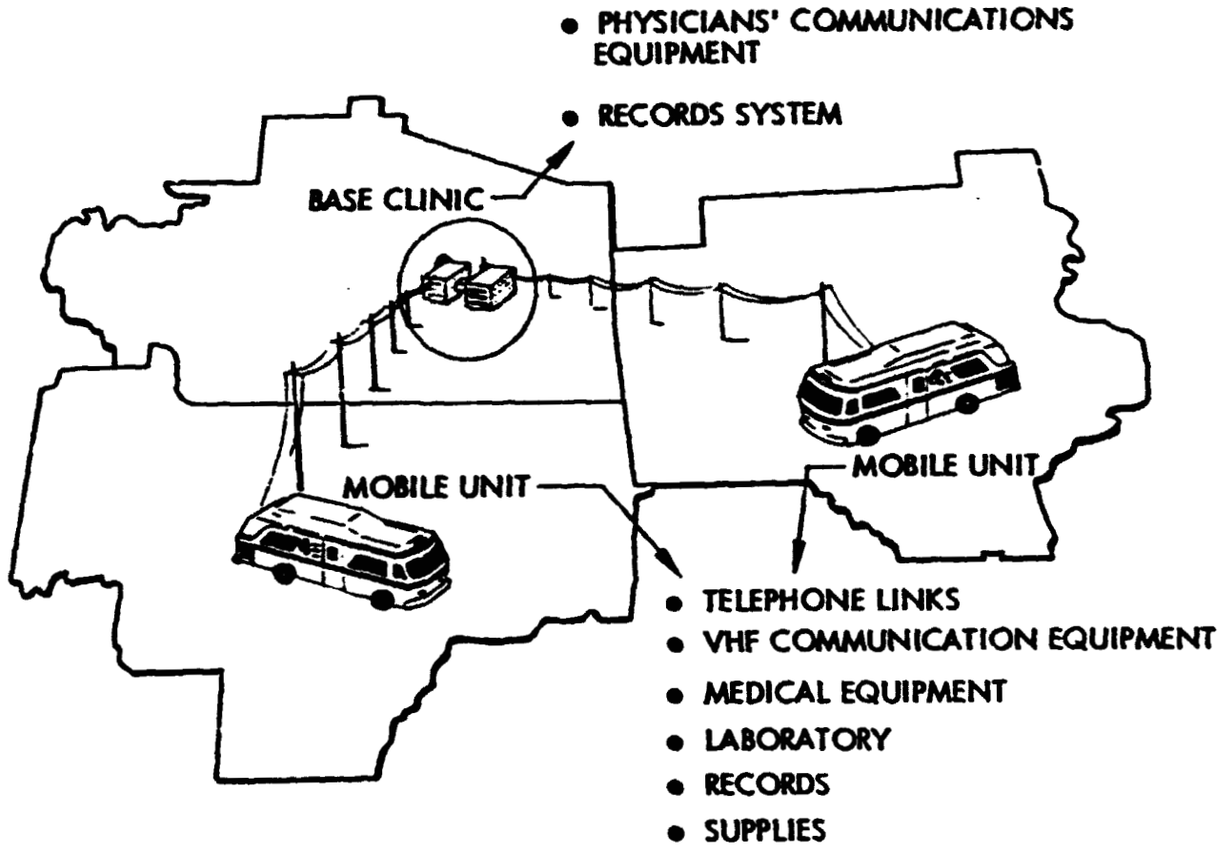
The selection of VHF is determined by the requirements for a low-cost transmission system capable of transmitting voice and data but not video. Figure 4-3 presents a typical configuration and capabilities. The need for a radio repeater is determined by topography and distance between communicating centers.

As illustrated Slow-Scan can be added to provide delayed video if required. Advantages of this option compared to the wideband and narrowband are; low cost, easy installation and maintenance, communication possible while mobile, and simple antenna - no costly tower. Disadvantages compared to the same two options are; single voice channel requires switching if multiple channels or additional transceivers, lower fidelity in audio transmission, lack of privacy control.

4.3.4 Telephone Link

The selection of the telephone link option is based on lowest possible cost and possibility that telephone hookups are easily available. Slow-Scan TV can provide the video capability if required. Figure 4-3 presents a typical configuration and capabilities. Two telephones are provided at each of the mobile or fixed clinics with corresponding two telephones at the medical center. The two lines are used for voice and/or data/video transmissions respectively. As the capabilities show any type of medical or even written data can be transmitted over the link. The advantage of this option compared to all the other options is low cost.

The disadvantages are; noncompatibility with high quality and broad range of frequency response, privacy cannot be secured as easily as with other system, and heart/lung sounds cannot be transmitted due to low frequency response.



REMOTE SITE

CAPABILITIES

- VOICE
- ECG INPUT
- FACSIMILE TRANSCEIVER
- PEN-WRITER TRANSCEIVER
- SLO-SCAN TV
- DIGITAL DATA I/O
- OTHER DATA ADAPTABLE TO VOICE RANGE
- VHF – HEART/LUNG SOUND TRANSMISSION
- VHF – MOBILE OR FIXED INSTALLATION

CONTROL CENTER

CAPABILITIES

- VOICE
- ECG RECORDING
- FACSIMILE TRANSCEIVER
- PEN-WRITER TRANSCEIVER
- SLO-SCAN TV
- DIGITAL DATA I/O
- OTHER DATA
- VHF – HEART/LUNG SOUND RECEPTION

Figure 4-3 VHF/Telephone Link System Configuration

4.3.5 Combined Communication Options

There are some advantages of combined communication options. The low cost telephone option can be supplemented at a small increase in cost by VHF back-up which will provide additional medical data transmission such as the heart/lung sounds, and will allow communication in a mobile unit while the mobile is in transit. Combining the narrowband and wideband microwave provides redundancy in everything video transmissions.

Combining VHF and narrowband provides voice and data backup, however, no video, while providing a lower cost than the wideband microwave. Increase relisbility summarizes the advantages of combining the various options.

An important recommendation for any of the options is to obtain good grade solid state commercial equipment. Spare parts in the form of modules should be procured after a thorough Critical failure analysis. Equally important is obtaining spares standardization and versatility through such modules as tuneable transmitters, permit varying the frequency without certain limits.

4.3.6 Slow-Scan TV

If a relatively low cost method of transmitting visual images is required, then Slow-Scan TV offers definite advantages. Color and B&W transceivers which use standard modems are readily available. Resolution is 450 lines with image transmission times of two and one-half minutes. B&W only transceivers are available with a built-in modems, but resolution is fairly low (250 lines), however image transmission times are reduced to 30 seconds. Other B&W high resolution units are being developed and should be available by the end of this year. Experience in transmitting X-ray images, patient examination, and microscopy has been detailed in this report based on use of the first production unit Color and B&W transceiver system. Applications of Slow-Scan TV are much broader than the medical health care field, e.g. education, law enforcement, teleconferencing, etc., and its value is enhanced

by disk and VTR recording/playback image storage capability, as well as a supplemental telephone line for 2 way voice communication/which may be for real time discussions during examinations and/or recorded for additional delayed study information).

Latest technology in microcomputers permits the addition of computer support at a low cost. One application is the use of the computer as a low cost high quality video disc recorder (VDR) for line-by-line slow-scan transmission. The VDR provides a means of preserving the received imagery, since the slow-scan equipment can store just one image and that image is erased when power is interrupted. Each of the discs in the VDR can store 400 images (200 on each side).

Peripheral equipment items required to support Slow-Scan operation are; monitors, cameras, recorders, and lighting. Advantages of slow-scan compared to the wideband option are; lower cost, easy installation, high reliability, and low power. Disadvantages of slow-scan TV are; image delayed in transmission; images of excessive motions not transmitted, and failed equipment must be repaired by vendor's field engineers or returned to vendor for repair.

4.3.7 Emergency

There are various types of emergency equipment available that have the capability to communicate back to a base station. The NASA developed portable ambulance module (PAM)*and its hospital base station used for the STARPAHC project, was very well accepted and used on the ambulance and in the hospital emergency room. These units may also extend care capability in "house visits" by health professionals, operating independently and/or in conjunction with mobile clinics.

4.3.8 Computer

The utilization of a computer and its memory system has proven highly desirable for storage and retrieval of patients history, and scheduling support.

* Produced under Tradename "Telecare"

Exportability requirements are highly dependent on the health care operational procedures, the facilities, existing capabilities, and the number of patients involved. STARPAHC provided a minicomputer that acted as an interface to an existing large central computer. Medical aid programs were provided from the minicomputer that supported the Community Health Medics functions such as a disease library, drug file, schedule etc. The most used application programs in STARPAHC proved to be the scheduling and patient history retrieval.

In a 50 bed hospital such as the PHS one at Sells the need for supportive computer aid programs may not be efficient. In a larger population, e.g. 350 bed hospital it is anticipated that computer and programs would be considerably more valuable and provide needed support to RNs and CHMs.

Loss and/or variation of facility power affects the operation of the computer. AC power stability in a rural area has proven to be a great problem in operating and maintaining computer operation. Frequent power outages accompanied by random power surges of up to 150 volts cannot be handled by stabilizing transformers and equipment failures resulted. In a rural area, requirements should specify an uninterruptable power system (UPS), particularly when a computer and any other voltage sensitive equipment is included. The UPS operation is that under normal operation, power is derived from the utility bus and is fed through a protective circuit breaker to the power rectifier/battery charger. The power rectifier converts the AC to DC which is fed through convenience circuit breakers to the power inverter and the battery reservoir. The battery charger maintains the reservoir at full energy level. The power inverter supplies NO-BREAK AC power to the critical load through a convenience circuit breaker. Should a utility power failure occur, the battery reservoir then supplies DC energy to the inverter. The STARPAHC complement of 9 batteries provided ten minutes of backup power at full load.

4.3.9 Facilities

Requirements for facilities are dependent on many factors among which are the nature of the existing health care facilities, the environment of the area, the overall system concept, and the needs of the health care systems performance. For efficient management of the system it is mandatory to establish a centralized control center. The director of this center must be responsible for the overall management of the system. Scheduling, referral, planning, record keeping and logistics are a few of the major requirements. Maintenance capability in form of repair and inventory control and storage facilities must be provided. A private facility m be provided for the monitoring physician. Other considerations are adequate space provisions for the equipment and personnel, and if necessary temporary and/or permanent living quarters and accommodations.

Remote site facilities either both fixed or mobile must be provided with adequate power, air/heat conditioning, and logistic support. Relay stations and utility installations must be designed to operate unmanned. Failure/ Fire/Break-in alarm links should be provided as well as shelter, power, and heating/AC. In some locations where jeep trails or mountain roads are the only means of access it is necessary to develop maintenance planning and to provide remote monitoring and controls, sufficient logistics support, and other functions so that frequent visits are precluded. For example, there are oil replenishment kits for diesel generators that can be used and when coupled with a large fuel tank (300 gallons), unattended operation for up to 30 days is normal. Tradeoff studies should be conducted on combinations of solar power sources, wind generators, utility services, and diesel to gain the most efficient and reliable maintenance-free power source, including a reliable back-up mode to the primary operational configuration.

4.3.10 Personnel

The primary care services delivered by health care personnel is a function of the capabilities of the health care professionals and the definitive protocols which define the scope of their services. These primary care

services, the number of members in the health care staff, and the required encounter rate are parameters in the design of the system and the instrumentation capabilities. Primary care services to be included when designing a T/M system are:

- o Physical examination, diagnosis, and treatment
- o Follow-up treatment of outpatients
- o Intermediate level emergency treatment
- o Preventive care including:
  - Immunizations
  - Pre- and post-natal care
  - Well baby care
  - Nutrition
  - Alcoholism
  - Drug abuse detection
  - Obesity
  - Family planning

Health care personnel should be selected whenever possible from the local population enhancing the community and acceptance. Personnel used will range from Community Health Aids to specialized physicians. A most valuable asset to STARPAHC was the capability of the majority of CHMs to converse with their patients and a system operator in their native language.

Early participation of the health care personnel in the planning, requirements definition, and design is essential to the formulation of an effective telemedicine system. Mockups and review meetings are very useful for securing a cooperative health care/engineering population.

STARPAHC personnel training and skills covered four general areas and was addressed to three skill levels respectively. The four areas were 1) system orientation covering system functions, requirements, equipment descriptions, 2) technical briefing giving the CHM's a basic knowledge of the equipment used, 3) physician's briefing giving the physician's knowledge and skills necessary to operate their console and peripheral equipment, and 4) non-MD briefing giving the infrequent non-MD personnel instructions in responding

to the special alarms and using the computer terminals. The three skill levels addressed were: 1) physician, 2) CHM, and 3) non-medical support personnel. STARPAHC experience indicates that the following approximate training time periods were provided to orient and train the system personnel.

Facility specific training varied with the type and needs of individual health care providers and with the particular facility. Total instructor time provided was the 296 hours as shown in the table below. However due to the busy schedules, the health providers had to be trained individually. On an individual basis the facility specific training time needed for proficient performance was estimated to be; physicians (2 hours), CHM on the MHU (8 hours), CHM at the Santa Rosa health center (4 hours), and nurses for computer terminal use (2 hours). In addition to this scheduled training, reinforcement of basic training was done as needed.

STARPAHC Orientation	3 Hours
Technical Briefing	13 Hours
Physician Briefing	24 Hours
Non-MD Briefing	24 Hours
Detailed Facilities Training	296 Hours
TOTAL	360 Hours

Equipment which with the personnel has had no prior training must be both demonstrated by skilled technicians in specialized and hands-on practice by the health care personnel. Examples of specialized instruments in STARPAHC were the endoscopic examination unit, the microscope, and the X-ray equipment.

On-the-job training is the most valuable form of acquainting the personnel with the equipment and observing their proficiency. This can be accomplished during the installation and checkout, and acceptance testing. Prior to start-up of operation, there should be a period allocated for practice.

Another lesson learned was that personnel who maintain continuity, e.g. technicians and CHM who remained on the job for extended periods (1 to 2 years) were able to maintain their proficiency through repetitive use of the equipment. Physicians, who had a high turnover rate, and infrequent exercise of the equipment needed continuous reinforcement training which in many cases is not too practical or in some cases was not acceptable by the physicians in the busy environment of a small hospital.

The complexity of the system and the reliability/QA performance determines the extent of logistic support. If generators are employed as power sources fuel must be provided and they must be maintained. Adequate capacity fuel tanks should be selected to maintain operations for at least 30 days. Diesel generators were found to be the most reliable and the easiest to maintain. LPG generators should never be used where a continuous services is required (due to the frequency of overhaul).

To keep down-time to a minimum, mobile units required frequent and thorough maintenance and replenishment resupply of expendables. Two days a week were allocated for the STARPAHC MHU. Out-of-service periods should be scheduled for overhauls, major repairs, etc. During these out-of-service periods, it is essential to provide a substitute for scheduled health care service, even though it may not be as complete as the primary service.

Arrangements should be made with major vendors for quick turn-around service to expedite replacement of failed units.

Equipment should be exercised regularly, especially if they are not used frequently during normal service. Auxiliary power equipment on a standby duty is in this category. Calibration should be done on at least a six month periodic basis. Spares inventory must be kept current and tracked weekly.

4.3.11 Human Engineering

Human engineering is recommended during the initial planning and the early design stage. Mockups were used extensively during the early planning stage of STARPAHC. Full-scale mockup of the interior of the MHU and its peripheral equipment, the physicians' console, and the ECG cart were designed and used for provider evaluation. Displays and controls must be simplified. Our STARPAHC experience revealed that relative simple terms such as RF is not understood.

Space requirements for the control center in a hospital must be carefully examined. In STARPAHC it was found convenient to add equipment to the physicians room such as Slow-Scan, and the emergency base station. This additional equipment saturated the available space. It should be anticipated that there will be a certain growth needed for equipment and/or examination.

Another important consideration in planning a telemedicine project is to provide flexibility in the removing and relocation of equipment. The original choice for placement of equipment, consoles, etc. may become changed due to factors such as available space, limited personnel, change of examination location, and the needs of the providers. To accommodate changes the design should be flexible and modular enough to permit relocating consoles, changing-out cables, and/or adding or removing equipment.

4.4 TELEMEDICINE PROJECT DEFINITION PROCESS

During the planning, development, operation and evaluation of the STARPAHC system, numerous inquiries were received from many interested health care organizations having a diversity of interests, needs, resources, requirements, and environments. All are seeking the optimum telemedicine configuration that would exactly fulfill their health care needs. The experience gained in health care planning needs and equipment operation and evaluation over the past four and one-half years enabled formulating a selection process that can result in a tailored exportable telemedicine system designed to satisfy providers, patients and other health care professionals, one which addresses priorities in proper perspectives.

A systematic analytical approach will define a telemedicine system to meet the requirements of a specific locale. This section describes an integrated medical/system engineering analytical approach for the requirements investigation, establishment of a cost-effective baseline design, tradeoff of alternate concepts to the baseline design, and a decision analysis technique to furnish a basis for value judgements and decision making. For example, the orderly process of converting program objectives, criteria and guidelines, requirements and constraints into a program definition document and system specifications is shown in Figure 4-4.

4.4.1 Criteria and Guidelines

The starting point in the definition process is establishing criteria and guidelines for the concept. The criteria and guidelines considered necessary for potential solutions to the problem of delivering quality health care to people in remote areas have resulted in several in-depth studies. The most significant of these criteria are:

(1) The need exists for a mechanism to extend the expertise of physicians (and other health professionals) great distances from their physical location to compensate for both scarcity and maldistribution. In essence, the physician becomes the director of a health care team.

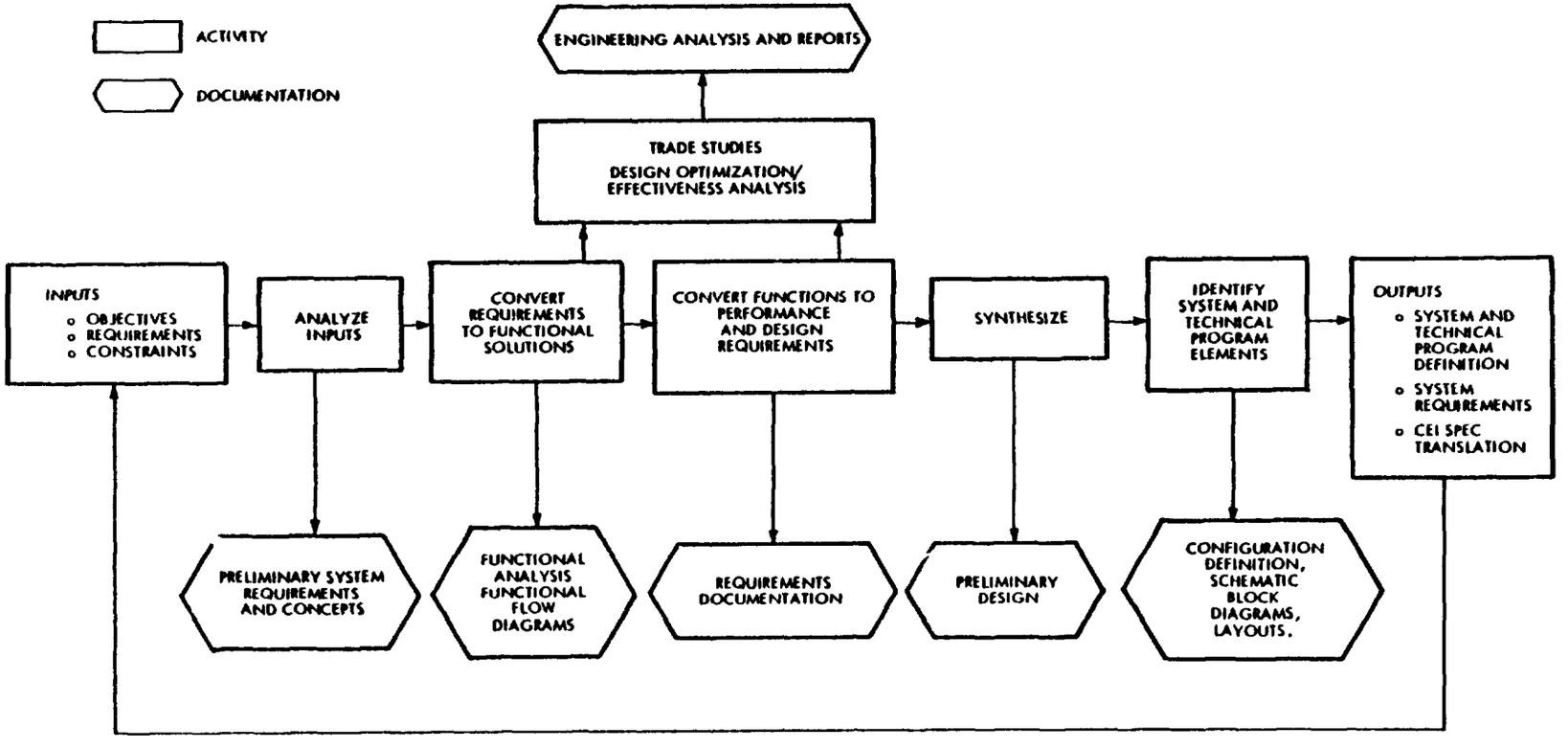


Figure 4-4 System Engineering Process

(2) The provision of easily accessible points of entry into the health care establishment is needed. Methods must exist to screen and route patients so that they are efficiently placed under the supervision and care of the most appropriate health care professional.

