

Telemedicine in Micronesia

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Abstract

Distance and isolation profoundly affect the delivery of health care in the islands of Micronesia. The lack of specialty services on most of the islands has led to a costly off-island referral system that strains health care budgets. Care providers have incorporated advances in telecommunications to create a telemedicine network amongst themselves and with a tertiary care hospital in Hawaii. They developed an interactive video teleconferencing system, a still-image transmission network, and a data-transfer network for use principally in patient care and continuing education. Patients now receive earlier evaluation by off-island specialists as part of an effort to improve the appropriateness of off-island referrals. Regularly-scheduled medical lectures are broadcast from Pohnpei, a main island, to physicians in several more remote locations. Transmission costs are kept low by using, when possible, pre-existing public service satellites, such as the PEACESAT system that serves the entire Pacific basin. The telemedicine system is evolving and its success depends greatly on the cooperative relationships of the partners.

Introduction

This paper describes a telemedicine programme designed to improve health care and health education in the Micronesian nations of the Republic of Belau (Palau), Republic of the Marshall Islands (RMI) and the Federated States of Micronesia (FSM). The programme is active and evolving, and it uses both low cost equipment and transmissions.

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Micronesia is an ethnogeographic region in the west-central Pacific, characterised, as its name suggests, by small islands (Figure 1). The names of few islands are well known: Yap because of its large stone coins, Bikini from America's testing of atomic weapons, Truk (now Chuuk) and Peleliu from World War II battles.

Among Palau, RMI and FSM, there are about 2,000 islands, atolls and islets, although only 97 are inhabited. The total land mass is only 529 square miles, less than half the size of Rhode Island, and the total population is 160,000. Although roughly 50 per cent of the people live in remote areas, the main villages are densely populated, and 45 per cent of the Islanders are under 15 years of age (Pihoa Data Matrix, 1993). Outsiders, imbued with the image of a tropical island paradise, may consider Micronesia idyllic, but its health care systems are limited. Micronesians suffer from problems of both the developing and developed countries. Malnutrition and communicable diseases, typical of the developing world (such as cholera, typhoid, and tuberculosis), are common. There are also high rates of chronic diseases such as diabetes, hypertension and cancer. These diseases are often undiagnosed until quite advanced (Smith, 1994).

Per capita health care expenditures across Micronesia are about \$105 per year. Perhaps the greatest financial burden on the health care system is the amount spent on off-island referrals – when patients are sent to Honolulu or Manila for specialty care. For example, Kosrae, a state in the FSM, spends 49% of its health care budget on referrals (Pihoa Data Matrix, 1993).

Some barriers to providing effective health care in Micronesia are listed in Table 1, including limited resources, expensive transportation, communication, professional isolation and limited opportunities for continuing medical education. In this paper, we describe how telemedicine may help resolve each problem.

Table 1. Some barriers to health care

Some barriers to health care
Limited primary care and specialty care
High cost of patient transfer off island
Limited diagnostic (laboratory, radiology, and pathology) facilities
Limited opportunities for continuing medical education
Stress of professional isolation
High cost of telecommunications
Too few indigenous practitioners and directors

Discussions of telemedicine often focus on distance and isolation as barriers to care. Perhaps nowhere else in the world do these factors have a more profound constraining effect on health care than in Micronesia. Occasionally islanders still travel by traditional canoe from outer islands to clinics, or they may wait for the periodic visits of government medical teams. Often, outer islanders may receive no intervention at all. Consequently, for much of Micronesia, primary care is episodic and specialty care either non-existent or extremely expensive.

Historically, the US Government has had an interest in health affairs of these islands for a variety of reasons. The islands experienced a succession of colonial rulers – the Spanish from the time of Magellan until the decline in Spain's empire in the late 19th century, the Germans until the end of World War I, and the Japanese until the end of World War II. After the Japanese occupation, the United Nations designated the region as a trust territory administered by the US. Independence came to RMI, FSM and Palau in the past decade but many indigenous institutions have been irreparably altered.

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Through treaties and compacts of free association, the US Congress has determined that several federal agencies will continue to provide financial and technical assistance in a number of areas (including health care) for these independent nations. The Public Health Service (PHS) helps develop the health programmes; and Tripler Army Medical Center in

Honolulu provides tertiary and specialty care for Islanders. The issues of licensure and liability for Tripler's staff were resolved in prior agreements.