(3) The application of unique technology and management skills is required to relieve health care professionals of time-consuming tasks that require lesser levels of training and knowledge. This can be accommodated through the use of paramedical personnel (such as graduates of physicians' assistant programs) as extensions of physicians, in conjunction with the use of communications technology to provide the consultation, supervision, and attention of a physician that is required to deliver quality health care at the point of patient contact. Visible and audible communications with the physician establish the rapport required to eliminate the stigma of "second class" health care and optimize the use of the physician's time and capabilities.

(4) Appropriate combinations of fixed and mobile facilities are required to meet the varying needs dictated by population density, terrain, existing transportation systems, and socio-economic characteristics of different areas. Staffed by physicians' assistants, these facilities can very easily increase the number of entry points into existing health care establishments.

(5) A successful approach must involve making maximum use of existing medical establishments and capabilities, so as to complement existing health care establishments without being redundant. The restraints imposed by unique social, economic, and health characteristics of the locality under consideration should also be recognized.

(6) And finally, the system design must be amenable to orderly, expeditious extension. Using optimal modularity and standardized techniques that utilize existing technologies can result in nonrecurring developmental activities that are cost effective. Basic design should be applicable to all future remote-area situations.

4.4.2 Requirements Definition

Requirements definition determines the requirements to a detail level for all necessary components and their respective functional, operational and design specifics. This process is illustrated in Figure 4-5.

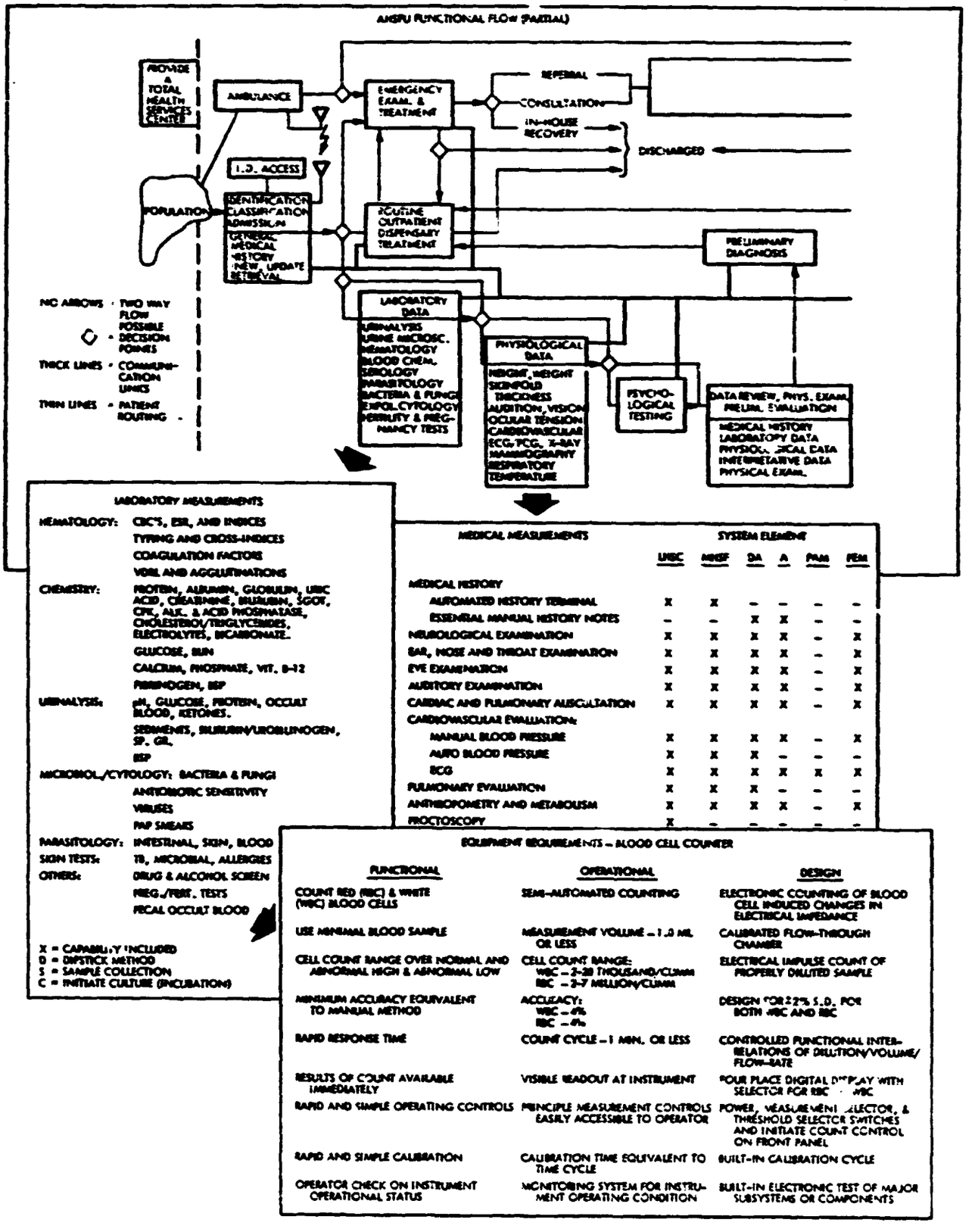


Figure 4-5 Requirements Investigation (Functional Analysis Through Requirement Definition)

As illustrated in Figure 4-5 1st level functional requirements are established, e.g. need to provide a total health services center. 2nd level functional requirements are next selected that define the type of services to be provided by the health center. Laboratory and medical measurements to carry out the 2nd level functions must next be established. Finally the functional, operational, and design equipment requirements are specified and form the End Item Specifications from which engineers can design and/or procure suitable equipment.

Important supporting analyses in the process involves characterization and resources of the area that will support the system. Characterization of an area results in defining such detail as the demography/topography, existing health care capabilities in personnel and facilities, physician/population ratios, health care service demands per locale. Resources involve availability of facilities, personnel, computerized health records etc.

Results from the system engineering effort are transferred into design specifications. The hardware specifications will define the requirements for major components and subassemblies, such as consoles, recorders, transmitters, receivers, video equipment, medical equipment, vehicle and structural modifications. The software specifications will fully delineate requirements for the necessary computer programs.

4.4.3 System Definition

This process starts with concept formulation to meet established requirements, defines a system which meets goals, objectives, and constraints of the area to be served and to accommodate resource limitations. The needs assessment under the requirements definition process has defined requirements in terms of personnel, measurements, resources and equipment. Analysis of this assessment may provide several alternate candidate concepts.

Selection of the most optimum candidate from alternate candidates, as well as site selection, selection of a mix of fixed and/or mobile units, computer, communication and bioinstrumentation can be accomplished using one of many

techniques of decision analysis. In STARPAHC it was essential and extremely valuable to have representatives of all involved disciplines (physicians, CHM's, Medical Administration, Papago Executive Health Staff, and Engineers) take part in this decision analysis.

There are many techniques of decision analysis. The Kepner-Tregoe and Associates (KTA) technique of decision analysis is one that can be used for applications of site selection, equipment selection and design evaluation. The KTA technique integrates subjective and quantitative data in accordance with a precisely organized rationale and priority scheme. It has been applied very successfully, in many NASA, DOD, and in-house programs for decision making and problem solving purposes. The approach in using the KTA technique for telemedicine system analyses will be briefly explained in this section. The "decision objective factors" that are considered typically essential to the formulation of a successful telemedicine project were selected and should prove useful for any group interested in testing their candidate concept against this criteria.

The KTA decision analysis approach is accomplished as follows. Following the formulation of the alternate candidates and the decision objective factors, decision-critical items are listed. The objectives and their qualifying or supporting factors are sorted into "Must" (it is absolutely essential - does it have GO. NO-GO importance - is it measurable?) and "Want" objectives are then weighted, the most important assigned a weighing factor of 10, and all other objectives weight (1-10) for their relative importance against this factor. The weight assigned to each objective has a major effect on the scoring outcome since it is a multiplying factor. One should carefully weigh each value assigned.

The next step consists of assigning a score to each of these "Want" objectives, to indicate how well a specific "Want" objective would be fulfilled by each one of the candidates. The candidate which provides the greatest satisfaction is assigned a score of 10. Evaluation of the relative satisfaction provided by all other candidates under consideration results in the assignment of a score between 9 and 0 to each of these alternatives.

Finally, the weighted scores are determined by every "Want" as it applies to each candidate by multiplying every score by the appropriate weighting factor. Totalizing all weighted scores results in a "total weighted score" for each alternate candidate, and thus establishes the most desirable or optimum candidate concept.

Concepts are many and diversified. Consider that these can range from a single fixed field clinic or a mobile health unit with intercommunication with a hospital to a multiple network comprised of mobile plus fixed clinics tied into general and specialized health facilities. Three candidate concepts as illustrated in Figure 4-1 through 4-3 shows various arrangements of facilities and telecommunication capabilities. They are progressive evolution to illustrate growth in function, capability, complexity, and costs.

Each of these candidates must be examined in terms of requirements for equipment, computer, facilities, personnel, logistics support, and available resources.

Three telemedicine candidates proposed for illustrating the analysis are:

Figure 4-3 Candidate A - Mobile unit with telephone link option to a small general hospital.

Figure 4-2 Candidate B - Mobile unit/Fixed Clinic/Field Hospital with narrowband microwave option.

Figure 4-1 Candidate C - Mobile unit/Fixed Clinic/Field Hospital/Large General/Hospital with Narrowband and Wideband Microwave option.

An illustrative STARPAHC export selection decision analysis involving three candidate concepts is shown in Table 4-1 for the purpose of describing the evaluation process. "Wants" shown are related primarily to desirable factors for an initial configuration. It must be recognized that anyone wishing to follow this procedure to select a telemedicine project configuration must be intimately familiar with the locations, health needs, constraints, capabilities

Table 4-1 Telemedicine Concept Selection Analysis

"MUSTS"	A. Mobile/Field Hospital Telephone Link	B. Mobile/Fixed Clinic Field Hospital Narrowband	C. Mobile/Fixed Clinic Field Hospital/ Large Hospital
1. Improve accessibility of patients to health care.	yes	yes	yes
2. Provide quality of care equal to or better than that previously available	yes	yes	yes
3. Assure acceptability by providers and patients.	yes	yes	yes

"WANTS"	W	S	WS	S	WS	S	WS
1. Competitive costs to the patient. Costs equal or below that of conventional health care.	9	8	72	7	63	4	45
2. Funding to be competitive with alternate forms of health delivery facilities.	8	7	56	7	56	5	56
3. High equipment reliability and maintainability.	6	5	30	4	30	4	24
4. High growth potential.	5	2	10	4	20	5	25
5. Adaptability of system for research and testing	4	1	4	4	16	4	16
6. Adaptability in meeting population shifts.	6	5	30	6	36	6	36
7. Adaptability in meeting changes in service demands and overall flexibility	6	4	24	5	30	6	36
Performance Totals, Want Objectives			226		251		238

W = Weighting Factor
S = Score
WS = Weighting Factor x Score

and resources of the existing health care facilities. It is of primary importance that anyone taking part in the project must concur on the selection of "Musts", "Wants" and weighing factors prior to conduct of key tradeoffs.

For a better understanding of some of the "Musts" and "Wants" the following definitions for STARPAHC Export Decision Objective Factors apply:

STARPAHC Export Decision Objective Factors

1. Accessibility. To improve access of rural patients to health care through use of telemedicine including equipped mobile clinics.
   a. To reduce analyses of patients waiting time, travel time, proportional amount of service time and scheduling delays.
   b. To improve health care system utilization.

      In this case analyze the total service unit utilization in view of the STARPAHC impact. Key factor is OPV's.
   c. To improve convenience to the patient.

      Analyze: Transportation availability.
      Reduced referral probability.
      Fewer visits per episode of illness.
   d. To reduce problem severity as patients seek help earlier.
2. Quality. To provide health care of a quality equal to or better than that previously available.
   a. The extent of compliance with protocols and program standards.
   b. Review by a panel of health professionals.
   c. A project to determine if telemedicine can reduce the number of unscheduled patient visits for unresolved patient problems.
   d. Review of resources diverted to the telemedicine project may have a negative impact elsewhere?
3. Acceptability. To assure acceptability and quality as perceived by involved people of alternatives.
   a. Patients.
   b. Non-professional providers.
   c. Professional providers.
   d. Tribal community attitude.
   e. Hospital organization attitude.

4. Costs. To be competitive.
   a. Cost to the patient equal or below that of conventional health care.
   b. To keep system costs compatible with conventional costs.
5. Funding. To be competitive with alternative forms of health delivery facilities.
   a. Relate capital costs to funding that might reasonably be expected.
   b. Relate costs of mobile clinics amortized over ten years to fixed site clinics amortized over 40 years.
6. Hardware. To be reliable and maintainable.
   a. To provide operationally accurate and reliable hardware.
   b. To provide functionally useful hardware.
7. Growth Potential.
   a. Ability to perform research and testing for specific purposes.
8. Population Shifts.
   Response of the system to population changing location.
9. Service Demands Changes.
   Response of the system to increase/decrease in utilization. Flexibility of system to meet these changing demands.

Completion of the definition process requires identifying system and technical program elements by design analyses and tradeoffs using the decision analysis technique described earlier. Technical problems are usually associated with communication reception, frequency allocation, console layouts, etc. Medical problems are usually associated with medical legal problems, availability, selection and training of operational personnel, and measurement requirements. Following the design period, assembly, test, and installation and checkout and operations and evaluation takes place. Planning for these steps must occur sufficiently in advance of the step. Test plans and procedures are generated during the design phase, while installation and checkout, operations and evaluation plans are formulated during the assembly phase.

Another means of approaching exportability analysis for STARPAHC specific alternatives are contained in reports and studies conducted for IHS, (Vol. 1, Project STARPAHC Export Decision Model Preliminary Report, August 1977.) This report contains in-depth philosophy, analytical process, and detail information pertinent to evaluating the expansion or contraction of STARPAHC major elements. The following will briefly summarize the reference report and give the results of the decision making process.

The STARPAHC Executive decision making process is a rational means of evaluating alternatives expressed in terms of health service delivery and hardware capabilities. The alternatives are evaluated against objectives established for the STARPAHC project. This process includes a case study for every objective or sub-objective leading to a probability forecast of the impact of each alternative expressed as a score from one thousand to two thousand. These scores are posted to a mathematical mode, which, when summarized, provides a means of integrating the interdisciplinary factors. The functions of the model are indicated in the following matrix.

MATHEMATICAL MODEL

VALUE MATRIX SCHEMATIC

		A_1	A_2	A_3
O_1	W	WS_{11}	WS_{21}	WS_{31}
O_2	W	WS_{12}	WS_{22}	WS_{32}
O_3	W	WS_{13}	WS_{23}	WS_{33}
Program Value		V_1	V_2	V_3
Cost/Funding Value		F_1	F_2	F_3
Performance Index		P_1	P_2	P_3
Decision Value		D_1	D_2	D_3

This table illustrates the type of value matrix used in which: O designates objectives; A, alternates; W, weight; WS, weighted score; V, total program numerical values; F, cost/funding values; P, performance index; and D, decision numerical values.

The STARPAHC export decision process drew upon the fund of knowledge and data collected during the two year demonstration at the Sells Service Unit on the Papago Indian Reservation in Southern Arizona. The decision process anticipates an organized analysis of health care delivery needs, a careful study of the environment, identification of requirements and preparation of specifications. The model developed from this process is intended to be suitable for and adaptable to other locations.

The mathematical model displayed in Table 4-2 is derived from Sells Service Unit operational data and is descriptive of experience on the Papago Reservation. Application elsewhere will depend upon a definition of requirements developed from analysis of local health care needs, demography, geography, community interest, existing health care facilities, availability of providers and other factors.

Decision making encompasses a process of evaluating viable alternatives so that one given alternative or a combination of alternatives will attain the desired end. The features of five alternatives are presented in Table 4-2. The evaluation consists of examining the objectives for the health care delivery system and weighing the potential of each alternative in terms of its expected performance in achieving each objective.

Table 4-3, Mathematical Model, presents in summary form the program objectives and sub-items, and the Computed Decision Values for five alternatives. Subtotals are shown for Total Program Values, Cost/Funding Decision Values, and the Performance Index.

Table 4-2 STARPAHC Export Model - Preliminary Report Alternative Choices - By Location

Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
One Mobile & One Fixed Clinic Wide & Narrow Band Microwave System VHF or UHF Radio	One Mobile Clinic Wide & Narrow Band Microwave System VHF or UHF Radio	One Fixed Site Clinic Wide & Narrow Band Microwave System VHF or UHF Radio	One Mobile & One Fixed Clinic Narrow Band Microwave Multiplex System VHF or UFH Radio	One Mobile Clinic No Microwave VHF or UHF Radio and/or Phone
1. Field Clinics	Field Clinic	Field Clinics	Field Clinics	Field Clinic
Communication Functions	Comm. Functions	Comm. Functions	Comm. Functions	Comm. Functions
O.P. Clinic - C.H. Medic Consult with Physician at 1st level site. Interactive TV & Audio - W. Band Multiplex Audio - N. Band Handsfree & Hotline. Complete privacy available. Microfiche health records. Half duplex voice backup. No slow scan TV.	O.P. Clinic - C.H. Medic Consult with Physician at 1st level site. Interactive TV & Audio - W. Band Multiplex Audio - N. Band Handsfree & Hotline. Complete privacy available. Microfiche health records. Half duplex voice backup. No slow scan TV.	O.P. Clinic - C.H. Medic Consult with Physician at 1st level site. Interactive TV & Audio - W. Band Multiplex Audio - N. Band Handsfree & Hotline. Complete privacy available. Microfiche health records. Half duplex voice backup. No slow scan TV.	O.P. Clinic - C.H. Medic Consult with Physician at 1st level site. ---------------------- Multiplex Audio - N. Band Handsfree & Hotline. Complete privacy available. Microfiche health records. Half duplex voice backup. Slow scan TV - X-rays, etc.	O.P. Clinic - C.H. Medic Consult with Physician at 1st level site. ---------------------- ---------------------- Limited privacy. Microfiche health records. Half duplex voice. No slow scan TV.
Hardware Features	Hardware Features	Hardware Features	Hardware Features	Hardware Features
Controls - in each room. To 1st consult site control panel operator.	Controls - in each room. To 1st level consult site control panel operator.	Controls - in 3 rooms. To 1st level consult site control panel operator.	Controls - minimum. Direct to 1st level consult site, switchboard or other location.	Controls - minimum. Direct to 1st level consult site physician's
Intercom Microwave - Wide Band Color TV - Transmit B & W TV - 2 way Voice - 2 way FDX Microwave - Narrow Band Voice - 2 way FDX Multiple channel VHF/UHF Radio Voice - 2 way HDX Backup Phone - where available Voice	Intercom Microwave - Wide Band Color TV - Transmit B & W TV - 2 way Voice - 2 way FDX Microwave - Narrow Band Voice - 2 way FDX Multiple channel VHF/UHF Radio Voice - 2 way HDX Backup Phone- where available Voice	Intercom Microwave - Wide Band Color TV - Transmit B & W TV - 2 way Voice - 2 way FDX Microwave - Narrow Band Voice - 2 way FDX Multiple channel VHF/UHF Radio Voice - 2 way HDX Backup Phone - where available Voice	Intercom ---------------------- ---------------------- ---------------------- ---------------------- Microwave - Narrow Band Voice - 2 way FDX Multiple channel VHF/UHF Radio Voice - 2 way HDX Slow scan TV or backup Phone - where available Voice or slow scan TV	No Intercom ---------------------- ---------------------- ---------------------- ---------------------- ---------------------- ---------------------- ---------------------- VHF/UHF Radio Voice - 2 way HDX Primary Communications Phone - where available Voice
Lab	Lab	Lab	Lab	Lab
Microscope X-Ray Other common equipment	Microscope X-Ray Other common equipment	Microscope X-Ray Other common equipment	Microscope X-Ray Other common equipment	Microscope ---------- Other common equipment

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Table 4-2 (continued)

	Alternative 1 One Mobile & One Fixed Clinic Wide & Narrow Band Microwave System VHF or UHF Radio	Alternative 2 One Mobile Clinic Wide & Narrow Band Microwave System VHF or UHF Radio	Alternative 3 One Fixed Site Clinic Wide & Narrow Band Microwave System VHF or UHF Radio	Alternative 3 One Mobile & One Fixed Clinic Narrow Band Microwave Multiplex System VHF or UHF Radio	Alternative 4 One Mobile Clinic No Microwave VHF or UHF Radio and/or Ph
2.	1st Level Consult Site	1st Level Consult Site	1st Level Consult Site	1st Level Consult Site	1st Level Consult Site
	Communication Functions	Comm. Functions	Comm. Functions	Comm. Functions	Comm. Functions
	G.P. Physician - on call for consult w/clinics.	G.P. Physician - on call for consult w/clinics.	G.P. Physician - on call for consult w/clinics.	G.P. Physician - on call for consult w/clinic	G.P. Physician - on call for consult w/clinics.
	Interactive TV & Audio - W. Band	Interactive TV & Audio - W. Band	Interactive TV & Audio - W. Band	----------	----------
	Remote control - field clinic cameras.	Remote control - field clinic cameras.	Remote control - field clinic cameras.	----------	----------
	Multiplex Audio - N. Band Handsfree & Hotline	Multiplex Audio - N. Band Handsfree & Hotline	Multiplex Audio - N. Band Handsfree & Hotline	Multiplex Audio - N. Band Handsfree & Hotlin	----------
	Complete privacy available.	Complete privacy available.	Complete privacy available.	Complete privacy available.	----------
	Microfiche health records.	Microfiche health records.	Microfiche health records.	Microfiche health records.	Limited privacy.
	Half duplex backup.	Half duplex backup.	Half duplex backup.	Half duplex backup.	Microfiche health records.
	Slow scan to 2nd level.	Slow scan to 2nd level.	Slow scan to 2nd level..	Slow scan from field clinic to 2nd level.	Half duplex primary Comm.
					No slow scan TV.
	Management & maintenance control center & shop.	Management & maintenance control center & shop.	Management & maintenance control center & shop.	Management & maintenance control center & shop.	Management & maintenance controls & shop.
	Hardware Features	Hardware Features	Hardware Features	Hardware Features	Hardware Features
	Console - Physicians. B & W TV Camera	Console - Physicians. B & W TV Camera	Console - Physicians. B & W TV Camera	No physicians console. Physician may stay in office.	No physicians console. Physician takes calls in his office.
	X-Ray viewer	X-Ray viewer	X-Ray viewer	X-Ray viewer	No X-Ray.
	Console-Panel operators. To link system as control center.	Console-Panel operators. To link system as control center.	Console-Panel operators. To link system as control center.	Simplified controls. No panel operator.	Much simplified controls. No panel operator.
	Microwave - Wide band Color TV Monitor B & W TV - 2 way Voice - 2 way FDX	Microwave - Wide band Color TV Monitor B & W TV 2 way Voice - 2 way FDX	Microwave - Wide band. Color TV Monitor B & W TV - 2 way Voice - 2 way FDX	----------	----------
				----------	----------
				----------	----------
				----------	----------

Table 4-2 (continued)

Alternative 1 One Mobile & One Fixed Clinic Wide & Narrow Band Microwave System VHF or UHF Radio	Alternative 2 One Mobile Clinic Wide & Narrow Band Microwave System VHF or UHF Radio	Alternative 3 One Fixed Site Clinic Wide & Narrow Band Microwave System VHF or UHF Radio	Alternative 4 One Mobile & One Fixed Clinic Narrow Band Microwave Multiplex System VHF or UFH Radio	Alternative 5 One Mobile Clinic No Microwave VHF or UHF Radio
Hardware Features, cont.	Hardware Features, cont.	Hardware Features, cont.	Hardware Features, cont.	Hardware Features, cont.
Microwave - Narrow Band Voice - 2 way FDX Multiple Channel VHF/UHF Radio Voice - 2 way HDX Backup Phone - where available Voice Slow scan from 1st to 2nd level consult.	Microwave - Narrow Band Voice - 2 way FDX Multiple Channel VHF/UHF Radio Voice - 2 way HDX Backup Phone - where available Voice Slow scan from 1st to 2nd level consult.	Microwave - Narrow Band Voice - 2 way FDX Multiple Channel VHF/UHF Radio Voice - 2 way HDX Backup Phone - where available Voice Slow scan from 1st to 2nd level consult.	Microwave - Narrow Band Voice - 2 way FDX Multiple Channel VHF/UHF Radio Voice - 2 way HDX Slow scan TV or backup Phone - where available Voice Slow scan TV on phone as an alternate.	---------- ---------- ---------- VHF/UHF Radio Voice - 2 way HDX Primary Communication Phone - where avaiable Voice No slow scan but it could be an option.
Lab & Pharmacy Access to existing facilities.	Lab & Pharmacy Access to existing facilities.	Lab & Pharmacy Access to existing facilities.	Lab & Pharmacy Access to existing facilities.	Lab & Pharmacy Access to existing facilities.
3. Relay Station	Relay Station	Relay Station	Relay Station	Relay Station
Communication Functions	Comm. Functions	Comm. Functions	Comm. Functions	Comm. Functions
Links field clinics with 1st level consult. Telemetry & special channel for system maintenance.	Links field clinics with 1st level consult. Telemetry & special channel for system maintenance.	Link field clinics with 1st level consult. Telemetry & special channel for system maintenance.	Links field clinics with 1st level consult. Channel for Systems maintenance.	Links field clinics with 1st level consult. ----------
Hardware Features	Hardware Features	Hardware Features	Hardware Features	Hardware Features
Microwave Tower 3 Dual feed dish ants. Small shelter Generators. VHF/UHF Radio, Ant. & Pole Batteries	Microwave Tower 2 Dual feed dish ants. Small shelter Generators. VHF/UHF Radio, Ant. & Pole Batteries	Microwave Tower 2 Dual feed dish ants. Small shelter Generators. VHF/UHF Padio, Ant. & Pole Batteries	Microwave Tower 3 dish antennas Small shelter Solar Cells or small generator. VHF/UHF Radio, Ant. & Pole Batteries	---------- ---------- Small shelter Solar cells or small generator. VHF/UHF Radio, Ant. & Pole Batteries

Table 4-2 (continued)

Alternative 1	Alternative 2	Alternative 3	Alternative 3	Alternative 4
One Mobile & One Fixed Clinic	One Mobile Clinic	One Fixed Site Clinic	One Mobile & One Fixed Clinic	One Mobile Clinic
Wide & Narrow Band Microwave System	Wide & Narrow Band Microwave System	Wide & Narrow Band Microwave System	Narrow Band Microwave Multiplex System	No Microwave
VHF or UHF Radio	VHF or UHF Radio	VHF or UHF Radio	VHF or UHF Radio	VHF or UHF Radio
2nd Level Consult Site	**2nd Level Consult Site**	**2nd Level Consult Site**	**2nd Level Consult Site**	**2nd Level Consult Site**
Communication Functions	Comm. Functions	Comm. Functions	Comm. Functions	Comm. Functions
Links w/1st level consult Medical specialist	Links w/1st level consult Medical specialist	Links w/1st level consult Medical specialist	Links w/1st level consult Medical specialist	Links w/1st level consult Medical specialist
Audio	Audio	Audio	Audio	Audio
X-Ray still pictures	X-Ray still pictures	X-Ray still pictures	X-Ray still pictures	---
Microfiche health records	Microfiche health records	Microfiche health records	Microfiche health records	Microfiche health records
Hardware Features	Hardware Features	Hardware Features	Hardware Features	Hardware Features
Telephone	Telephone	Telephone	Telephone	Telephone
Voice	Voice	Voice	Voice	Voice
Slow scan	Slow scan	Slow scan	Slow scan	---

Table 4-3 STARPAHC - Preliminary Export Report Mathematical Model Program Objectives by Project

PROGRAM OBJECTIVES	WEIGHT	Alternative 1 One Mobile & One Fixed Clinic Wide & Narrow Band Microwave System VHF & UHF Radio SCORE	Alternative 1 VALUE	Alternative 2 One Mobile Clinic Wide & Narrow Band Microwave System VHF & UHF Radio SCORE	Alternative 2 VALUE	Alternative 3 One [illegible] 1 Site Clinic Wide & Narrow Band Microwave System VHF Radio SCORE	Alternative 3 VALUE	Alternative 4 One Mobile & One Fixed Clinic Narrow Band Microwave Multiplex System VHF & UHF Radio SCORE	Alternative 4 VALUE	Alternative 5 One Mobile Clinic No Microwave VHF & UHF Radio and/or Phone SCORE	Alternative 5 VALUE
1. Accessibility	20	1,608	32,150	1,680	33,600	1,326	26,525	1,648	32,9[illegible]	1,750	35,000
a. Reduce patients' travel	5	1,650	8,250	1,645	8,225	1,200	6,000	1,740	8,700	1,800	9,000
b. Reduce patients' waiting time	5	1,700	8,500	1,800	9,000	1,600	8,000	1,700	8,500	1,800	9,000
c. Improve System Usage	5	1,700	8,500	1,900	9,500	1,500	7,500	1,700	8,500	1,900	9,500
d. Reduce Cost to Patient	5	[illegible]30	6,900	1,375	6,875	1,005	5,025	1,450	7,250	1,500	7,500
2. QUALITY	20	1,675	33,500	1,688	33,750	1,663	33,250	1,600	32,000	1,388	27,750
a. Positive Impact Tribal Health Programs	5	1,800	9,000	1,800	9,000	1,800	9,000	1,600	8,000	1,300	6,500
b. Positive Impact IHS Health Programs	5	1,800	9,000	1,800	9,000	1,800	9,000	1,700	8,500	1,300	6,500
c. Improve Common Health Problems	5	1,600	8,000	1,700	8,500	1,500	7,500	1,600	8,000	1,500	7,500
d. Accuracy of Diagnoses & Lab Work	5	1,500	7,500	1,450	7,250	1,550	7,750	1,500	7,500	1,450	7,250
3. ACCEPTABILITY	20	1,713	34,250	1,763	35,250	1,688	33,750	1,550	31,000	1,456	29,125
a. To Patients	5	1,800	9,000	1,850	9,250	1,750	8,750	1,500	7,500	1,400	7,000
b. To Providers	5	1,800	9,000	1,800	9,000	1,800	9,000	1,700	8,500	1,625	8,125
c. To Tribal Community	5	1,800	9,000	1,900	9,500	1,700	8,500	1,600	8,000	1,500	7,500
d. To IHS Organization	5	1,450	7,250	1,500	7,500	1,500	7,500	1,400	7,000	1,300	6,500
4. HARDWARE & SYSTEMS	20	1,438	28,750	1,388	27,750	1,500	30,000	1,650	33,000	1,738	34,750
a. Operationally Reliable	5	1,400	7,000	1,400	7,000	1,450	7,250	1,600	8,000	1,800	9,000
b. Functionally Available	5	1,400	7,000	1,400	7,000	1,400	7,000	1,700	8,500	1,800	9,000
c. System Maintainable	5	1,300	6,500	1,100	5,500	1,500	7,500	1,700	8,500	1,800	9,000
d. Data System	5	1,650	8,250	1,650	8,250	1,650	8,250	1,600	8,000	1,550	7,750
5. ADAPTABILITY	20	1,819	36,375	1,838	36,750	1,788	35,750	1,688	33,750	1,350	27,000
a. Communications Network	5	1,950	9,750	1,900	9,500	2,000	10,000	1,850	9,250	1,300	6,500
b. Clinics/Mobile & Fixed	5	1,750	8,750	1,800	9,000	1,700	8,500	1,700	8,500	1,400	7,000
c. Program Changes	5	1,825	9,125	1,850	9,250	1,800	9,000	1,650	8,250	1,400	7,000
d. Special Projects	5	1,750	8,750	1,800	9,000	1,650	8,250	1,550	7,750	1,300	6,500
Total Program Values	100		165,025		167,100		159,275		162,700		153,625
COST/FUNDING DECISION VALUES			11,496		17,608		17,294		15,128		45,154
PERFORMANCE INDEX			33,600		7,020		26,580		35,004		9,459
TOTAL DECISION VALUES			210,121		191,728		203,149		212,832		208,268

The Mathematical Model presents the Total Program Values and the values of each objective for review and comparison. The Cost/Funding Decision Values, the Performance Index, and the Total Decision Values may then be compared with Total Program Values. The decision process highlights the program values or benefits against costs and performance indicators.

The five major objectives, each with four sub-objectives, are briefly described below in the same sequence as listed on the mathematical model. (Table 4-3)

Accessibility. To improve the accessibility of health care to the patients.

Quality. To provide health care of a quality equal to or better than that previously available in the same location.

Acceptability. To assure acceptability insofar as the quality of health care is perceived by involved people.

Hardware and Systems. To assure that hardware and systems are reliable, available for use and maintainable.

Adaptability. To provide for flexibility and growth potential consistent with charging demands of the system.

The sub-total values shown on Table 4-3 are compiled as follows:

Total Program Value. Evaluation for total program value was accomplished by inputs from various individuals that had a direct contact with the STARPAHC project. Compilation of values for each of the five alternates weighed against the 5 major and 20 sub-major project objectives is shown in Table 4-3. Averaging the four inputs for each of the five objectives resulted in the total program values as shown in Table 4-3.

Cost/Funding Decision Value. The cost funding objectives are to keep STARPAHC telecommunication and other system costs compatible with conventional costs and maintain the present IHS cost and funding levels with no or minor increases. Both implementation costs and recurring costs of operation, maintenance and services were considered. The cost/funding analysis includes (1) implementation costs of designing, acquiring, accepting, installing, and starting up equipment and facilities, and (2) recurring costs of operations and maintenance.

Implementation Costs by Alternatives, was computed using LMSC and IHS STARPAHC cost data, adapted to funding the design, installation, and start up of the five export alternatives. Adjustments were made by deleting costs of equipment removed from the STARPAHC system (See Alternative 1) and by anticipating reductions in the prime contractor's design, installation, check out and acceptance costs sufficient to pay for Alternative 1 startup. Prices are adjusted to 1977 levels.

Computation of Cost/Funding decision values is based on consolidating implementation costs and recurring costs over a three year period. A decision numerical value for each alternative is computed by dividing the total program values by three year costs. This factor is adjusted by a multiplier to derive a cost funding decision value for insertion in Table 4-3.

The three year cost period was selected because of current industrial and governmental practice of entering only into capital projects with early payouts, and also because a three year period tends to level out the impact of the equipment acquisition beyond the first year's implementation cost/ funding.

Performance Index. Management may determine that one or more additional factors should be reflected in the model other than the program values and cost/funding decision values. Management may recognize unusual circumstances that are not related to the program and cost analyses. In this model a "performance index", Table 4-3 has been selected. In comparing performance, there are substantial differences in the annual OPV capacity of

mobile unit and fixed site clinics. This differential is highlighted for management by treatment as a performance index. To arrive at the final performance index value, the clinical capacity is multiplied by three years for comparability with the cost/funding decision value.

4.4.4 Other Ideas for Consideration

Although STARPAHC was designed for the delivery of health services in a rural setting, the telemedicine concept application that has been implemented can be directly adaptable to "inner city" situations. It has definitely proved effective for specialist-consultation purposes in such fields as dermatology, psychiatry, radiology, speech therapy, orthodontics, orthopedics, and anesthesiology.

Telemedicine's potential for education and training in medicine and other fields has not been thoroughly explored. Projects using satellites for transmission of medical-education information have demonstrated the feasibi ty of telemedicine for educational purpose as well as the potential for tieing-in a network of ground stations world-wide for use in a series of related and/or unrelated fields.

The advent of reliable, high resolution and relatively low cost slow-scan TV has opened telemedicine projects to smaller group of providers, or users, as well as supplied the capability to support intercommunication between libraries, law enforcement agencies, real estate developers, teleconferences between industries, and/or teleconferences between industry and government agencies.

Leasing arrangements for ground-to-satellite terminals may well be the stimulus for allowing smaller group to participate in this interactive method of communication.

There are serious problems in the delivery of health service in the United States and other countries. A more systematic approach to developing techniques in which telecommunications can be used throughout the entire health-care system may well provide the solution to other problems in areas involving interactive communication.

Section 5
CONCLUSIONS

The major goal of the STARPAHC project was achieved - establishing the feasibility of the STARPAHC concept in the delivery of health care, (1) to evaluate the value and potential of telemedicine using CHMs for providing quality health care to people in a remote area, (2) gaining information for developing health care systems for future manned spacecraft, (3) determining the constraints and capabilities involved in the interaction between physicians and non-physician health care personnel, (4) determining the effectiveness and exportability of the STARPAHC technique, and 5) defining the additional developments that are needed and/or most valuable to improving telemedicine and its exportability potential.

It has proven feasible to design, construct, test, operate, and maintain a reliable telemedicine system in a remote environment. Performance and quality of the system were rated high. Maintenance was within the capability of the site crew.

5.1 MEDICAL CONCLUSIONS

The STARPAHC concept is indeed an effective, realistic way to administer quality health care to people isolated in remote areas. There have been overall increases in the utilization of all health care facilities, and appreciable increases in the utilization of both the mobile and fixed clinics. The quality of care administered by CHMs at these facilities has been rated as "better than or as good as" that administered in facilities staffed by physicians and other health professionals.

Physician direction has been effective in diagnosing and/or treating patients by telemedicine in a wide variety of case types. Physician and CHM users have reported that the TCE capability has been either critical or important and useful in 86.3% of the teleconsultations for providing proper treatment and diagnoses. A major value of the telediagnostic capability is reassurance to the initiator that the proposed treatment plan is satisfactory (whether the initiator is a CHM or a physician).

Utilization of the combined fixed and mobile facilities resulted in an increase in, 1) the number of patients, 2) the number of individual patients treated, and 3) the percentage of total population. It was concluded that a significant part of the increase resulted from deploying the mobile facility to a remote part of the reserviation that was underutilizing health services prior to STARPAHC.

The five most valuable capabilities of STARPAHC in the opinion of the providers were, 1) computerized health records, 2) audio teleconsultations, and 3) mobile health unit, 4) color TV, and 5) B&W TV.

Providers have negative as well as positive attitudes; they have problems accepting equipment malfunctions and making time for consultations, plus problems in overcoming old biases and parochial attitudes toward innovative practices. It is important that providers be sufficiently trained, and they be made to feel part of the system through early involvement and organizational responsibility. All providers recognize the significance of providing the Papago people with better access to good care.

Research evaluation of Slow-Scan TV for diagnosis of X-ray images, patient examinations, and microscopic slide images concluded that quality visual data presented in the specialist were effective. More experimental work is needed in this area.

The patients report considerable satisfaction with the services provided. The Mobile Health Unit is the most important aspect because it provides health service to the western districts which prior to STARPAHC received less than the other districts. The time saved for a patient in an outlying village receiving remote health care compared to that required in his visit to the central hospital is one of the significant side benefits.

Cost per outpatient visit (OPV) for STARPAHC patients is $49.69. The relatively higher cost than that published for on other telemedicine projects (East Harlem Child Health Care Station/Mount Sinai Project - $52 in 1973, and $43 in 1974) is attributed to the field conditions in the remote area served by STARPAHC.

Projected costs during the on-going IHS operation resulted in certain economics that are reflected in costs per OPV of $47.22. It is concluded that further reduction in cost per OPV can be effected if the number of patient visits increase, and/or fixed and mobile clinics were operated on a longer schedule.

5.2 ENGINEERING CONCLUSIONS

Commercial off-the-shelf equipment can indeed by synthesized into a reasonably dependable, reliable, and maintainable system. (For example, out of 7390 telecommunications during the May 1975 to May 1977 time period, there were 120 failures, resulting in a 98.38% performance acceptability ratio.) High maintainability with minimum down-time requires skilled maintenance technicians, adequate spares, and redundant communications mode. A back-up audio link is essential.

Operation in a rural desert environment requires attention to several unique situations. Power in rural areas is not stable enough for equipment operation. All equipment that can be should be powered from D.C. power supplies. Where it is necessary to provide A.C., - e.g. for a computer operation, an uninterruptable power system (stable A.C. power supply) should be specified. Sensitive equipment installed in mobile units should be shock-mounted. Protection from dust should be provided, particularly for optical equipment. Consideration should be given to providing positive air pressure inside a mobile van while moving and while in position for dust control. Test in the desert proved this was a feasible method of inhibiting the entrance of fine dust into the mobile unit. Grounding and lightning protection must be installed. Grounding is particularly difficult in rocky ground. Eight-foot copper rods (5/8 in. diameter) must be buried and, in many cases, must be wet down to create an effective ground.

Equipment utilization was found dependent on the capability of the provider, the medical need of the measurement, and the individual assessment of its value. Some equipment was beyond the capability of the provider while others were not needed because of the low incident of the problem. Computers were found valuable in storing and providing current patient histories to the field health care personnel. Software application programs designed to give special aid to the CHM or the hospital nurses and pharmacists were not used frequently because of the low need in a small 50-bed hospital. These programs would probably be very useful in a larger (350 bed) hospital.

5.3 SUMMARY

The STARPAHC concept verified the feasibility (telemedicine plus physician assistant - under the direction of a physician) of delivering quality health care to people in remote areas. The two-years of operational evaluation have provided considerable medical and engineering data which will be valuable to the designers and planners of future health care systems on earth and in space.

The anticipated plus the known benefits demonstrated by STARPAHC will, in time, prove the foresight of those willing to initiate an innovative and unique health care approach. STARPAHC provides a direly needed solution to the major problem of delivering quality health care to people in remote geographical areas.