Kwajalein telemedicine programme

The Department of Defense leases Kwajalein Atoll in the Marshall Islands for testing the trajectories of strategic missiles. Three thousand Americans, a mix of federal and contract personnel, live on one islet of Kwajalein. There are a few US primary care physicians assigned to Kwajalein, but until recently, residents who required specialty consultations or care were evacuated to Honolulu. The annual cost of these evacuations was nearly \$1 million in transportation alone. The commander of Kwajalein's army base asked the commander of Tripler to devise a programme to reduce the cost of off-island referrals – hence the impetus for Tripler to establish a telemedicine program (Delaplain, 1993). The Pacific telemedicine programme was inaugurated in January 1993, using video teleconferencing systems already in place at Tripler and Kwajalein. Transmission relies on an existing defense satellite system. Twice a month, the physicians on Kwajalein arrange by fax or electronic mail for particular Tripler specialists to meet over the airwaves for a teleconsultation.

Adjacent to Kwajalein islet is Ebeye, densely packed with 14,000 Marshallese on an islet smaller than one square mile. Medical conditions are unsatisfactory. Patients from Ebeye are also seen regularly by teleconsultation under Tripler's mandate to provide specialty care to the Marshallese. From 1993 to 1996, more than 250 teleconsultations in 23 specialties (Table 2) have been conducted.

Table 2. Specialty consultations between Kwajalein and Tripler

Specialty	Per cent
Dermatology	40 %
Orthopaedics	20 %
Radiology	20 %
Urology, cardiology, ophthalmology, otorhinolaryngology, psychiatry, social work service	20 %
Surgeries: Plastic, thoracic, general, oral; physical therapy, paediatric neurology, gastroenterology, adult neurology, obstetrics, allergy, nutrition, podiatry	20 %

The telemedicine programme has enabled prompt intervention before the patients' conditions, acute or chronic, have deteriorated to the point of requiring evacuation. Although no systematic data have been gathered to document its specific benefit, it seems evident that the programme has averted many evacuations of both American personnel on Kwajalein and the Marshallese on Ebeye.

Telemedicine in other Pacific Islands

The residents of Kwajalein and Ebeye constitute a small proportion of the federal beneficiaries in the Pacific. Tripler Army Medical Center organised a loose consortium of agencies, governmental and non-governmental (e.g. University of Hawaii), to consider additional telemedicine programs to reach the remainder of beneficiaries. This consortium first met in Honolulu in 1994 and continues to work together to coordinate telecommunications activities for the provision of health care services in the Pacific.

The initial goals of the telemedicine/telehealth programme as envisioned by the consortium are as follows:

- to extend primary care services;
- to provide specialty consultations as necessary;
- to develop continuing health education;
- to provide patient and community health education; and
- to provide a communications link among providers in the Pacific.

Together with the physicians and the senior medical leadership from the islands, the group adapted the following principles to guide the planning of additional telemedicine programmes:

- existing low-cost telecommunications technology should be used whenever possible rather than buying expensive new equipment;
- select equipment that is easy to use, as most health workers in Micronesia are unfamiliar with technological devices;

- equipment must be durable and easy to maintain;
- the telemedicine system must be integrated with the existing medical and telecommunications infrastructure;
- local support for telemedicine must be secured before installation; and
- local control should be maximised to maintain traditional cultural values.

PEACESAT

Several of the programmes use the existing satellite communication system known as PEACESAT or Pan-Pacific Education and Communication Experiments by Satellite. This programme is funded by the US Department of Commerce and is housed at the University of Hawaii. It uses older federal satellites (e.g., from the National Aeronautics and Space Administration [NASA] and the National Oceanic and Atmospheric Administration [NOAA]) to provide non-commercial, public-access satellite communications across the Pacific. Many of PEACESAT's ground stations have been in place and operating since 1971. They avoid long-distance charges associated with conventional telephones.

The current satellite, a GOES-2 meteorological satellite provided by NOAA, has a fixed orbit over the Pacific and supports links between and among 44 ground stations in 22 countries and in both US-affiliated and non-US-affiliated states, covering nearly every political entity in the Pacific. The basic hardware of a ground station consists of a three-metre dish and a work station that have a combined cost of \$30,000. The devices are usually housed at a government office, often the Ministry of Education. Currently each PEACESAT station is capable of transmitting voice, data, fax, and electronic mail. Several stations can also handle simple still images.