Appendix A
EVALUATION PLAN

The STARPAHC Evaluation Plan has been structured to provide data and information toward achieving these goals:

- o STARPAHC Improvement
- o Exportability *
- o Acquisition of Space System Design Data

A.1 DATA COMPILATION

Figure A-1 illustrates the hardware evaluation approach. Acquisition of field data is accomplished through the individual site personnel daily records (system operator -- telecommunications records; computer operator -- software/hardware; maintenance technician -- daily maintenance/logistic records; site manager -- summary records and IHS daily operation records). Data from these records is entered into computer-based or manual logs. These log entries are periodically cross-checked and correlated with the IHS medical evaluation data compilations. There are four computer-based logs and two manual logs which, with their data and format, are described in Table A-1.

A.2 ANALYTICAL PROCESS

Raw data in each of the four computer-based logs is reduced to a summary printout giving pertinent data as indicated in Fig. A-1. For example, a report program for the equipment usage log produces total telecommunication transmission by facility, by type of TCE, and lists the quality and purpose of each transmission. Similarly, the Equipment Trouble Reports are summarized on a monthly basis, per specific components or in any format that lends itself to trend analyses or comparative analyses.

* Potential for use in other areas.

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Fig. A-1 Hardware Evaluation Approach

Table A-1

DATA LOGS

- Equipment Usage Log

  The Usage Log identifies Date the equipment was used, Equipment Name, Purpose for the telecommunication, Quality, and Location to Location of the transmission.

- Equipment Trouble and Corrective Maintenance Report

  The Trouble Report identifies Date, Hour, Equipment, Facility, Model, Location, Serial Number, When Observed, and Action Taken. Also, this report indicates parts required and a complete description of the incident. Time back on line and date is also indicated.

- Equipment Preventive Maintenance and Calibration Log

  This report indicates Date, Hour, Equipment Name, Facility, Equipment Type, Manufacturer, Model, Serial Number, Location, and Description of work to be done. This report is very narrative and gives the technician a clear work schedule and exactly what manuals (if any) to use and the frequency and materials required to do any given mairtenance.

- Computer System Statistics

  The Computer Log provides User's Name, Tool Name, Terminal Used, Date Base Number, Number of Inputs from Terminal, and Number of Outputs to Terminal.

- Manual Cost Log

  The Cost Log per se indicates only the original cost of each piece of equipment in the system by equipment types. Cost sources are varied and cover the spectrum of time charge monitoring of Lockheed site personnel to separation of cost as a result of petty cash expenditures. Only direct costs associated with the hardware will be reported.

Brief computer printouts of three computer-based logs follow.

Equipment Usage Log Computer Printout

Periodically, the data from the hand-written log is entered in the evaluation data base within the Varian mini-computer. The hard-copy log is retained as backup for the computer data. A typical example of an equipment usage log computer printout is as follows:

DATE	EQUIPMENT TYPE	PURPOSE	QUALITY	TOTA	LOCAT	LOCAT
01DEC75	VHF	COMMUNICAT	GOOD	.1	MHU	HSSCC
01DEC75	TELEMETRY (OPS)	CONTROL	GOOD	.1	HSSCC	OPS
01DEC75	HOTLINE	COMMUNICAT	GOOD	.1	MHU	HSSCC
01DEC75	COLOR TV, PATIE	CHECK OUT	GOOD	..	MHU	HSSCC
01DEC75	COLOR TV, LAB M	CHECK OUT	GOOD	1.2	MHU	HSSCC
01DEC75	VHF	COMMUNICAT	GOOD	.1	HSSCC	OPS
01DEC75	ORDERWIPE	COMMUNICAT	GOOD	.1	OPS	HSSCC

Table A-1 (Continued)

Equipment Trouble Report Log Computer Printout

This Log is entered as soon as it is reported and remains open until fixed. A brief extract of the computer printout is shown below:

```
DATE:03DEC75
HOUR:0930
EQUIPMENT NAME:MAIN GEN
FACILITY:MHU
FORM NAME: TROUBLE REPORT #1
MODEL:                              30EK-3R
LOCATION:                           MG/A01
SERIAL NO.:
PREPARER:                           P.A.RUIZ
OBSERVED DURING:                    OPERATIONS
INCIDENT CLASS:                     FAILURE
ACTION TAKEN:                       REPLACED HIGH TENSION WIRE BETWEEN -
                                    COIL AND DISTRIBUTOR. *16DEC75*
PARTS REQUIRED:                     1FT HIGH TENSION WIRES *16DEC75*
TIME FOR CORRECTION:                .5 HRS *16DEC75*
DESCRIBE INCIDENT:                  WIRE TO COIL OF DISTRIBUTOR BROKEN.-
                                          IMMEDIATE ACTION:TEMP. F-
                                    IX WITH TAPE.
DATE BACK ON LINE:                  16DEC75 *19DEC75*
TIME BACK ON LINE:                  1000 *16DEC75*
T.R. SERIAL NO:                     302
```

Preventive Maintenance Instructions Log Computer Printout

The Preventive Maintenance Instructions (PMI) supports the Trouble and Corrective Maintenance report for further evaluation as to "why" and "how" the problem occurred and what future action needs to be taken to prevent a reoccurrence.

```
DATE:01DEC75
HOUR:0003
EQUIPMENT NAME:AUDIO/INST. RECORDER
FACILITY:HSSCC
FORM NAME: PM REPORT #1
MANUFACTURER:                       H.P.
MODEL:                              3960F-005
SERIAL NUMBER:                      2116
LOCATION:                           H02/A14
MATERIALS USED:                     HEAD CLEANER & COTTON SWABS
TOTAL TIME:                         0.2)
```

The reduced raw data are next subjected to an analytical process that yields products such as arithmetical ratio, usage trends, performance acceptability ratios, transmission usage time, monthly comparisons, and frequency/distribution of equipment usage. Two of the analytical processes are concerned with (1) anomalies (any measurement/data that deviates from normal performance -- fair, poor, not acceptable quality ratings) and (2) cost. The cost analysis collects capital equipment and operational costs and then relates the data to the system and medical usage time and to the number of patients treated. This affords a measurement of the effectiveness of the system.

The products of the analytical process as shown in Figure A-1 furnish the basis for conclusions and recommendations.

Resulting actions, as indicated in Figure A-1, are directly associated with meeting the three evaluation goals. Specific system or design changes and cost improvements are typical of the resulting actions.

A.3 DATA AUDIT

Three methods of auditing the accuracy of the entries in the equipment usage log are (1) local surveillance, (2) surveillance during visits, and (3) review of computer printout correlated against the system manager log, the two system operator's daily written reports, and the maintenance technician daily report.

The site manager oversees and routinely checks the entries on a daily basis as part of his preparation of his daily system status report. Spot checking on accuracy of entries is done directly while observing daily occurrences.

LMSC Sunnyvale personnel, on periodic visits to the site, also directly observe entries and verify accuracy on a sampling basis. The most important surveillance is scrutiny of the daily tape printout. Because there are hourly communications with site personnel on a variety of items, status of conditions, troubles, and incidents are being discussed continually. Accuracy of the entries can be verified by cross-checking the source of information. Errors in entry have been detected and corrected by this means.

A.4 MEDICAL EVALUATION APPROACH

The purpose of this section is to provide a description of the procedures, data sources and methods utilized in the medical evaluation approach.

There are some differences between the medical usage statistics and the hardware usage statistics. This section will clarify the reasons for these differences.

The primary reason for the apparent difference lies in the different approaches taken by the evaluation studies. The medical evaluation analyzes the use of the STARPAHC equipment from the viewpoint of the impact upon patient care, whereas the hardware evaluation assesses the performance and use of equipment types.

One tool used in the medical evaluation is the analysis of each "patient episode" where telecommunication equipment is being utilized.

The hardware evaluation as discussed in previous sections, analyzes the use of each component of the telemedicine system. One parameter is the purpose of the use of each piece of communications equipment. Of the six purpose categories listed, two are related to patient services, i.e., Medical Administration and Clinical Consultation. The two patient service purposes are abbreviated as "MED/ADM" and "CHM/PHY", respectively.

The purpose for each transmission requested by the health care staff is logged by the console operator at the Sells Hospital (HSSCC). If the request is for medical records personnel to come to the physician's console room, then the purpose is always designated medical administration (MED/ADM). If the field request is for a telephone connection to another Sells office, such as the laboratory, medical records, or the pharmacy, then this purpose is also designated as MED/ADM. All requests for the Sells physicians, dentists, physical therapists etc. are entered as a clinical consultation purpose (CHM/PHY).

The Sells system operator can usually ascertain the correct purpose except when the privacy switch is in operation. The operator has been instructed not to ask the health service staff for the purpose to avoid interruption of the dialogue. If a voice connection is utilized (i.e., hot line, hands-free MUX or VHF), by the system operator or the health care staff, to discuss problems unrelated to any individual patient, then the operator has been instructed to code the purpose as "communication". If the health staff has the time to send reference signals, then this calibration activity is coded as "check out".

A.5 DATA SOURCES USED FOR MEDICAL EVALUATION

Both the hardware and medical evaluation have one common source, the systems operator's logs. The medical evaluation uses the following additional sources.

A.5.1 The Telecommunication Evaluation Forms (Tables A-2 and A-3)

These forms are to be filled out by both the sender and the receiver immediately after each teleconsultation. The information requested on each form is slightly different but similar in most respects. These forms are completed only by the health care staff, and only for transmissions relative to individual patients. Evaluation forms are filled out even when transmissions are classified as "poor" or "not acceptable". The

Table A-2

TELECONSULTATION EVALUATION FORM FOR SELLS CONSULTANTS

1) Patient ID #_____

2) Date_____

3) Provider Code of Consultant_____

4) Consultation with (Check One):
- ☐ 03 - Santa Rosa
- ☐ 77 - Ambulance
- ☐ 83 - [illegible]
- ☐ Pa-- rath.
- ☐ 98 - Other

5) Reception - Indicate (✓) below, quality of transmission for each modality received during this consultation:

	Good	Fair	Poor	
a. Color TV	☐	☐	☐	
b. Color Endoscope	☐	☐	☐	
c. Color Microscope	☐	☐	☐	
d. Black & White TV	☐	☐	☐	
e. Cardioscopescope	☐	☐	☐	
f. Voice	☐	☐	☐	
g. Data	☐	☐	☐	
h. ECG	☐	☐	☐	
i. X-ray	☐	☐	☐	
j. Regular Telephone	☐	☐	☐	
k. Hotline	☐	☐	☐	
l. Video Tape Viewed	☐	☐	☐	Save Video Tape: Yes ☐ No ☐
m. Other_____	☐	☐	☐	
n. Audio Tape Used	/1/	/2/	/3/	

6) Transmission - Indicate (✓) below, each modality you wanted to use but were unable to transmit during this consultation and reason why:

	Too Diff. Or Time Consuming	Schedule Problem	Patient Refused	Equip. Failure	Equip. Not Available	Other - Specify
a. Black & White TV	☐	☐	☐	☐	☐	6._____
b. Voice	☐	☐	☐	☐	☐	6._____
c. Data	☐	☐	☐	☐	☐	6._____
d. Video Tape	☐	☐	☐	☐	☐	6._____
e. Regular Telephone	☐	☐	☐	☐	☐	6._____
f. Hotline	☐	☐	☐	☐	☐	6._____
g. Slow Scan TV	☐	☐	☐	☐	☐	6._____
h. Other_____	☐	☐	☐	☐	☐	6._____

7) Indicate (✓) your impression of the result of this teleconsultation (Indicate responses for items a - g):

	None	Some	Great
a. Confirmed or reassured first impression	☐	☐	☐
b. Assessment of patient problems more definite	☐	☐	☐
c. Change in treatment plan	☐	☐	☐
d. Educational value to yourself	☐	☐	☐
e. Education value to remote provider or patient	☐	☐	☐

	No One	PHH	CHR	Sells	PIHC	Tucson	Other
f. Generated a referral to	☐	☐	☐	☐	☐	☐	☐
g. Eliminated a referral to:	☐	☐	☐	☐	☐	☐	☐

h. Other result or impact_____

8) In summary, this teleconsultation was (Check One):

a. ☐ Critical for the proper care of this patient
b. ☐ Important or useful
c. ☐ Of little or no value
d. ☐ Confusing or harmful

FORM SEA 775

Table A-3

TELECONSULTATION EVALUATION FORM FOR SANTA ROSA CLINIC AND MOBILE HEALTH UNIT

1) Patient ID #_____

2) Date_____

3) Provider Code_____

4) Consultation with (Check One):
- ☐ 01 - Sells
- ☐ 02 - Santa Rosa
- ☐ 03 - MHU
- ☐ 04 - PIMC
- ☐ 98 - Other

5) Reception - Indicate (✓) below, quality of transmission for each modality received during this consultation:

	Good	Fair	Poor
a. Black & White TV	☐ 1	☐ 2	☐ 3
b. Voice	☐ 1	☐ 2	☐ 3
c. Data	☐ 1	☐ 2	☐ 3
d. Video Tape Viewed	☐ 1	☐ 2	☐ 3
e. Regular Telephone	☐ 1	☐ 2	☐ 3
f. Hotline	☐ 1	☐ 2	☐ 3
g. Other_____	☐ 1	☐ 2	☐ 3
h. Audio Tape Used	/1/	/2/	/3/

6) Transmission - Indicate (✓) below, each modality you wanted to use but were unable to transmit during this consultation and reason why:

	Too Diff. or Time Consuming	Schedule Problem	Patient Refused	Equip. Failure	Equip. Not Available	Other - Specify
a. Color TV	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	6._____
b. Color Endoscope	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	6._____
c. Color Microscope	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	6._____
d. Black & White TV	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	6._____
e. Cardiostethoscope	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	6._____
f. Voice	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	6._____
g. Data	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	6._____
h. ECG	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	6._____
i. X-ray	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	6._____
j. Regular Telephone	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	6._____
k. Hotline	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	6._____
l. Other_____	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	6._____

7) Reason for initiating teleconsult (Check One or More):

- a. ☐ For help in diagnosing or treating patient problem
- b. ☐ Patient request
- c. ☐ Educational
- d. ☐ By instruction or protocol
- e. ☐ Other reason - specify _____

8) Indicate (✓) your impression of the result of this teleconsultation (indicate responses for items a - f):

	None	Some	Great
a. Confirmed or reassured first impression	☐ 1	☐ 2	☐ 3
b. Assessment of patient problem more definite	☐ 1	☐ 2	☐ 3
c. Change in treatment plan	☐ 1	☐ 2	☐ 3
d. Education value to yourself.	☐ 1	☐ 2	☐ 3
e. Education value to patient	☐ 1	☐ 2	☐ 3

	No One	PHN	CHR	Sells	PIMC	Tucson	Other
f. Generated a referral to:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
g. Eliminated a referral to:	/1/	/2/	/3/	/4/	/5/	/6/	/7/

h. Other result or impact_____

9) In summary, this teleconsultation was (Check One):

- a. ☐ Critical for the proper care of this patient
- b. ☐ Important or useful
- c. ☐ Of little or no value
- d. ☐ Confusing or harmful

protocol has excused the health staff from completing these forms only when a voice transmission is requested via a telephone patch to a site other than the physician's console room. This exception was made at the request of the health staff to avoid the paper work. However, these transmissions are logged by the systems operator under the appropriate identification number for the patient. The other exception is when only patient data has been requested by the field staff from the STARPAHC computer at Sells.

In addition, each Sells consultant's form is stamped by a time clock at the beginning and the end of each television consultation. From this information, the time and cost by health service staff category may be calculated.

A.5.2 The Computer Printouts from the Health Information System (HIS) (Table A-4)

Each month, all patient visits to the mobile unit and to the Santa Rosa Health Clinic are received by the IHS evaluation office. The patient's name, identification number, health provider and health problems are included in this printout along with other information. This request is processed for each month at the end of the third week of the following month. This delay is for the purpose of including as many late patient encounter forms as possible and yet be able to produce a timely monthly report.

Table A-4

HIS MONTHLY PATIENT TABULATION

FACILITY: MOBIL HEALTH

••••••••••CONFIDENTIAL MEDICAL INFORMATION••••••••••

10/21/75

Patient's Name & Exact ID Deleted to Protect Privacy

PATIENT NAME DELETED

BIRTH DATE	SEX	HR NO.	ENCTR FAC	ENCTR DATE	O I	F Q	P S	PROV	LCDA. STAGE	DIAGNOSIS
09/10/928	M		000183	09/02/75	O	1	2	11	01/0091-1	DIARRHEA I
09/10/928	M		000183	09/02/75	O	1	1	11	01/401 -	HYPERTENSION CHECK
09/10/928	M		000183	09/02/75	O	1	2	11	01/7873-	PAIN L HIP
07/04/927	F		000183	09/02/75	O	1	2	11	01/9160-	ABRASIONS L LEG
07/04/927	F		000183	09/02/75	O	1	1	11	01/401 -	HYPERTENSION CHECK
07/16/948	F		000183	09/02/75	O	1	1	05	01/0340-	TREATED FOR POS STREP THROAT
07/09/935	F		000183	09/02/75	O	2	1	11	01/5990-	F U, U T I
11/11/966	F		000183	09/02/75	O	1	1	11	01/380 -	BILATERAL OTITIS EXTERNA
11/11/966	F		000183	09/02/75	O	1	2	11	02/9000-	SCHEDULE I V P, U T I SURVEILLANCE
03/17/950	F		000183	09/02/75	O	2	1	11	01/465 -	U R I
03/17/950	F		000183	09/02/75	O	2	2	11	01/8479-	BACK STRAIN
01/11/965	F		000183	09/02/75	O	2	1	11	01/8930-	LACERATION TOE, R FOOT
08/28/948	M		000183	09/02/75	O	1	2	11	01/V049-	G C CONTACT
08/28/948	M		000183	09/02/75	O	1	1	11	01/401 -	HYPERTENSION CHECK
03/19/938	M		000183	09/02/75	O	1	1	11	01/7855-	ABDOMINAL DISCOMFORT UNCERTAIN ETIOLOGY
02/05/953	F		000183	09/02/75	O	1	2	11	01/0049-	SUSPECT SHIGELLA
02/05/953	F		000183	09/02/75	O	1	1	11	01/401 -	HYPERTENSION CHECK
06/22/971	F		000183	09/02/75	O	2	1	11	01/9969-	F U TRAUMA, HEMATURIA
07/31/972	M		000183	09/02/75	O	2	1	11	01/684 -	IMPETIGO SCALP, IMPROVED
12/15/973	M		000183	09/02/75	O	1	1	11	01/V005-	IMMUNIZATIONS, WELL CHILD EXAM
07/01/936	M		000183	09/03/75	O	2	1	11	01/8100-	F U FX R CLAVICLE
02/28/927	M		000183	09/03/75	O	2	1	11	01/2959-	SCHIZOPHRENIA, THORAZINE REFILL
08/13/954	F		000183	09/03/75	O	1	2	11	01/V009-	GRAVINDEX NEGATIVE
08/13/954	F		000183	09/03/75	O	1	1	11	01/465 -	U R I
12/25/955	F		000183	09/03/75	O	2	1	11	01/V060-	PRENATAL
05/13/965	F		000183	09/03/75	O	1	1	11	01/7099-	LESION R 3RD FINGER
03/15/942	F		000183	09/03/75	O	2	1	11	01/V060-	PRENATAL

••••••••••CONFIDENTIAL MEDICAL INFORMATION••••••••••

10/21/75

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A.5.3 The Patient's Health Records (Table A-5)

The complete hard copy health record for each patient whose encounter involves a STARPAHC transmission is analyzed by the evaluation office. The purpose is to describe the results of the communication within the total context of the patient's problem. The time intervals between the steps in the process of health care, and the miles traveled by the patient are documented. (The process of health care includes the time and distance between the occurrence of the problem and the first contact with the health system, the time between first contact and symptomatic treatment, first impression and definitive diagnosis, definitive diagnosis and definitive treatment, and finally, time of resolution of the problem.)

The HIS system also provides narrative medical summaries for certain patients. Patient's records are selected for critical case review if a clinical consultation utilizing the STARPAHC television equipment occurred or if the consultation results are coded as either "critical for the proper care of the patient" or "confusing or harmful" in the opinion of the health staff.

A.5.4 Interviews with the Health Staff and Patients

The STARPAHC evaluator interviews all users of the system when there is difficulty in reconstructing a patient transmission selected for critical case review. These difficulties usually arise because of incomplete records or incongruous records.

Periodically interviews are conducted by a trained behavioral scientist with all the health staff using a structured questionnaire. Other questionnaires are designed to be administered by Papago speaking interviewees to residents of communities served by the MHU.

TABLE A-5

HEALTH SUMMARY FROM THE HEALTH INFORMATION SYSTEM

```
                                    ◆◆◆◆CONFIDENTIAL PATIENT DATA◆◆◆◆

HEALTH SUMMARY
  (06/04/76)

NAME: DOE-000001 ,JANE          PMID
LITTLE TUCSON      AZ
SEX: FEMALE
BIRTH: 07/01/1927
MOTHER: MOM-LAST    ,MOM-FIRST    MMID
SSN: 526-47-5634
INT ID: 6-000001
REGISTER NOS:
HYPER REG 00-01-HY-002869
R.F. REG  00-01-RF-002869
H.R. NOS:
SELLS       00-01-01-006688
S.X.        00-01-02-010278
S.R.        00-01-03-001934
PISINEMO    00-01-04-000960


MEASUREMENTS

   DATE        WT   PCT  HT PCT  BLD PRS  HD CIRC
 04/08/76   137-08              140/100
 01/06/76                       134/080
 12/03/75   180-00              130/100
 10/17/75   176-08        64    100/080


VISION
                                UNCORR  CORR
03/21/75     SELLS          L 20/050
                            R 20/050
                                    ◆◆◆◆CONFIDENTIAL PATIENT DATA◆◆◆◆


ACTIVE PROBLEMS

  025 04/11/75 034 SELLS        ANTICOAGULATION
  004 03/04/69 097 PISINEMO     DIABETES MELLITUS
  016 03/11/69 024 SELLS        OBESITY EXOGENOUS
  027 07/29/75 034 SELLS        PERIPHERAL NEUROPATHY
```

TABLE A-5 CONTINUED

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INACTIVE PROBLEMS

015	03/13/74	030 SELLS	ANXIETY REACTIONS
007	02/28/73	025 SELLS	OTITIS MEDIA SUPPURATIVE CHRONIC PSEUDOMON
023	07/29/75	034 PISINEMO	R OTITIS MEDIA
022	07/29/75	034 PISINEMO	STASIS ULCER L LE5

ACTIVE MEDICATIONS

04/20/76	DIGOXIN	1 TAB 250 MCG	1 TIME /DAY	030
04/14/76	HYDROCHLOROTHIAZIDE	1 TAB 50 MG	1 TIME /DAY	03
04/14/76	K-LYTE	1 TAB 25MEQ K	2 TIMES/DAY	060
04/14/76	ACETOHEXAMIDE	1 TAB 500 MG	3 TIMES/DAY	090
04/08/76	BACITRACIN	9 OINT 500U/GM	1 TIME /DAY	01
04/08/76	DETERGENT, SURGICAL	9 SOLN 3 PCT	1 TIME /DAY	30

◆◆◆◆CONFIDENTIAL PATIENT DATA◆◆◆◆

INPATIENT ENCOUNTERS

10/15	10/17/75	SELLS	GASTROENTERITIS, SHIGELLA ISOLATED
			DIABETES MELLITUS. MEDICATION NONCOMPLIANC
			RHEUMATIC HEART DISEASE
10/14	10/15/75	CHS OTHER	R S H D WITH TACHYCARDIA, ATRIAL FIBRILLATIO
08/07	08/12/75	SELLS	UTERINE MYOMA
			DIABETES MELLITUS
			MITRAL STENOSIS. CONGESTIVE HEART FAILURE
			MEDICATION OVERDOSE.DIGOXIN,COUMADIN,DYMEL
04/07	04/11/75	SELLS	MITRAL STENOSIS,ATRIAL FIBRILLATION.ANTICO

OUTPATIENT AND FIELD ACTIVITIES

04/20/76	MD	SELLS	2 MITRAL STENOSIS 5 III F C
04/14/76	MD	SELLS	2 MED REFILL
04/08/76	CHM	SELLS	1 PUNCTURE WOUNDS L LOWER LEG
03/16/76	LPN	MHU	2 R F PROPHYLAXIS
03/10/76	DCP	HOME	2 RHEUMATIC FEVER F U
03/01/76	DCP	HOME	2 RHEUMATIC FEVER
01/20/76	MD	SELLS	2 MITRAL STENOSIS,ATRIAL FIBRIL,FUNCT II,III
01/20/76	DCP	OTHER	2 PT TRANSPORTED FOR CARDIAC CLINIC
01/15/76	DCP	HOME	2 WELL PATIENT VISIT
01/15/76	PHN	HOME	2 DIABETIC

TABLE A-5 CONTINUED


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SCHEDULED - ENCOUNTERS

IMMUNIZATIONS

 SMALLPOX  B 11/18/64
 DT        3 10/07/64
 SABIN TRI 3 12/02/64
 INFLUENZA 2 01/02/74
 INFLUENZA   12/12/73

                                  ◆◆◆◆CONFIDENTIAL PATIENT DATA◆◆◆◆

SKIN TESTS

 TINE        12/29/71
 PPD         04/11/75 N 00
 PPD         09/07/73 N 00
 PPD         05/05/70 N

LAB/X-RAY RESULTS

          04/20/76 03/12/76 01/20/76 01/06/76 12/19/75 12/03/75 10/16/75
FBS                                                      390.     284.
POTASSIUM                                                          4.2

SPECIAL SURVEILLANCE
      HYPERTENSION
         PATIENT IS HYPERTENSIVE CHECK BLOOD
         PRESSURE, WEIGHT + COMPLIANCE WITH PLAN
        ◆05/14/76  DUE FOR MED REFILL