PEACESAT's charter designates four service areas: education, economic development, disaster management and health. An example of an education programme is a multipoint voice-only interactive teacher conference. For economic development, the system is used primarily for fisheries management. PEACESAT's role in disaster management involves both pre-disaster planning and postdisaster response, especially if conventional communication systems are damaged by a typhoon or tsunami. For instance, after Hurricane Iniki devastated the Hawaiian island of Kaua'i in 1992, the Federal Emergency Management Agency (FEMA) used PEACESAT to broadcast from that island for three days before phone service was restored. But until now the health part of the charter has been largely ignored.

The first telemedicine project with PEACESAT was to create an electronic database – Pacific HealthNet – for health care workers. One objective was an e-mail service, for rapid dissemination of health information and an efficient resource for answering questions about specific patients and health problems. However, during the occasional outbreaks of cholera, typhoid, dengue and measles on the islands, rapid multipoint becomes necessary.

The Pacific HealthNet has a limited link with GratefulMed, an on-line database from the National Library of Medicine. Once refined, it will allow MEDLINE searching from some of the most remote locations in the world. Recently the Centers for Disease Control and

Prevention (CDC) placed the *Morbidity and Mortality Weekly Report (MMWR)* (CDC, 1995) on-line, and it may now be downloaded weekly. More important than acquiring the specific information in each issue is the symbolic importance for the staff at these small, remote hospitals to be able to use the communication system for linking them to sophisticated medical databases.

Tripler's medical database (Composite Health Care System [CHCS]) is also on-line. This database allows eligible clinicians rapid retrieval of laboratory and surgical pathology results on specimens sent to Tripler, thereby reducing delays associated with the postal system. The database is available only to federal health care workers in the Pacific, including those in the armed forces, PHS, Peace Corps and Coast Guard. Nevertheless, almost every island has a federal health care worker who can assist the Micronesian physicians with patient data retrieval.

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Several current and imminent developments will further improve the PEACESAT system. Today a health care provider must travel from the island's hospital to the island's PEACESAT ground station as the PEACESAT sites and the hospitals are not collocated. New hardware may obviate this problem by enabling remote dial-in access. Several hospitals are planning to install these devices in the near future. Other devices like the AT&T Picasso picturephone can improve the PEACESAT system. This picture phone is capable of transmitting high-quality, color still images over PEACESAT. Engineers from AT&T and PEACESAT are continuing to test the system and may soon place Picasso picturephones at several PEACESAT stations.

Most importantly, PEACESAT will soon upgrade its services in eight Island states to add multiple compressed video circuits and INTERNET connections to existing services. The sites to be upgraded are Fiji (Suva), Solomon Islands (Honiara), Palau (Koror), Guam, Commonwealth of the Northern Mariana Islands (Saipan), FSM (Pohnpei) and RMI (Kwajalein). The upgraded system should allow interactive motion video among hospitals (including facilities in New Zealand, Fiji and Hawaii) for patient care, medical education, public health and other health-related purposes.

Formal medical education

The Pacific Basin Medical Officers Training Programme (PBMOTP) in Pohnpei, FSM, a satellite programme of University of Hawaii's John A. Burns School of Medicine, is committed to developing an indigenous physician workforce to serve the US-affiliated central Pacific states (RMI, Palau, FSM and American Samoa). Each year, about 15 students are admitted to a five-year programme to become physicians. Graduates earn a Medical Officer degree and are licensed to practice in the participating jurisdictions (Dever, 1994).

Physicians graduating from the PBMOTP return to their home islands for a year-long, poorly structured, locally-controlled, apprentice-style internship. Afterwards they have

little or no further medical education. Continuing and graduate medical education programmes (CME and GME) are virtually non-existent, and there is neither adequate funding nor opportunity to send the graduates abroad for courses. The directors of the two medical schools in the mid-Pacific, the PBMOTP and the Fiji School of Medicine, have long sought to develop a distance learning programmes for CME and GME. This model for distance-learning has been adopted by the Fiji School of Medicine under the auspices of the World Health Organization for dissemination in much of the western tropical Pacific basin (WHO, 1995).

In April 1995, a distance-learning network for the Pacific was established. AT&T Picasso picturephones were used to transmit voice and high-quality still images over phone lines. An inaugural interactive lecture on acquired immunodeficiency syndrome

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(AIDS) in the Pacific was presented from Honolulu via the Picasso picturephone, to about 60 on-site health care workers on both Pohnpei and Palau. The audience listened to the lecturer's voice on the Picasso's speakerphone, observed a series of still images on the television monitor, and discussed issues interactively with the lecturer. The lecture was attended by senior clinical and political health officials from several nations, the director of

the PBMOTP, and the dean of the Fiji School of Medicine.

The demonstration led to the proposed expansion of this education network in the Pacific basin. The PBMOTP's weekly grand rounds lecture is now transmitted from the medical school to the hospital on Kosrae. Furthermore, instructors at the remote sites can present lectures to the more populous sites. For example, staff at the PBMOTP have delivered presentations on telemedicine to the annual Waianae Comprehensive Health Care Conference on O'ahu, Hawai'i, to the Alaska Telemedicine Project in Anchorage, Alaska, and to the South Pacific Commission in Noumea, New Caledonia.

Patient care network

The telemedicine network has another primary purpose: patient care. Patient care connections will be conducted at three levels. The first level will be intra-island, from one side of Pohnpei to another. PBMOTP students rotate for one-month assignments at a clinic on the opposite side of the island, which is several hours' drive away from the medical school. The Picasso picturephone permits regular teleconsultations and patient-based learning to continue.

The second level is intra-national (for example, between the FSM's smallest hospital on Kosrae and its largest one on Pohnpei). The third level is international (e.g. consultations between the medical officers on Pohnpei and Palau, or between a Micronesian hospital and Tripler). To date, approximately 25 international teleconsultations have been conducted. In about half of the cases, an evacuation was averted. Another use of the Picasso picturephone system will be to bring community-oriented education to several sites simultaneously. This programme will be designed and conducted on the local level.

Electronic mail

A major goal of the telemedicine programme is to establish e-mail links in countries that have no Internet nodes. The health benefits of e-mail include access to medical bulletins, clinical consultations, transfer and discharge summaries, laboratory and biopsy information, educational materials, supply requests, and epidemiological data. Moreover, the interactive or conversational aspects should reduce professional isolation, especially in the more remote areas. For example, Compuserve accounts at 2,400 baud have been established on Pohnpei and Yap for users to retrieve biopsy results, to pose questions to Tripler consultants, or to send transfer notes before an evacuation. The medical sector continues to encourage the telecommunications authorities in Micronesia to establish more efficient e-mail access.

Other beneficiaries

There are a number of other potential beneficiaries in Pacific countries. The Peace Corps medical officer for Micronesia has used the Picasso system from Pohnpei to support the Peace Corps volunteers in FSM. Professional organisations, such as the Pacific Basin Medical Association and the PBMOTP Alumni Association, are considering whether to hold regular meetings over PEACESAT as an inexpensive alternative to periodic gatherings on a particular islands.

Conclusions

We have described the early experiences of a telemedicine network in the central Pacific. The system uses inexpensive, low-bandwidth equipment and, where possible, relies on existing communications systems. This is an ongoing operational programme, not simply a demonstration project. Data collection is underway to permit analysis of costs, clinical outcomes, and effects on referral patterns. Further improvements and expansion are planned as warranted. The Pacific telemedicine programme now provides the following services and capabilities:

- a clinical consultation network for timely access to specialty consultations, which is likely to improve appropriateness of off-island referrals; and
- a health education network to provide CME and GME programmes, which is likely to enhance quality of care and reduce professional isolation.

The following areas have been demonstrated but still require technical refinement:

- access to electronic medical databases such as those at the CDC, National Library of Medicine, and Tripler;
- an efficient e-mail network to permit connections among Pacific basin health workers and from the Pacific basin to the outside world.

This project may be one of the few large-scale, self-sustaining telemedicine programmes in the world. The entire costs of the programme are offset simply by preventing several unnecessary evacuations. Some of the lessons from this programme may be exportable to other underserved communities.

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