REGULAR SURVEILLANCE STATUS

              LAST      NEXT

◆DT          10/07/64  DUE NOW

◆COCCI                 DUE NOW


 CH X-RAY    04/20/76  04/20/77
◆PAP         01/22/75  DUE NOW

◆BREAST      04/11/75  DUE NOW
 HEART       08/20/75  08/20/76
 RECTAL      07/02/73  07/02/76

◆◆◆◆END◆◆◆◆                      ◆◆◆◆CONFIDENTIAL PATIENT DATA◆◆◆◆
```

A.5.5 Data Source Common to Both Evaluations (Table A-1)
Both studies utilize a computer printout titled "Equipment Usage Log". The program is constructed from the console operator's logs. It includes the date, type of equipment used, locations involved in the transmission, purpose of the use, and the quality of the signal as estimated by the operator.

In one respect, the printout for the hardware evaluation differs from the printout for the medical evaluation. The hardware evaluation form contains the time in minutes that each component was in use. The retrieval report used for medical evaluation contains the patient's identification number for each use of each piece of communications equipment instead of the elapsed time.

A.6 PROCEDURES FOR ANALYSIS OF UTILIZATION REPORTS
At the end of each month, the telecommunication evaluation forms from the IHS staff are received by the STARPAHC evaluator.

The computer printout from the equipment usage logs maintained by the Sells systems operator is also received. Comparisons are made, and a list of patient transmission discrepancies is generated and sent to the system operator. The operator then consults the daily hand-written logs for those transmissions reported by IHS, but not indicated in the equipment usage log printout. The missing patient consults are entered into the computer if they can be located in the daily log and matched to the patient's identification number. However, the tables prepared by the IHS evaluator for the monthly reports include all known patient transmissions whether or not they were recorded by the systems operator.

Transmissions known to the systems operators, but for which the IHS staff failed to return evaluation forms, are included in the tables reporting the ratio of use, by site and purpose, and whether voice or television was used. Charts are then located for clinical use of television (as reported by the systems operators) and analyzed for impact whether or not IHS evaluation forms are available. Only a sample of cases were used due to staff time constraints.

Occasionally, the printout indicates that a clinical transmission occurred using certain communications equipment but the operator failed to indicate the patient's identification number. If an IHS evaluation form with an identification number is available for these transmissions, then both the hardware and medical reports will include this information, and the printout will be corrected. If no information is available to relate the transmission to an identifiable patient, then this consult will not be tallied in ths IHS report. However, the hardware report will include in the totals the fact that specific items of equipment were used for clinical or administrative purposes.

The following example using a portion of the equipment usage printout should clarify the above procedure:

05May75	x	TEL-CPLR	MED/ADMIN.	GOOD	HSSCC	MHU
05May75	x	HANDSFREE, MUX	MED/ADMIN.	GOOD	MHU	HSSCC
05May75	x	HOTLINE	COMMUNICAT	GOOD	MHU	HSSCC
05May75	x	HANDSFREE, MUX	MED/ADMIN.	GOOD	MHU	HSSCC
05May75	x	HOTLINE	COMMUNICAT	GOOD	MHU	HSSCC
05May75	x	HANDSFREE, MUX	MED/ADMIN.	GOOD	MHU	HSSCC

This use of equipment occurred on May 5, between the mobile unit and the Sells hospital. In the column where the patient's number should appear, an "x" is seen instead. The purposes were indicated by the systems operator as "medical administration" and as "communicat ion" referrable to a patient.

In order to avoid losing potentially valuable data, it was agreed that the hardware tally should include these data. However, it is impossible for the IHS evaluator to decide from this data alone whether one or six patient episodes occurred. Therefore, this information is omitted from the IHS report. Every effort is made to find the missing patient numbers from the IHS evaluation reports and correct the printout.

The totals of specific pieces of equipment used in medical transmissions in the hardware reports cannot be equal to the total of patient episodes. One patient episode could potentially account for the use of from one to twenty-two different components of STARPAHC communications equipment to complete the consultation. (The list of equipment used in the hardware evaluation does not include any computer components, nor any non-communication equipment utilization such as microscopes, X-ray machine, incubators, etc.). Few, if any, episodes used more than 8 components.

A.7 PROCEDURES FOR ANALYSIS OF PATIENT VISITS

The tally of patient visits to the mobile and fixed clinics is provided by the Health Information System printout. The information on this printout includes ID and district of residence of the patient.

The IHS evaluator requests this printout three weeks after the end of the previous month for monthly reports, and eight weeks after the end of the quarter for quarterly reports. This delay is necessary so that patient encounter forms that are delayed for being entered into the computer can be counted.

Only those "encounters" forms that relate to an actual visit to a site for health services are counted in this printout.

Each IHS evaluation form (as discussed under A.5.1) recording a STARPAHC transmission and a patient number is checked against this evidence of a patient encounter as listed in the HIS printout. The quarterly listing of all diseases and patient problems for which the STARPAHC equipment was utilized is prepared after correlation and corrections are made.

Patient encounter forms are utilized by the health staff for many purposes other than to record an actual patient visit. Some of these purposes are to keep the computerized medical summary up to date by recording information obtained before or after the actual patient visits; to record medication renewals given to a patient attending a clinic but intended for another patient not in attendance; to schedule appointments for patients not in attendance; and many other purposes. These encounters are not totaled as patient visits in the IHS monthly evaluation reports. They are included under the category of "Other Patient Services" in the IHS quarterly reports.

On the other hand, many patients visit facilities in person and no encounter forms are generated. These visits may be for the purposes of: Bringing a specimen for a laboratory test that was requested during a formerly recorded encounter, to make an appointment for themselves or someone else, to bring letters or other documents requested by health providers, and many other reasons. On rare occasions, the provider fails to complete the encounter form, or the form fails to reach the keypunch operator in Tucson.

In addition to obtaining the number of patient visits from the HIS printout, the medical evaluation reports also include the total patient "problems" that are listed for each visit. Some "problems" as written by the health provider are actually reasons for the visit rather than health problems such as "immunizations", "well child exam".

The total of patient visits, and the total patients' problems are used to calculate two different ratios for equipment utilization in the STARPAHC project.

A.8 LIST OF MEDICAL TABLES AND CORRELATIONS TO BE COMPILED MONTHLY IN THE EVALUATION REPORTS

1. Frequency of use by site and type of communication (voice or television).
2. Patient utilization by day for two CHM sites equipped with telecommunications (Mobile Clinic and Fixed Health Center).
3. Frequency of use of STARPAHC communications equipment by health provider category and site.
4. The reason for initiating telecommunications by site.
5. The type of impact from the completion of the telecommunication by degree.
6. The value of each telecommunication by type of health provider.
7. Frequency of failure to complete a desired telecommunication by type of equipment and reason.
8. Correlation table of patient episodes where telecommunications were used by data source (IHS or TMSC) and reason for use.
9. Summary of each patient episode where television was used for clinical consultation.
10. Summary of each patient episode valued by IHS staff as being "critical for the proper care of the patient" or "confusing or harmful".
11. Telecommunications ratio of use by number of patient visits and number of recognized patient problems.

A.9 QUALITY OF CARE STUDIES

A series of about 50 computer programs were designed to measure the quality of care rendered by the health system relative to specific tracer conditions. Each quality measurement program uses the data in the health information system gathered by the providers at the time of each patient encounter. The programs were developed as part of an IHS Experimental Medical Care Review Organization (EMCRO), originally funded by DHEW, National Center for Health Research.

Appendix B
STARPAHC SYSTEM DESCRIPTION

STARPAHC combines basic health care facilities, and supporting technical services into a health care delivery system. The STARPAHC operational concept is based on utilizing the professional IHS staff of the Sells Hospital, where the HSSCC is located, to provide direction and consultation to paramedical and technical personnel stationed at the remote clinics, LHSC, and the MHU. The interchange of information between the HSSCC, LHSC, and MHU is accomplished by voice, data, and video communication links. Computer-based data management techniques implements record keeping, data retrieval and data analysis.

The STARPAHC elements are operated by a team consisting of IHS-provided physicians and health-care professionals and by LMSC-provided technical personnel. Remote health-care professionals are under the direct supervision of an IHS physician at Sells by means of voice, data, and video communication channels between the STARPAHC elements interconnected by the relay station on Quijotoa (as depicted in Figure B-1). The configuration as shown in Figure B-1 consists of:

- o The control center, located in one wing of the Sells Hospital. It is staffed by IHS physicians and LMSC Telemedicine system operators.
- o A local health service center at the Santa Rosa Clinic. It is staffed by IHS CHM's and functions as a fixed remote clinic.
- o A mobile health unit. This is a clinically equipped van-type vehicle that is staffed by an IHS CHM and an IHS practical nurse. It functions as a remote mobile clinic, visiting a number of villages on a preselected route and schedule.

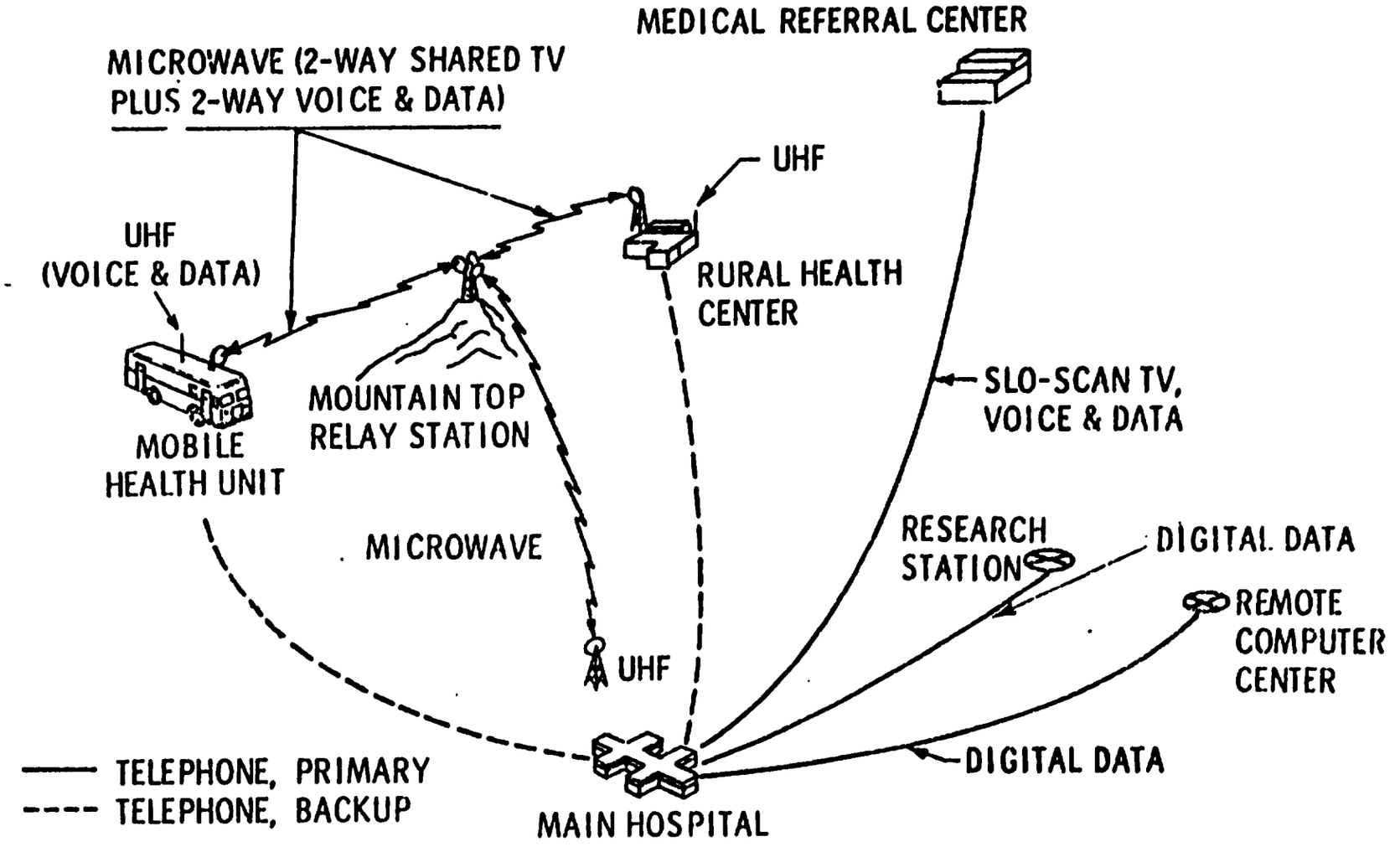

Fig. B-1 Typical Telemedicine System

- o The Phoenix Referral Center. This facility provides a Telemedicine room in the Indian Health Service Hospital in Phoenix for access to specialists (through audio and slo-scan television links) from the control center.
- o The Albuquerque Computer Center. This facility provides STARPAHC data system access to the Indian Health Service patient information system data base.
- o The Quijotoa Relay Station. This station is used for microwave transmission of television, voice, and data and VHF voice/data between major system elements.

B.1 HSSCC

The Indian Hospital at Sells, Arizona contains the Control Center of the system. Here, the physician directs the community health medics and laboratory technicians, communicates with patients, and calls up data to assist in the examination and treatment of patients.

The physician also can consult with specialists at the Phoenix Indian Health Hospital and can direct the system operator to perform specific functions such as recording a TV image, sending slo-scan TV X-ray images to Phoenix, and selecting other needed communications modes.

The nerve center of the STARPAHC communications system is contained in the Operator/Communication room at Sells. From the operator's console, the system operator interconnects all video, voice, and data links in the system by means of the equipment in the room. Communication outputs and inputs are provided in three separate modes: microwave (video, voice, data); VHF radio (voice, data); and telephone (voice, data, single-phased recorded video).

The data equipment room at Sells contains the computer system and data bank and peripheral data equipment. STARPAHC data is fed into the computer from LHSC, MHU, an -ther remote location video display, teletypewriter, and printer sources. This information is stored in the data base for playback to all sources or to the Albuquerque Computer Center (ACC). Information at the ACC can also be received and routed to STARPAHC locations by the Sells computer.

The Physician's Room at Sells contains equipment and apparatus allowing the physician to view, hear, and direct medical activities at the MHU and the LHSC, to communicate visually or by voice with all other elements of the STARPAHC system; to ask for and receive computerized patient's records and other data; and to have consultation with other physicians at the PRC. The Physician carries out these activities with a minimum of controls from his desk at the Physician's Console. In addition to the Console, he has at his disposal a 3-channel ECG cart with cardioscope/strip-chart recorder, and a B&W TV camera and X-ray film viewer. A dedicated B&W TV camera is housed in his console to provide his image to the patient at the MHU and LHSC. All of this equipment can be operated by the physician while seated at the console.

The HSSCC provides space for a VHF radio controller to enable communications with the existing IHS ambulance radio frequency. An area and interface capability is also provided at the HSSCC for a base station for communication with a Portable Ambulance Module (PAM) installed in the IHS Ambulance Van.

Interface between the HSSCC and the Albuquerque Computer Center is by high-speed serial-digital signals via telephone lines.

B.2 LHSC

The Santa Rosa Clinic is an existing clinic whose capabilities are enhanced by the telecommunication equipment provided by the STARPAHC system. The clinic is well equipped and staffed by paramedical personnel, laboratory technicians, and a secretary/receptionist. It provides the physician at the hospital control center with an "outreach" capability to deliver quality health care to patients through the STARPAHC system. There are three rooms in the clinic used for STARPAHC applications.

The Emergency Room at the Santa Rosa Clinic contains the STARPAHC operational console which is the central controlling unit for all of the clinic's STARPAHC equipment. The console controls the transmission and reception of visual and audio signals to and from Sells Hospital from several rooms including the Emergency Room. It also contains the individual controls that operate the two TV cameras and the intercom. One camera is used for patient viewing while the other is used for endoscopic examinations. A video data terminal is located in the room to receive, send, and display information to and from the HSSCC computer.

The Examination Room, like the Emergency Room, has an intercom system and a video data terminal (identical to the emergency room's unit), a B&W camera and monitor is located in the room that can be used for sending X-ray images or any other visual data and can also be used for patient monitoring.

The Laboratory at the Santa Rosa Clinic has intercom units, a color TV camera matched to a standard binocular microscope, and a color monitor for viewing the transmitted slide image.

The Data Management area is a small room outside of the main entrance to the clinic. The room contains the two equipment rack assemblies that power and control all of the television, voice, and data communications equipment. The room is air conditioned to provide cool operating temperatures for the equipment, and comfort for maintenance personnel. A room-to-room intercom is provided

A 55-KW Auxiliary Generator is permanently mounted on a concrete foundation outside by the rear of the LHSC. This generator provides electric power to the clinic and all electric equipment in the event of a failure of the regular power supply.

B.3 MOBILE HEALTH UNIT (MHU)

The MHU is a smaller version of the Santa Rosa Clinic. It serves rural populations by scheduled visits to four Papago Villages Monday through Thursday. Friday and Saturday are used for clean-up, maintenance, and repair. Overall vehicle specifications are:

Overhead Clearance	16 ft
Vehicle Width	8 ft
Vehicle Length	35.6 ft
Vehicle Length with Trailer	51 ft
Maximum Permissible Speed	45 mph
Fuel Capacity	60 gal

The MHU has four areas: 1) Cab, 2) Examination Room, 3) Reception/Communication/Lab Room, and 4) X-Ray Room. A 30-KW generator is mounted on a trailer which is towed behind the MHU.

The MHU has a number of two-way communication devices, both audio and visual, to permit full coverage of all situations between the MHU and Sells Hospital. The MHU roof antenna allows microwave TV and voice transmission from and to HSSCC via the Quijotoa Relay Station. VHF capability between LHSC and HSSCC is also available. Teletype and data equipment, both visual and printout, are provided for data input and retrieval, and the equipment is connected into computers serving the system. Inside the van, a

room-to-room intercom is provided. When the van is unattended, an outside VHF handset can be used for emergency calls to Sells, and an alarm system will automatically sound an alert at Sells in case of fire, break-in, or an emergency call.

Most of the communications equipment in the MHU is controlled by or through the control panels located in each of these rooms. A hotline RF telephone is wall-mounted in both the Examination and the Reception Rooms which allows private talks with the HSSCC physician or operator.

Color TV monitors are provided in the Examination Room and the Laboratory area for monitoring transmitted images or for monitoring the transmitted Sells physician image. A B&W monitor is used in the X-ray room to view the transmitted X-ray images. Color TV cameras are used to send color pictures of the patient to the physician's console at Sells. One camera is used for standard patient viewing while the other is used for endoscopic examinations. A color TV camera combined with a microscope is located in the laboratory area for transmission of microscopic slide images.

A teleprinter is used in the reception area for sending or retrieving printed patient's records and other information. A CRT data terminal is located in the examination room which performs a similar function.

B.4 QRS

The QRS is located on the Quijotoa range which is approximately 3800 feet high. A good access road is available that is easily negotiated by a 4-wheel vehicle. The QRS provides a central location covering 350 degrees of coverage over the Papago Indian Reservation. There are three dual-feed dish antennas mounted on a 30-ft tower. They are dedicated to the HSSCC, LHSC, and MHU. The MHU antenna positioner can be rotated through 350 degrees covering all village stops presently scheduled and is capable of extending village coverage if needed. There is an 8' x 8' air conditioned shelter housing the communication equipment, battery charger, and batteries. A 2.5-KW wind generator provides primary power and a 6-KW diesel generator provides backup power.

B.5 PRC

The Indian Health Hospital at Phoenix, Arizona, which is referred to as the Phoenix Referral Center, is staffed with and has access to medical specialists. In the STARPAHC system, these specialists will be called upon to consult with the physicians at the HSSCC when unique or complex medical advice is in order. To enhance the consultation, the system provides the capability for transmitting X-rays or pictures of the patient, lesions, etc., via slow-scan TV using existing telephone lines. These same telephone lines also provide capability for voice communication and data transmission between the HSSCC and the PRC. The slow-scan capability provides X-rays or picture transmission in two minutes. It inherently records the transmission which enables almost unlimited playback capability for extensive, repetitive studying at different times and for various durations.

Appendix C

MAJOR EQUIPMENT LIST

The following appendix provided an accountability record during the two year operation and also served in a modified form as a record for the transfer of accountability from NASA-JSC to IHS. A location coding is provided that is listed on the inventory list as well as other descriptions of the equipment item. Replacement cost data is as mid-1974, and as shown totals approximately $994,000.

The following Inventory List identifies, locates, and gives 1974 replacement cost on all STARPAHC equipment, including Spares. The primary purpose of the List is to assist those assigned responsibility for the hardware selection details of future telemedicine systems.

The Inventory List describes each line item under seven headings in the following sequence, left-to-right:

Location Reference (See Coding List)
Description of Item
Manufacturer
Model
Serial No.
LMSC Engineering Drawing Reference (last three digits of drawing used)
Cost

Location Coding List follows.

LOCATION CODING LIST

HSSCC

HA	Admitting Office
HB	Base Station (PAM)
HC	Computer Room: #123
HC1	Central Processing Unit Console
HC2	Card Reader and Modem Cabinet
HC3	Disk Drive
HC4	Teletype
HC5	Line Printer
HC6	Keypunch
HD	Disease Control Trailer
HE	Exterior of Hospital Building
HF	Follow-Up Clerk
HG	Garage Bays 19 & 20
HH	Public Health Nurse Trailer
HL	LMSC Manager's Office: Room #121
HM	Mental Health Trailer
HN	Nurse's Work Area
HO	Operator's Room: #122
HO1	Operator's Console
HO2	Comm. Racks
HO3	Teledisc Cart
HP	Physician's Room: #124
HP1	Physician's Console
HP2	Physician's Console Table
HP3	ECG Display Cart
HS	Service Unit Director
HT	Tower (for dish antenna)

LHSC

LC	Mobile Data Cart (Exam or Reception Room)
LD	Data Management Area (Patio)
LD1	Rack for Data Management and Video Comm. Equipment
LD2	Rack for Communication Equipment
LE	Exterior of Clinic Building
LG	Auxiliary Power Generator
LL	Laboratory: Room #126
LM	Emergency Room: #119
LM1	Operational Console
LM2	Video Display Terminal
LM3	Patient Viewing and Microscope Camera
LM4	Overhead Camera
LR	Reception Area (Business Office): Room #103
LT	Tower (for dish antenna)
LX	Examination Room: #115

MHU

MZ	Vehicle
MC	Cab
ME	Examination Room
MG	Generator Trailer
ML	Reception/Comm/Lab Room
ML1	MUX Equipment Rack
MR	Restroom
MS	Storage (Outside Access)
MT	Top of MHU
MX	X-Ray Room

PRC

PC	All STARPAHC Items

QRS

QG	Grounds (Not Shelter or Tower)
QS	Shelter
QS1	Equipment Rack Assembly
QS2	Battery Rack Assembly
QT	Antenna Support Tower

STARPAHC INVENTORY LIST

LOCATION	DESCRIPTION OF ITEM	MANUFACTURER	MODEL	SERIAL NO.	LMSC ENG. DWG. REF.	COST
HA/	PRINTER/KB	CDI	1030	GFE (IHS)	219	
HA/	PRINTER/KB	G.E.	1200	GFE (IHS)	219	
HB/	BASE STATION PAM	SCI		GFE (NASA)	219	
HC1	MEMORY	VARIAN	7024	--	212	$20,000
HC1	PWR SUPPLY MEMORY	VARIAN	7950	64140	212	$ 1,000
HC1	PWR SUPPLY MASTER	VARIAN	SYSTEM	64140	212	$ 1,000
HC1	MEM EXPANDOR CORE	VARIAN	7960	61440	212	$ 1,000
HC1	MAINFRAME COMPUTER	VARIAN	7001 V73	64140	212	$11,000
HC1	I/O EXPANDOR	VARIAN	620/F-118	64140	212	$ 1,200
HC1	I/O EXPANDOR	VARIAN	620/F-118	64140	212	$ 1,200
HC1	PWR SUPPLY EXPANDOR	VARIAN	620/L-95-5	1512	212	$ 1,000
HC1	PWR SUPPLY EXPANDOR	VARIAN	620/L-95-5	1536	212	$ 1,000
HC1	DATA J BOX T'MNLS	LMSC	SD 406	-	402	$ 500
HC1	DATA MODEMS 300 BD	LENKURT	25135	01	227	$ 520
HC1	TAPE DRIVE MAG.	WANGCO	10	2689	212	$ 9,000
HC1	DISK DRIVE MEMORY	VARIAN	620-36D	64140	212	$12,500
HC1	PWR SUPPLY DISK	DIABLO	429	1577	--	$ 1,000
HC1	MEMORY MAP	VARIAN	7069	--	--	$25,700
HC2	MODEM CABINET	LMSC	5521406	--	406	$ 500
HC2	DATA MODEM 4800 BD	AT&T	208A	--	227	
HC2	DATA MODEM 300 BD	AT&T	103	--	227	
HC2	DATA MODEM 1200 BD	AT&T	202	--	227	
HC2	DATA MODEM 300 BD	AT&T	103	--	227	
HC2	DATA MODEM 300 BD	AT&T	103	--	227	
HC2	DATA MODEM 300 BD	AT&T	103	--	227	
HC2	DATA MODEM 300 BD	AT&T	103	--	227	
HC2	CARD READER	VARIAN	620-28	64140	212	$ 4,000
HC3	DISK DRIVE CONSOLE	VARIAN	620-35	64140	212	$24,000
HC4	TELETYPE ASR-35	VARIAN	620-08A	319	212	$ 4,250
HC5	LINE PRINTER	VARIAN	620-77	64140	212	$15,500
HC6	KEYPUNCH	IBM - $20/MO REPAIR CONTRACT LMSC OWNED	026		212	$20/mo.
HD	PRINTER/KB	CDI	1030	GFE (IHS)	219	
HE	XFMR-115 VC 10 KVA	SOLA	33-16-310-6		560-S	$ 800
HE	XFMR-208 VC 2KVA	SOLA	33-26-220-6		560-S	$ 1,357
HE	WWV ANTENNA	S'FC PROD	AK-8			$ 250
HE	XFMR-115VC 15 KVA	SOLA	33-16-315		560-S	$ 800
HF	CRT/CTLR	TEC	455	211	219	$ 2,040
HF	KEYBOARD	TEC	EKA8002	157	219	$ 350

Lease from Mt. Bell IHS

LOCATION	DESCRIPTION OF ITEM	MANUFACTURER	MODEL	SERIAL NO.	LMSC ENG. DWG. REF.	COST
HG	DEGAUSSER M-TAPE	BELL & HOWELL	TD2903-4B	475265K	307	$ 695
HG	SCOPE DUAL-CH.	TEKTRONIX	7603N-11S	B20457	307	$ 3,755
HG	WATTMETER RF	BIRD	43		307	$ 500
HG	COUNTER FREQ.	H.P.	5382A	327	307	$ 2,100
HG	CAMERA SCOPE	POLAROID	CR-9/33-1		307	$ 750
HG	SIGNAL GEN. W'FORM	KROHN-H'T	5400A	3038	307	$ 575
HG	TEST SET MODEM	DATAPULSE	225	225168	307	$ 900
HG	CALIBRATOR ECG	PARKE-DAVIS	3150	764	307	$ 185
HG	DIFF. AMP. SCOPE	TEKTRONIX	7A22	B093031	307	$ 675
HG	SIGN. GEN. NTSC	TEKTRONIX	149A	B070742	307	$ 3,975
HG	VECTORSCOPE NTSC	TEKTRONIX	R520A	B394509	307	$ 2,825
HG	TESTER TRANSIS.	B&K	162	-	307	$ 275
HG	MULTIMETER DIGITAL	S-D	7004A	794	307	$ 1,350
HG	MULTIMETER W/CASE	TRIPLETT	630-NA	01	307	$ 295
HH	PRINTER/KB	CDI	1030	GFE (IHS)	219	
HL	MICROFICHE READER	EASTMAN-KODAK	1058858	--	219	$ 100
HL	DESK PHONE FTS	MT. BELL		GFE (IHS)		
HM	PRINTER/KB	CDI	1030	GFE (IHS)	219	
HN	NURSES ALARM	LMSC	5521362	-	362	$ 890
HN	CRT/CTLR 1200 BD	HAZELTINE	150128-72	786	219	$ 2,995
HN	KEYBOARD-WHITE	HAZELTINE	DTD150130	460	219	$ 500
HN	ADAPTER EIA/LOOP	HAZELTINE	150504	105	219	$ 85
HN	TERM. STRIP WALL-MT	INSTALLER	-	-	227	$ 75
HO	OPERATOR'S CONSOLE	LMSC	5521209	-	209	$70,000
HO1	CORRECTOR VIDEO	TEKTRONIX	R1440	B030222	209	$ 2,450
HO1	TAPE RCDR LOOP	AUD. ANCR	773.020	01	290	$ 217
HO1	MONITOR W'FORM	TEKTRONIX	528/146B	B239366	209	$ 1,117
HO1	INTERCOM SYS.	TALKAPH.	K-LC-2(S)	01	293	$ 900
HO1	PWR SUPPLIES TWO 24V	ABBOTT	RNR7-5	-	209	$ 165
HO1	SIG. GEN. NTSC	TEKTRONIX	R149A	B070723	209	$ 3,975
HO1	ENCODER TONE	BRAMCO	ME47C	054	294	$ 90
HO1	JOYSTICK PAN/TILT	PELCO	PT&M-3200	178 & 169	229	$ 300
HO1	LENS CTRL ZOOM	PELCO	LZ3200M	0153	229	$ 300
HO1	SWITCHER VIDEO	TELEM'TN	TVS-12X8	220	209	$ 5,875
HO1	CTRL XMTR TV CAM.	PELCO	DM3200TX	0172	209	$ 608
HO1	COAX RELAY PRIVACY	AMPHENOL	36011896-19	-	301	$ 110
HO1	TV MONITOR COLOR #2	SONY	PVM120	10254	209	$ 634
HO1	TV MONITOR B&W	CONRAC	SHA 14/R	260294	209	$ 610
HO1	CNTRL RACK MT	TEC	455	210	209	$ 2,040
HO1	KEYBOARD-BLUE	TEC	EKA8002	151	209	$ 350
HO1	PHONE CPLR. ACOUSTIC	A-J	A30	3388		$ 100
HO1	HANDSET TO CPLR.	MT. BELL	-	GFE (IHS)		
HO2	COMMUNICATION RACK	LMSC	5521218	-	218	$42,000
HO2	TV XMTR 8 GHZ	TERRACOM	TCM-604F	295	218	$ 5,000
HO2	CIRCULATOR 8 GHZ	RAYTRON	30093	27	218	$ 5,000
HO2	TV RCVR 8 GHZ	TERRACOM	TCM-604F	322	218	$ 5,000
HO2	TERM BLOCK MUX	FARINON	12150	01	218	$ 100
HO2	DEMODULATOR ECG	EMR	-	-	218	$ 2,345
HO2	TRANSCEIVER VHF	G.E.	MK56TAS66M	4191586	218	$ 1,750

LOCATION	DESCRIPTION OF ITEM	MANUFACTURER	MODEL	SERIAL NO.	LMSC ENG. DWG. REF.	COST
H02	HANDSET VHF	G.E.	4EM11A1	-	-	$ [illegible]
H02	TAPE RCDR VIDEO	IVC	800-ASMC	008386	218	$ 4,[illegible]
H02	TAPE RCDR INSTRUM.	H.P.	3960F-005	2116	218	$ 90
H02	TIME RCVR WWV	S/FC PROD	WVTRA	1789	218	$ 1[illegible]0
H02	MUX RADIO 2 GHZ	FARINON	TR-2000R	37686	218	$14,[illegible]
H03	Slo Scan Transceiver	Nippon Electric	DFP-751	-	-	$32,000
HP	TV CAMERA B&W #2	SHIBADEN	HV-16SU	020616	246	$ 68[illegible]
HP	ZOOM LENS RMT CTRL	PELCO	TV-10C	0544	246	$ [illegible]
HP	CAMERA MOUNT PAN/TILT	PELCO	PT-77	0272	246	$ [illegible]
HP1	PHYSICIAN'S CONSOLE	LMSC	5521264	-	264	$14,000
HP1	PWR STRIP 115 VAC	WABER	17	01	264	$ [illegible]
HP1	TV MONITOR COLOR #1	SONY	PVM1200	10777	264	$ [illegible]
HP1	TV CAMERA B&W #1	SHIBADEN	HV-16SU	020642	264	$ 650
HP1	TV MONITOR B&W NEG	CONRAC	SNA 14/R	020364	264	$ [illegible]
HP1	INTERCOM OPERATOR	TALKAPH.	K-LC-2(H)	01	264	$ [illegible]
HP1	JOYSTICK PAN/TILT	PELCO	PT&M 3200	182 & 165	264	$ 608
HP1	LENS CTRL ZOOM	PELCO	LZ3200M	0148	264	$ .300
HP1	INTERCOM HANDSFREE	FAIRCHILD	1001	197	264	$ [illegible]
HP1	HANDSET TO CPLR.	MT. BELL		GFE (IHS)	264	
HP1	X-RAY ILLUM.	PICKER	240050		264	$ 65
HP2	KEYBOARD	TEC	EKA8002	159	264	$ 2,[illegible]
HP2	CTRL UNIT X-R CAM.	PELCO	PT1577CZLZ5	109	246	$ 143
HP2	PHONE CPLR ACCUSTIC	A-J	A30	3459	278	$ 100
HP3	ECG CART	LMSC	5521263	-	263	$12,6[illegible]
HP3	REC STRIP	PARKE DAVIS	44-3350-001	81880190	263	$ 1,150
HP3	CARDIOSCOPE	H.P.	7803B	11853	263	$ [illegible]
HS	PRINTER/KB	CDI	1030	GFE (IHS)	219	
HT	ANTENNA TOWER	MICROFLEX	Q-30	-	210	$ [illegible]
HT	DISH ANTENNA	STI	SA61779DBH	68742	210	$ 3,[illegible]
HT	VHF ANTENNA	MOTOROLA	TAD-1004B	01	210	$ [illegible]
LC	CTRL BOX MODEM	LMSC	5521381	-	381	$ [illegible]
LC	CRT/KB	INFOTON	VISTAR/GT	4871	217	$ 1,[illegible]
LC	DATA MODEM 300 BD	LENKURT	25132	01	242	$ 300
LD	INTERCOM LMSC	TALKAPH.	K-LS-5	01	242	$ [illegible]
LD1	EQUIP. RACK/VIDEO	LMSC	5521253	-	253	$11,[illegible]
LD1	TV XMTR 8 GHZ	TERRACOM	TCM-604F	296	253	$ 5,00
LD1	TV RCVR 8 GHZ	TERRACOM	TMC-604F	321	253	$ 5,[illegible]
LD1	MONITOR-W'FORM	TEKTRONIX	528/146B	B239436	253	$ 1,[illegible]
LD1	SIG. GEN. NTSC	TEKTRONIX	R149A	B070740	253	$ 3,[illegible]
LD1	TV MONITOR COLOR #2	SONY	PVM1200	10782	253	$ [illegible]
LD2	EQUIP RACK/COMM.	LMSC	5521254	-	254	$11,[illegible]
LD2	TRANSCEIVER VHF	G.E.	MK56TAS66M	4191588	254	$ 1,2[illegible]
LD2	MUX RADIO 2 GHZ	FARINON	TR-2000R	37690	254	$ 9,[illegible]
LE	VHF ANTENNA OMNI	MOTOROLA	TAD-1004B	02	242	$ [illegible]

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ION	DESCRIPTION OF ITEM	MANUFACTURER	MODEL	SERIAL NO.	LMSC ENG. DWG. REF.	COST
	GENERATOR ENGINE	ONAN	55KB-1SR	-	217	$ 5,840
	MICROSCOPE ASSY.	LMSC	5521312	-	312	$ 4,900
	CTRL UNIT LAB VID.	LMSC	5521383	-	383	$ 440
	INTERCOM HANDSFREE	FAIRCHILD	1001 (D)	069	217	$ 630
	TV MON/RCVR COLOR	SONY	CVM-1225	100514	242	$ 446
	CAMERA CTRL COLOR #3	SHIBADEN	CU-1500U	020087	242	$ 395
	CAMERA HEAD COLOR #3	SHIBADEN	HV-1500U	020087	242	$ 2,900
	INTERCOM LHSC	TALKAPH.	K-IS-5	02	242	$ 93
	CALCULATOR	UNICOM	1000	-	-	$ 220
	SPECTROPHOTOMETER	COLEMAN	S2036-20	-	-	$ 635
	INCUBATION HTR.	SCIENT. PROD.	H2025-1	-	-	$ 56
	DIFFERENTIAL BLOOD CTR	SCIENT. PROD.	B4120-3	-	-	$ 78
	CENTRIFUGE HEMO.	SCIENT. PROD.	B4390-1	-	-	$ 135
	INCUBATOR MICRO.	SCIENT. PROD.	J-1500	-	-	$ 265
	ANEROBIC SYS.	SCIENT. PROD.	J-30542	-	-	$ 40
	COLOR COUNTER	SCIENT. PROD.	C8376-1	-	-	$ 290
	MICROFICHE READER	EASTMAN-KODAK	105-8858	-	-	$ 100
	RESUS/INH/ASP	OHIO MED.	305-7600	-	-	$ 425
	PHONE CPLR ACOUSTIC	A-J	A30	2388	242	$ 100
	HEADSET H-F ICOM	PL/TRNCS	HSO-108-1B	02	242	$ 38
	HANDSET HF-ICOM	G.E.	4EM26A10	01	242	$ 22
	ECG SYSTEM W/RCDR	BURDICK	EK-5A	72598	242	$ 894
	STETHOSCOPE E'TRONIC	HSP CORP.	51-1000E	01	242	$ 110
	MICROPHONE H-F ICOM	FAIRCHILD	M602	01	242	$ 30
	PHONE-HSSCC HOTLINE	AT&T	554-N	03	242	$ 30
	INCUBATOR/INFANT		304-3225-900	-		$ 810
	OPERATIONAL CONSOLE	LMSC	5521208	-	208	$11,000
	INTERCOM LHSC	TALKAPH.	K-LS-5	03	208	$ 93
	JOYSTICK PAN/TILT	PELCO	PT&M 3200	180 & 167	300-210	$ 300
	LENS CTRL ZOOM	PELCO	LZ3200M	0154	300-208	$ 300
	CTRL RCVR TV CAM	PELCO	DM3216RX-M	0718	208-06	$ 300
	INTERCOM HANDSFREE	FAIRCHILD	1001	051	208-15	$ 630
	CAMERA CTRL COLOR #1	SHIBADEN	CU-1500U-R	020066	208-16	$ 395
	CAMERA CTRL COLOR #2	SHIBADEN	CU-1500U-R	020072	208-16	$ 395
	TV MONITOR COLOR #1	SONY	PVM1200	10639	208-20	$ 570
	CARDIOSCOPE TWO-CH.	H.P.	7803B	11829	208-14	$ 770
	CTRL BOX MODEM	LMSC	5521381	-	381	$ 440
	CRT/KB	INFOTON	VISTAR/GT	4872	217	$ 1,300
	DATA MODEM 300 BD	LENKURT	25132	02	242	$ 300
	FIBEROPTICS ASSY	WILDE-HEERBURG	-	-	312	$ 6,600
	CAMERA HEAD COLOR #1	SHIBADEN	HV-1500O	020066	312-501	$ 2,900
	CAMERA HEAD COLOR #2	SHIBADEN	HV-1500U	020072	337-201	$ 2,900
	ZOOM LENS RMT CTRL	PELCO	TV-10C	0537	337-202	$ 940
	CAMERA MOUNT PAN/TILT	PELCO	PT-77	0275	337-204	$ 300
	CAMERA MOUNT	LMSC	5521337	-	337	$ 6,160

ON	DESCRIPTION OF ITEM	MANUFACTURER	MODEL	SERIAL NO.	IMSC ENG. DWG. REF.	COS
	DATA MODEM 300 BD	LENKURT	25132	03	242	$ 300
	PRINTER/KB CPLR N/A	CDI	1030		217	$ 2,7 0
	CTRL HEAD VHF	G.E.	4EC59A103M		242	$ .5
	INTERCOM LHSC	TALKAPH.	K-LS-5	04	242	$ 93
	SPEAKER VHF	G.E.	4EZ20A12		242	$ 0
	HANDSET VHF	G.E.	4EM11A1		242	$ 5
	HOOKSWITCH HANDSET	G.E.	19B204867G1		242	$ 35
	ANTENNA ASSY.	LMSC	5521250	-	250	$ 1,0
	DISH ANTENNA 2 & 8 GHZ	STI	SA61779DBH	68743	217	$ 3,0 0
	OTOSCOPE/OPHTHL. SCOPE	CENCO	99302	-	-	$ 72
	TONOMETER	PARSON	350	-	-	$ 1 5
	CTRL UNIT	LMSC	5521371	-	371	$ 4.0
	MICROPHONE H-F ICOM	FAIRCHILD	M602	02	242	$ 30
	INTERCOM HANDSFREE	FAIRCHILD	1001(D)	077	217	$ 6 0
	TV CAMERA B&W	SHIBADEN	HV-16SU	021144	296-03	$ 7 0
	TV MONITOR B&W	CONRAC	ENA 9/C	264698	217	$ 275
	SPEAKER H-F ICOM	FAIRCHILD	ROBINS	02	217	$ 5
	INTERCOM LHSC	TALKAPH.	K-LS-5	05	242	$ 3
	ZOOM LENS RMT CTRL	PELCO	TV-10C	0540	296-04	$ 297
	CAMERA MOUNT PAN/TILT	PELCO	PT-155-SPT-	776950-3G	296-05	$ 297
	JOYSTICK PAN/TILT	PELCO	PT&M 320C	181 & 166	296-18	$ 7
	LENS CTRL ZOOM	PELCO	LZ3200M	0147	296-17	$ 941
	HEADSET H-F ICOM	PLANTRONICS	HSO-108-1B	03	242	$ 50
	HANDSET H-F ICOM	G.E.	4EM6A10	02	242	$ 0
	CAMERA DOLLY	LMSC	5521296	-	296	$ 2,2 0
	MICROFICHE READER	EASTMAN-KODAK	1058858	-	-	$ 100
	DATA MODEM 300 BD	LENKURT	25132	04	310	$ 3 0
	TRANSCEIVER VHF	G.E.	MK56TAS66	4191589	310	$ 1,2 0
	CTRL HEAD VHF	G.E.	4EC59A103	-	310	$ 500
	SPEAKER VHF	G.E.	4EZ20A12	-	310	$ 0
	MICROPHONE VHF	G.E.	4EM25M10	-	310	$ 0
	ALARM SYS BGL/FIRE	ON-GUARD	820F	-	310	$ 300
	INTERCOM MHU	FARINON	DIRECTOR 7	-	310	$ 0
	AM-FM RADIO W/TAPE	WHITNEY	55-1738	-	310	$ 1 0
	SPEAKERS-2 AM-FM	WHITNEY			310	$ 40
	VEHICLE - MHU	MEDICOACH	001	001	-	$129,5 0
	NARCOTIC CABINET	SCHERER	3007	-	-	$ 46
	OTOSCOPE/OPTHAL. SCOPE	GENTEC	40415	-	-	$ 164
	TONOMETER	PARSONS	350	-	-	$ 1 0
	NEUROLOGICAL INSTR.	MUELLER	DE-10710	-	-	$ 2
	RESUS/INHAL/ASP.	OHIO	305-7600-901		-	$ 425
	MICROFICHE READER	EASTMAN-KODAK	105-8858	-	-	$ 1
	EXAM TABLE	GENTEC	6010	-	-	$ 1
	CAMERA MOUNT	LMSC	5521335	-	335	$ 2,4
	CTRL PNL	LMSC	5521344	-	344	$11,7
	INTERCOM HANDSFREE	FAIRCHILD	1001	162	285	$ 6
	TV MONITOR COLOR	SONY	PVM9100	010690	285	$ 4

CATION	DESCRIPTION OF ITEM	MANUFACTURER	MODEL	SERIAL NO.	LMSC ENG. DWG. REF.	COST
	CAMERA CTRL COLOR #1	SHIBADEN	CU-1500U-R	020093	285	$ 400
	CAMERA HEAD COLOR #1	SHIBADEN	HV-1500U-M	020093	285	$ 2,900
	CAMERA HEAD COLOR #2	SHIBADEN	HV-1500U-M	020095	285	$ 2,900
	CAMERA CTRL COLOR #2	SHIBADEN	CU-1500U-R	020095	285	$ 400
	CAMERA MOUNT PAN/TILT	PELCO	PT-77	0280	285	$ 298
	ZOOM LENS PMT CTRL	PELCO	TV-10C	0569	285	$ 942
	JOYSTICK PAN/TILT	PELCO	PT&M 3200	179 & 168	285	$ 300
	LENS CTRL ZOOM	PELCO	LZ3200M	0152	285	$ 300
	KEYBOARD BLUE	TEC	EKA8002	147	227	$ 350
	CRT/CTLR BLUE	TEC	455	209	227	$ 2,040
	ECG SYSTEM W/RCDR	SIEMENS	122-600	1611		$ 1,351
	ECG SCOPE W/CPLR	J. WALKER	PW9B	3426	285	$ 117
	STETHOSCOPE E'TRONIC	HSP CORP.	51-1000E	02		$ 109
	MICROPHONE HF I"COM	A.R.S.	33-983		347-S1	$ 30
	HEADSET PVCY	P1/TRNCS	HS0-108-1B	01	347-S1	$ 38
	HANDSET PVCY	G.E.	4EM26A10	03	347-S1	$ 29
	SPEAKER H-F I'COM	BOGEN			347-S1	$ 45
	PHONE-HSSCC HOTLINE	IT&T	554-N	04	285	$ 30
	PAM W/O RF	SCI	GFE (NASA)		285	
	RECHARGER PAM	SCI	GFE (NASA)		285	
	SPEAKER P.A.	BOGEN			347-S3	$ 30
	INTERCOM MHU	FARINON	DIRECTOR 7		347-S1	$ 150
	REGULATOR AC	SORENSEN	ACR 1000		223	$ 90
	XFMR-115 VAC ISOL	TRIAD	N-54M		223	$ 50
	COLOR TV MON. MT.	LMSC	5521336	-	336	$ 1,920
	FIBEROPTICS ASSY.	WILDE-HEERBURG	551312	-	312	$ 6,600
	MAIN GENERATOR ENGINE	ONAN	30EK-3R	-	258	$ 5,000
	CENTRIFUGE	BECKMAN	M708	-	-	$ 447
	STOP WATCH	SCIENTIF. PROD.	06560	-	-	$ 20
	PIPET SHAKER	SCIENTIF. PROD.	B4110-2	-	-	$ 65
	BACTI-CINERATOR	SCIENTIF. PROD.	B9752	-	-	$ 48
	SPECTROPHOTOMETER	COLEMAN	S2036-20	-	-	$ 635
	DIFFERENTIAL COUNTER		B4120-3	-	-	$ 77
	MICROSCOPE ASSY	LMSC	5521312	-	312	$ 4,900
	CTRL PNL COMM SYS	LMSC	5521344	-	344	$11,740
	INTERCOM HANDSFREE	FAIRCHILD	1001	193	287	$ 600
	TV MONITOR COLOR	UNIMEDIA	SMT-9		309-S3	$ 1,344
	CAMERA CONTROL COLOR 3	SHIBADEN	CU-1500-U-R	020084	309-S3	$ 400
	CAMERA HEAD COLOR #3	SHIBADEN	HV-1500U-M	020084	287	$ 2,900
	HANDSET-VHF MOVABLE	G.E.	4EM11A1	-	347-S2	$ 75
	PHONE-HSSCC HOTLINE	IT&T	554-N	05	287	$ 30
	DIST. AMP. VIDEO/2	DYNAIR	FR-1000A+	094499E4	309-S3	$ 455
	SIG. GEN. NTSC	TEKTRONIX	R149A	B070730	309-S3	$ 3,975
	MONITOR W'FORM	TEKTRONIX	528/146B		309-S3	$ 1,117
	TV RCVR 8 GHZ	TERRACOM	TCM-604F	319	309-S3	$ 5,000
	TV XMTR 8 GHZ	TERRACOM	TCM-604F	297	309-S3	$ 5,000
	CIRCULATOR 8 GHZ	RAYTRON	300093	31	309-S3	$ 5,000
	STATUS MON.	LMSC	5521367	-	367	$ 960

ON	DESCRIPTION OF ITEM	MANUFACTURER	MODEL	SERIAL NO.	LMSC ENG. DWG. REF.	COST
	DATA MODEM 300 BD	LENKURT	25132	05	309-S3	$ 3(
	MICROPHONE H-F ICOM	A.R.S.	33-983		347-S1	$
	PWR SUPPLY +12V	LAMBDA	LM-CC-12R	C38235	347-S1	$ 179
	PRINTER/KB	TEXAS INS	725	11233	287	$ 2,7
	SPEAKER H-F ICOM	BOGEN			347-S1	$
	MICROPHONE P.A.				347-S3	$ 45
	SPEAKER P.A.	BOGEN			347-S3	$ 25
	AMPLIFIER P.A.	AMPLIVOX	S-302		347-S3	$ 1(
	INTERCOM MHU	FARINON	DIRECTOR 7		347-S1	$ 66
	PWR SUPPLY -24V	LAMBDA	LM-EE-28R	B17097	347-S1	$ 300
	CTRL RCVR TV CAM.	PELCO	DM3216RX-M	0179	347-S1	$ 6
	BATT. CHGR. -24V	GLOBE	GRC242000		347-S1	$
	MUX RADIO 2 GHZ	FARINON	TR-2000R	37691	309-S2	$ 9,620
	TERM BLOCK MUX	FARINON	12150	03	347-S1	$ 1,0
	SPEAKER P.A.				286	$ 50
	BATT. CH'GR +12V	SEARS	28K7198C	-	347-S1	$
	HANDSET VHF				347-S2	$
	HOOKSWITCH HANDSET	G.E.	5490436G1	-	347-S2	$ 15
	SIG STR MTR	FARINON	SIMPSON	-	347-S1	$
	SIG STR MTR	TERRACOM	SIMPSON	-	347-S1	$
	HANDSET VHF	G.E.	4EM11A1		347-S2	$ 75
	VHF ANTENNA OMNI	G.E.	4EY12A13	-	258	$
	DISH ANTENNA 2 & 8 GHZ	STI	SA41779DBH	68739	258	$ 3,0
	X-RAY UNIT	PICKER	DG01010	-	-	$ 9,700
	EXAM TABLE	GENTEC	6010	-	-	$ 4
	CTRL PNL COMM SYS	LMSC	5521344	-	344-501	$11,7
	INTERCOM HANDSFREE	FAIRCHILD	1001	151	284	$ 600
	TV MONITOR B&W	CONRAC	ENA 9/C	263528	284	$ 2
	JOYSTICK PAN/TILT	PELCO	PT&M 3200	177 & 170	284	$ 3
	LENS CTRL ZOOM	PELCO	LZ3200M	0155	284	$ 300
	TV CAMERA B&W	SHIBADEN	HV-16SU/C	C21115	284	$ 700
	CAMERA MOUNT PAN/TILT	PELCO	PT-77	0281	284	$ 2
	ZOOM LENS RMT CTRL	PELCO	TV-10C	0569	284	$ 94
	MICROPHONE H-F ICOM	A.R.S.	33-983		347-S1	$ 50
	SPEAKER H-F ICOM	BOGEN			347-S1	$
	SPEAKER P.A.	BOGEN			347-S3	$
	INTERCOM MHU	FARINON	DIRECTOR 7		347-S1	$ 100
	X-RAY UNIT CAP. DIS.	PICKER	DGC 1010	NO LTEST	214	$ 9,2
	CAMERA MOUNT	LMSC	5521304		304	$ 5,4
	Slo Scan Transceiver	Nippon Electric	DFP-751	-	-	$ -
	Recorder, Disc	Vast	-	-	-	$ 8,0
	TV MONITOR B&W NEG	CONRAC	SNA 14/C	267086	241	$ 61C
	PRINTER/KB	CDI	1030	GFE (IHS)	241	$ -
	VHF ANTENNA OM.	DB PROD.	DB-304C	-	222	$ 7
	GENERATOR BACKUP	ONAN	2.5LK-1R/E	785364	247	$ 1,950
	GENERATOR PRIME	ONAN	2.5LK-1R/E	815089	-	$ 1,9

LOCATION	DESCRIPTION OF ITEM	MANUFACTURER	MODEL	SERIAL NO.	LMSC ENG. DWG. REF.	COST
QS	SHELTER EQUIP.	STI	EEE088	68710	-	$ 5,000
QS1	CAT UNIT	LMSC	5521315	-	315	$ 8,000
QS1	DECODER TONE	BRAMCO	MD47R	114	222	$ 515
QS1	W.G. SWITCH SPDT	TRANSCO	33D03400	012	222	$ 190
QS1	TV XMTR MHU/LHSC	TERRACOM	TCM-604F	298	222	$ 5,000
QS1	CIRCULATOR MHU/LHSC	RAYTRON	300093	26	260	$ 5,000
QS1	TV RCVR MHU/LHSC	TERRACOM	TCM-604F	320	222	$ 5,000
QS1	TV XMTR HSSCC	TERRACOM	TCM-604F	299	222	$ 5,000
QS1	CIRCULATOR HSSCC	RAYTRON	300093	28	260	$ 5,000
QS1	TV RCVR HSSCC	TERRACOM	TCM-604F	318	222	$ 5,000
QS1	BATT. CH'GR 24V	GOULD	GRF24S25F30	10B241	222	$ 1,000
QS1	BATT. CH'GR 12V	GOULD	GRF12S16F30	10B240	222	$ 1,000
QS1	TRANSCEIVER VHF	G.E.	MK56TAS66M	4191587	222	$ 1,200
QS1	DUPLEXER VHF	DB PROD.	DB-4055	56958	222	$ 1,500
QS1	MUX RADIO HSSCC	FARINON	TR-2000R	37687	222	$ 6,500
QS1	MUX RADIO LHSC	FARINON	TR-2000R	37688	222	$ 6,500
QS1	MUX RADIO MHU	FARINON	TR-2000R	37689	222	$ 6,500
QS1	GEN. CTRL DAY/NITE	STI	GCU-025	68758		$ 2,000
QT	POSITIONER ANTENNA	STI	AP 6-350	68755	222	$ 2,500
QT	DISH ANTENNA MHU	STI	SA61779DBH1	68709	222	$ 3,000
QT	DISH ANTENNA LHSC	STI	SA61779DBH	68740	222	$ 3,000
QT	DISH ANTENNA HSSCC	STI	SA61779DBH	68741	222	$ 3,000
QT	ANTENNA TOWER	MICROFLEX	Q-30		222	$ 500

SPARES INVENTORY LIST *

tion	Description of Item	Manufacturer	Model	Serial No.	LMSC Dwg.	Cost
	AFC RCVR (1)	TERRACOM	TCM-6 0340	7417	218/253	$ 540
	IF RCVR (1)	TERRACOM	TCM-6 0340	7417	218/253	$ 55
	AFC XMTR (1)	TERRACOM	TCM-6 0340	7417	218/253	$ 63
	SYNTH XMTR (1)	TERRACOM	TCM-6 0340	7417	218/253	$ 187
	B-BAND & AUD RCVR (1)	TERRACOM	TCM-6 0340	7417	218/253	$ 76
	LAND CAMERA (1)	POLAROID	CR-9 Mod 33-1	-	07	$ 15
	DRY AIR PUMP (1)	ANDREWS	878A	-	-	$ 25
	CAMERA, B&W (1)	SHIBADEN	HV-16S	-	-	$ 700
	ADDING MACHINE (1)	VICTOR	73-85-54	-	-	$ 15
	TYPEWRITER (1)	REMINGTON	TWENTY-FIVE	-	-	$ 150
	COLOR CAMERA W/CONTROLLER AND COLOR BAR GENERATOR	SHIBADEN	HV 1500	-	-	$ 3,299
	COLOR VIDICON	SHIBADEN	--	-	-	$ 750
	COLOR B&W CARD	SHIBADEN	--	-	-	$ 23
	COMPUTER CKT. BDS.	VARIAN	--	-	-	$ 3,500

* LIST DOES NOT INCLUDE MISCELLANEOUS SMALL PARTS (CONNECTORS, RESISTORS, ETC.).

Appendix D

TROUBLE REPORT REVIEW

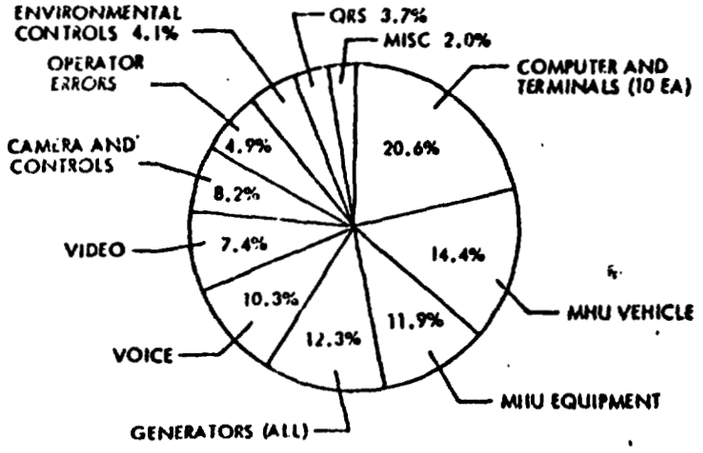
Another approach to analyzing system problems was adopted at the start of operations. This approach was to file a trouble report of any equipment malfunction, record the time it took to correct the failure, and to categorize the type of failure, e.g. hard failure, degradation, deficiencies, or modifications. This approach differed from our evaluation of equipment performance wherein we listed 24 TCE and recorded their performance from a standpoint of Quality, Usage, and User.

Recording failures in groups of equipment was useful during the operations as trends in failure in certain equipment categories could be pinpointed. This was obvious in the computer area where the cause of the failure was associated with wide variation in the utility power. Not so noticeable was the increasing incidents of failure in the nerators as they started approaching their maintenance servicing periods.

Figure 2-9 illustrates the trouble report analysis for the two year period. A detailed analysis of the first year trouble reports resulted in identifying the major categories of equipment requiring the majority of repair/replacement. Figure D-1 illustrates this distribution. As shown in the figure, computer terminals are the single high source of trouble reports.

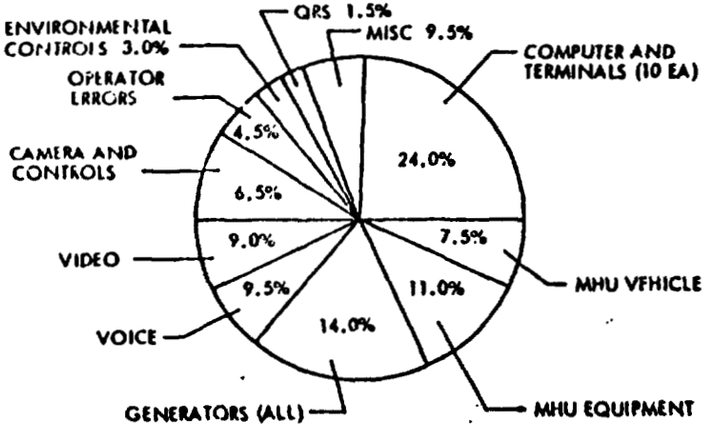
A detailed review of the second year of operation Trouble Reports, on a monthly analysis basis, was completed and forms the remainder of this appendix.

May 1976 Trouble Reports. Nature of 25 May TR's were: Failures (10), Degradation (14), and the Modification (1). The ten failures were divided among the facilities as follows: MHU (3), LHSC (4), HSSCC (2), and the QRS (1). The MHU failures required repair work, while the majority of the



MAY THROUGH OCTOBER 1975

COMPUTER AND TERMINALS	50
MHU VEHICLE	35
MHU EQUIPMENT	29
GENERATORS (ALL)	30
VOICE	25
VIDEO	18
CAMERAS AND CONTROLS	20
OPERATOR ERRORS	12
ENVIRONMENTAL CONTROLS	10
QRS	9
MISC	5
TOTALS - TROUBLE REPORTS	243



NOVEMBER 1975 THROUGH APRIL 1976

COMPUTER AND TERMINALS	48
MHU VEHICLE	15
MHU EQUIPMENT	22
GENERATORS (ALL)	28
VOICE	19
VIDEO	18
CAMERAS AND CONTROLS	13
OPERATOR ERRORS	9
ENVIRONMENTAL CONTROLS	6
QRS	3
MISC	19
TOTALS - TROUBLE REPORTS	200

Fig. D-1 Trouble Report Distribution
First Two 6-Month Periods

LHSC failures required replacement of parts. One of the HSSCC failures was attributed to operator error. The division between repair/replacement was 5/5.

The principal equipment types experiencing failure were: control receiver for cameras (3), RF voice link, generator, and terminal (2 ea.). One failure is attributed to operator error.

Three of the May equipment failures out of ten resulted in operational down-time. The MHU Camera Control had a partial failure resulting in 18 hours of down-time. The unit could not be repaired in the field and had to wait until the MHU returned to Sells on Friday. The MHU Auxiliary Generator failed one evening in the field and remained inoperative over-night. The generator was repaired the following morning. A total down-time was recorded of 12 hours. The third failure was a HSSCC GE terminal which resulted in 1½ hours of down-time. It was repaired during operational hours.

The 14 degradations were divided among the facilities as follows: MHU (4), LHSC (1), HSSCC (6), and the QRS (3). The MHU degradations were corrected by repair/replacement of parts, the LHSC degradations required replacement of parts, the majority of the HSSCC degradations required repair, while the QRS degradations required both repair/replacement. The division between repair/replacement was 7/7.

The principal equipment types experiencing degradation were: generator (3), terminal (3), video (2), voice (1), vehicle engine (2), QRS (1), and the wind driven generator tower (2).

In summary, during May, a total of 25 Trouble Reports were opened: 22 were closed. The 25 TRs were distributed among the elements as follows: MHU (7), LHSC (5), HSSCC (9), and QRS (4).

The principal equipment types having troubles were: computer terminals (6), generators (5), camera/control (5), voice (3), QRS wind driven gen0 erator tower (2), and MHU vehicle, video, misc., (1) each. There was one trouble report attributed to operator error.

Total computer system down-time recorded during May was 31½ hours. Comparison of May data against prior year of operation shows that May's TR's are significantly below the yearly average (25 compared to 36.9 TR's). A comparison of the one year operation regarding equipment types shows that the computer/terminals remain as a high source of trouble reports. This is associated with four computer and two terminal problems. Next highest trouble reports in May concerned generators which are also the second highest average yearly source of troubles. Two TR's were for the 30 KW MHU generator (2 weeks apart and not associated), two TR's were for the MHU 6.5 KW aux generator (3 weeks apart and associated), and 1 TR on the QRS diesel 6.5 KW generator. Three of the TR's reported had start or fail to start which were repaired by tune-ups. The other two TR's were associated with mechanical problems.

June 1976 Trouble Reports. Nature of the 27 June TR's were: Failures (15), Degradation (10), Deficiency (1), and Modification (1).

The 15 Failures were divided among the facilities as follows: MHU (6), HSSCC (5), and QRS (4). The majority of the MHU and the LHSC failures required repair, while the majority of the HSSCC required replacement. The QRS failures were fixed equally between repair/replacement. The division between repair/replacement was 9/6.

The principal equipment types experiencing failures were: computer terminals (5), generators (4), camera/control (2), and MHU equipment and wind-driven generator (1 each). Two failures were attributed to operator error.

Two of the June equipment failures out of fifteen required in operational down-time. The HSSCC computer was down for three hours due to a blown fuse caused by low input power. The MHU main generator was down for two hours.

The ten degradations were divided among the elements as follows: MHU (3), LHSC (2), HSSCC (4), and QRS (1). The MHU and LHSC degradations were fixed by repair. The HSSCC degradations required both repair/replacement while the QRS required only replacement. The division between repair/replacement was 6/4.

The principal equipment types experiencing degradation were: computer/terminals (4), camera/control (3 ea.), and the MHU vehicle (2) and voice (1).

In summary, during June, a total of 27 trouble reports were opened and 25 were closed. The 27 TR's were distributed among the facilities as follows: MHU (10), LHSC (3), HSSCC (9), and QRS (5). The principal equipment types having troubles were: computer/terminals (9), camera/controls (5), generators (4), MHU vehicle (3), and MHU equipment, voice, miscellaneous, and wind-driven generator (1 each). There were 2 TR's attributed to operator error. Total down-time recorded during June was 5 hours.

Comparison of June data against prior year of operation shows that the June TR's are below the yearly average (27 against 36.9). A comparison of the one year operation regarding equipment types shows that the computer/terminals remain as a high source of trouble reports. This is associated with 3 computer and 6 terminal problems. The three computer problems were attributed to a power brownout condition. The UPS had recently been installed and was undergoing a start-up problem. The six terminal problems were associated with fuse blowing during brownout and cable damage that occurred during some modification work that took place in the hospital.

July Trouble Reports. Nature of the 22 July TR's were: Failure (9), Degradation (11), and Deficiencies (2). The 9 Failures were divided among the elements as follows: MHU (5), HSSCC (1), and QRS (3). The majority of the MHU and QRS failures required replacement, while the HSSCC failures required repair. The division between repair/replacement was 2/7.

The principal equipment types experiencing failures were: MHU equipment (3), QRS (2), computer/terminals, generator, camera/control, and wind-driven generator (1 each).

Only one of the July equipment failures out of nine resulted in operational down-time. The HSSCC IBM modem was down for four hours and required Varian service maintenance.

The 11 degradations were divided among the elements as follows: MHU (6), HSSCC (2) and QRS (3). The majority of the MHU, HSSCC, and QRS degradations required repair. The division between repair/replacement was 7/4. The principal equipment types experiencing degradations were: voice (3), generator (5), computer/terminals, video, and MHU vehicle (1 each).

In summary, during July, a total of 22 TRs were opened and 16 were closed. The 22 TRs were distributed among the facilities as follows: MHU (12), HSSCC (3), and QRS (7).

The principal equipment types having trouble were: generator (6), MHU equipment and voice (3 each), computer/terminals, camera/control, QRS, and wind-driven generator (2 each), and MHU vehicle and video (1 each). Total down-time recorded during July was 4 hours.
Comparison of July data against prior year of operation shows that July TR's were slightly above the yearly average (22 compared to 21.9). A comparison of the one-year operation regarding equipment types shows a significant reduction in the computer/terminal problems (3) attributed to the reliable operation of the UPS. No other equipment type problem is large enough to be considered.

August 1976 Trouble Reports. Nature of the 18 August TR's were: Failures (9), Degradations (6), Deficiencies (1), and Modifications (2). The 9 failures were divided among the facilities as follows: MHU (5), LHSC (1), HSSCC (2), and QRS (1). The majority of the MHU failures required repair, the HSSCC failures required repair, and the LHSC and QRS failures required replacement. The division between repair/replacement was 3/6.

The principal equipment types experiencing failures were: computer/terminal and MHU equipment (3 each), MHU vehicle, Voice, and QRS (1 each).

Two of the August equipment failures out of nine resulted in operational down-time. The HSSCC IBM modem was down for eight hours while the MHU had a flat tire delaying operations by two hours.

The 6 degradations covered in the MHU vehicle were corrected by repair. The principal equipment types experiencing degradation were: MHU vehicle (3), and the generator (3).

In summary, during August, a total of 18 TR's were opened and all were closed. The 18 TR's were distributed among the facilities as follows: MHU (13), LHSC (2), HSSCC (2), and QRS (1). The principal equipment types having troubles were: MHU vehicle (8), computer/terminals and MHU equipment (3 each), generator, voice, camera/control and QRS (1 each). Total down-time recorded during August was 8 hours.

Comparison of August data against prior year of operation shows that the August TR's were well below the yearly average (18 compar to 36.9) and very close to the lowest failure months (Dec. 1975 and March 1976, with 14 failures).

The computer/terminal problems continued to show a significant decrease. The MHU vehicle had the majority of the problems (9). A major problem was associated with an air brake failure which caused an out-of-service period. This out-of-service period allowed extensive maintenance to be performed on the vehicle, of which three tasks were written up as trouble reports. The other two Trouble Reports were for flat tires.

September 1976 Trouble Reports. Nature of the 28 September TR's were: Failures (13), Degradation (13), Deficiency (1), and Modification (1). The 13 failures were divided among the facilities as follows: MHU (5), LHSC (1), HSSCC (4) and QRS (3).

The MHU required repair/replacement while the HSSCC, LHSC, and QRS required repair. The division between repair/replacement was 9/4.

The principal equipment types experiencing failures were: generator (4), MHU equipment and voice (3 each), computer terminal (2) and Slow Scan (1).

Three of the September equipment failures out of thirteen resulted in operational down-time. The QRS generator was down for thirteen hours, however, during this period the standby generator was operated. The LHSC terminal was down for three hours and the HSSCC Slo-Scan was down for one hour.

The 13 Degradations were divided among the facilities as follows: MHU (5), LHSC (5), HSSCC (2) and QRS (1). The MHU required repair/replacement, LHSC, HSSCC and QRS required repair only. The division between repair/replacement was 10/3.

The principal equipment types experiencing degradation were: voice (10), generator (2), and terminal (1).

In summary, during September, a total of 28 TR's were opened and 18 were closed. The 28 TR's were distributed among the facilities as follows: MHU (11), LHSC (6), HSSCC (7), and QRS (4). The principal equipment types having troubles were: Voice (13), generator (6), terminals (3), and MHU equipment (6). Total down-time recorded in September was 17 hours.

Comparison of September data against prior year of operation shows that the September TR's were above the yearly average of 36.9. The multiple failures/degradation in the MUX radio and VHF units accounted for the majority of the TR's.

October 1976 Trouble Reports. Nature of the 17 October TR's were: Failures (9), Degradation (7), and Modification (1). The 17 failures were divided among the elements as follows: MHU (4), and HSSCC (5). The MHU required 3 replacements and 1 repair, and HSSCC required 2 replacements and 3 repairs. The division between repair/replacement was 4/5. The principal equipment types experiencing failures were: Computer/terminal (5), MHU equipment (2), generator and camera/control (1 each).

Two of the October equipment failures out of nine resulted in operational down-time. The HSSCC Century Disc Drive was down for fourteen hours and the MHU Camera Control Unit was down for one hour.

The 7 degradations are divided among the facilities as follows: MHU (4) and HSSCC (3). The MHU required 3 repairs and 1 replacement, while the HSSCC required 3 repairs, giving a division between repair/replacement of 6/1.

The principal equipment types expericing degradation were: computer/terminal (3) and MHU equipment (4).

In summary, during October, a total of 17 TR's were opened and 8 were closed. The 17 TR's were distributed among the facilities as follows: MHU (8), LESC (1), and HSSCC (8). The principal equipment types having troubles were: computer/terminal (9), MHU equipment (6), generator and camera/control (1 each). Total down-time recorded in October was 15 hours.

Comparison of the October data against prior year of operation shows that the October TRs were below the yearly average of 36.9. The multiple failure caused by the computer head crash accounts for the majority of the TR's.

November 1976 Trouble Reports. Nature of the 20 November TR's were: Failures (11), Degradation (5), Modifications (1), Deficiency (1) and other (2). The ten failures were divided among the facilities as follows: MHU (1), HSSCC (4) and QRS (6). The MHU failures required replacement (3) while the majority of the HSSCC failures required repair. The QRS failures resulted in four repair operations, three replacement activities and one modification, which was the installation of a diesel engine oil level maintainer.

The principal equipment type experiencing failure were: QRS (6), Batteries (3) computer (4) and generators (5).

The total corrective time for this month was 131.6 hours with the highest expended on the antenna positioner failure at QRS (32), the radiator repair in the MHS necessitated due to a lack (30) and the troubleshoot and subsequent replacement of the modem in the slow-scan element (30). The oil level maintains installation and MHU door lock repair required 6 hours each to correct and checkout with the remaining problems being 3 hours or less each.

The five degradations were divided among the facilities as follows: MHU (3), HSSCC (1) and QRS (1). The MHU degradations were corrected by repair or replacement of parts and the HSSCC were corrected by hardware repair or software correction. The QRS degradation was caused by the corrosion of the WDG battery terminals.

The principal equipment types experiencing degradation was the MHU vehicle equipment (3).

Comparison of November 1976 data against the first year of operation shows that November 1976 TR's are slightly below the same month of 1975 (20 vs 27) and significantly below the first years average (23 compared to average of 36.9 TR's). The compute TR's) and generator remained the prime sources of trouble (five TR's) with the relay station rating highest this month with 8 TR's.

The three TR's requiring approximately 30 operational hours each to implement were: (1) the antenna positioner drive motor failure at the QRS, (2) the MHU radiator began leaking and was removed from the vehicle for repair and (3) the slo-scan was intermittently transmitting bad images which turned out to be a faulty modem.

December 1976 Trouble Reports. Nature of the 21 TR's were: Failures (9), Degradation (8), Deficiencies (2) and other (2).

The 10 failures were divided among the facilities as follows: MHU (4), HSSCC (2) and QRS (3). The MHU and degradations were MHU (4), HSSCC (2) and QRS (2).

The MHU was equally split between repairs and replacements 5/5 with the HSSCC at 4 repairs, 2 replacements and the QRS with 3 repairs and two replacements.

The most significant failure experienced this month was that of the blades, hub and tail assembly of the wind driven generator which was later deactivated and removed from the QRS. The most operational down time was due to a memory board failure in the computer main frame (20 hrs). The computer again lead the other equipment types with failures (5) with the generators and (4). Other computer problems were computer software, a line printer tape breakage, mechanical failure in the TTY, and Diablo disc replacement all of which required little operational interruption.

A total of 49.9 operational hours was spent performing corrective maintenance with most of the TR's consuming less than two hours.

The 21 trouble reports were distributed among the facilities as follows. MHU (10), HSSCC (6), and QRS (5) and 13 repairs and 9 replacements for all facilities.

Comparison of December 1976 data against the first year of operation shows that December 1976 TR's are significantly below the same month of 1975 (21 vs 31) and considerably below the first year average (21 compared to an average of 36.9 TR's).

January 1977 Trouble Reports. Nature of the 16 January 1977 TR's were: Failure (9), degradation (3) and other (4). The nine failures were divided among the facilities as follows, MHU (4), HSSCC (3) and QRS (2). The degradation were distributed as: MHU (1) LHSC (1) and QRS (1). A total of 10 repairs were made and 5 replacements.

Total corrective time for the month of January 1977 was 105.8 hours with the UPS consuming by far the most with 64 hours. The remaining TR's were eight hours (2) or less.

The computer experienced two failures this month, not including the UPS and both were line printer malfunctions corrected by site personnel.

The UPS sustained damage caused by a shorted silicon controlled Rectifier (SCR) and resulting in 6 printed circuit board traces being burned due to hi-voltage applied after the SCR shorted between Anode, Cathode end date.

Only two generator problems occurred this month with the remaining TR's spread across all elements.

In summary, during January 1977, a total of 16 TR's were distributed among the facilities as follows, MHU (6), LHSC (2), HSSCC (4) and QRS (4).

Comparison of January 1977 data against the first year of operation shows that January 1977 TR's are well below the same month of 1976 (16 vs 40) and the first year's average (16 compared to average of 36.9).

February 1977 Trouble Reports. Nature of the 18 February TR's were: failure (1), degradation (8) modification (2) deficiencies (2) and other (5). The only failure occurring this month was at the HSSCC which was the line printer. The distribution of degradations were: MHU (6), HSSCC (1), and QRS (1).

The distribution of TR's by facilities was MHU (13), HSSCC (2) and QRS (3).

The total corrective time for the month was 38.7 with problems with the hands free units and MHU fuel gage consuming the most (both 8 hours). The remaining TR's required three hours or less.

A total of eleven repairs were accomplished with five replacements and two minor modifications. The mods were both relative to the MHU.

Comparison of February 1977 data against the first year of operation shows that February 1977 TR's are well below the same month of 1976 (18 vs 39) and below the first year average (18 compared to average of 36.9 TR's).

March 1977 Trouble Reports. Nature of the 10 March 1977 TR's were: failures (5), degradation (1), modification (1) and other (3). The failures were divided among the facilities as MHU (2), LHSC (2) and QRS (1).

Three repairs were accomplished with five replacements and 1 modification.

One TR was attributed to human error.

The total corrective time expended was 41.0 hours with 14 hours spent on two TR's related to the MHU prime generator, 12 hours for installing additional MHU grounding rods and connections to existing water pipes and 6 hours consumed replacing the motor/gear assembly in the QRS/MHU antenna positions.

In summary the distribution of the TR's by facilities was: MHU (7), LHSC (2) and QRS (1).

April 1977 Trouble Reports. Nature of the 20 April 1977 TR's were: failures (10), degradation (8) and other (2). The distribution of the failures were: MHU (3), HSSCC (4) and QRS (3). Degradations were MHU (6), LHSC (1) and HSSCC (1).

Fifteen repairs were accomplished and five replacements.

A total of 64 corrective hours were spent this month with 12 hours expended installing the backup deisel generator. A total of 70 operational downtime hours occurred on the computer subsystem caused by two failures. One in the diablo disc (48 hours) and the other on one of the memory boards (22 hours).

A third failure (TTY) occurred which was concurrent with the disc failure and did not result in additional subsystem downtime (32 hours). The remaining times were four hours or less.

Comparison of April 1977 data against the first year of operation shows that April 1977 TR's are moderately below the same month of 1976 (20 vs 31) and significantly below the first year average (20 compared to average of 36.9).

Summary. The number of Trouble Reports and Mean Corrective Time (MCT) generally decreased from the commencement of operation to the end of the two years. The Trouble Reports peaked during the fifth month of operation (50), then generally declined over the next nineteen months. The average numbers of TR's during the first year was 36.9 per month and 20.5 during the second year with a two year average of 28.6 per month.

Most of the corrective times decreased as operations and maintenance continued, as personnel gained experience with the particular equipment and maintenance [illegible] corrected by minor modifications and/or change in maintenance p[illegible] of 31 modifications were made to the system during the

two years. Most of these modifications were accomplished in order to reduce subsystem maintenance and/or corrective time.

The increase in down times and corrective time relative to the computer during the last month was due to the lowered priority of computer maintenance. This change in priority was due to: (1) all HIS data was routed via the Time Division Multiplexer (TDM), (2) the scheduler data was being maintained manually per an IHS decision and (3) most of the equipment data base data was already in the computer and little computer time was required to input the remainder.