

TIIAP FY 1999

Project Narrative

**Kapi'olani Medical Center for Women &
Children**

Grant # 15-60-99035
Health
Honolulu, Hawaii

REMOTE FETAL IMAGING BY HIGH-RESOLUTION ULTRASOUND

This proposal is intended for the Health application area

CONCEPT:

Provide accessible, quality healthcare to under served pregnant Native Americans and their unborn children through use of telemedicine for remote fetal imaging by high-resolution ultrasound.

STATEMENT OF PROBLEM:

Pregnant Native Americans of Polynesian descent as well as recent immigrants from South Asia do not always receive optimal healthcare in Hawaii. Consequently, their newborns suffer disease, disability and injury that could often be detected, treated and/or prevented through accessible, specialty prenatal care.

Hawaii's resident population of 1.1 million people on seven different islands is 13% Native American/Hawaiian (143,841), 15% Filipino (168,682), 6% Chinese (68,804), 22% Japanese, 33% Caucasian, 2% Black and 7% Other, largely Pacific Islander.

The number of live births in Hawaii is about 19,500 per year (1994 most recent data).

Hawaii's Native American and Southeast Asian women have more babies than other ethnicities in Hawaii (22 births/1000 residents versus 16.7/1000). Pregnancies in these under served groups have high rates of complications due to high prevalence of diabetes, thalassemia, poor nutritional status, recreational drug use, congenital anomalies, pre-term labor and non-compliance with basic prenatal care due to cultural, technological and geographical barriers in an island state. Infants born to these under served women die at almost twice the target rate set by the National Year 2000 Initiative of 7 deaths per 1000 residents (13.2 deaths/1000 live births among Native Hawaiians and 8.1/1000 among Filipinos versus 7.3/1000 for Hawaii overall).

Native Hawaiians and Southeast Asians customarily seek healthcare services from Hawaii's network of nine largely rural community health centers rather than from urban hospitals. The prominent example is the Waianae Coast Comprehensive Community Health Center, the largest provider of Native American health care in Hawaii. Established in leeward Oahu in 1970, the Waianae Center is designated as a Medically Under-Served Area and is a USPHS 330 Grant recipient. It serves over 20,000 patients per year of which 48% are Native Hawaiian.

The community health centers can provide basic prenatal "wellness" checks but are not equipped to manage complicated pregnancies. Women with high-risk pregnancies are referred to Hawaii's only comprehensive, tertiary level Fetal Diagnostic Center, a department within Kapi'olani Medical Center for Women and Children in Honolulu. Fetal Diagnostic Center averages 15,000 high-risk patient contacts per year. There are only five obstetric-specialty physicians (perinatologists) in Hawaii (excluding military), all with Fetal Diagnostic Center.

When pregnancy complications receive timely, specialty medical care, optimal birth outcomes are assured. Fetal imaging by high-resolution ultrasound is the well-established standard of care for these patients. Through ultrasound, the health of a fetus can be precisely assessed.

Currently, more than 6,000 health problems can be detected, treated and/or prevented prenatally if detected sufficiently early in gestation. Every woman in Hawaii with a high-risk pregnancy should receive timely high resolution ultrasound, but many do not due to inaccessible specialists in a state with scattered island geography and the concentration of the state's five pregnancy specialists in urban Honolulu.

Among Native Hawaiian women, there is strong cultural resistance to travel from rural communities to an urban setting. Many do not have access to airplanes or cars, cannot drive or manage public transportation, and will not make any kind of journey without several family members in attendance, both costly and inconvenient. Further, primary care providers are often reluctant to insist that women in the midst of high-risk pregnancies travel.

In an effort to partially extend specialty obstetric care to the communities most in need, Fetal Diagnostic Center's five perinatologists currently fly and/or drive to eleven different locations (six of them rural) on four islands; about 3,000 high-risk pregnant women were seen last year in these itinerant clinics. It is estimated that up to 7,500 women who need this care are not receiving it due to geographic, technologic and cultural barriers. The nine community health centers refer the preponderance of patients for specialty pregnancy care. For example, about 75 Native American women with high-risk pregnancies are seen at Waianae Center each month by a visiting perinatologist. While these itinerant clinics resolve some of the cultural, geographic and technological barriers to needed care, the visits by the specialist physicians are too infrequent to adequately serve the needs of Native Hawaiian and Southeast Asian communities in Hawaii. Inevitably, high-risk pregnancies need fetal ultrasound services at a time when the perinatologist is not available; timeliness is often at issue. A woman with a complicated pregnancy needs specialty consults available seven days per week.

PROPOSED SOLUTION:

Telemedicine can remove technological, cultural and geographic barriers to optimal care of high-risk pregnancies among under served women in Hawaii. Telemedicine can assure that pregnant Native Hawaiian and Southeast Asian women with high-risk pregnancies have access to obstetric specialists virtually around the clock. Further, telemedicine can permit greatly improved utilization of a scarce and precious specialist physician resource. By joining together twelve non-profit organizations as partners in this effort, quality healthcare services could be made available to under served women statewide.

The pregnant patients served by the nine community health centers would be "seen" via telemedicine link to Fetal Diagnostic Center at Kapi'olani Medical Center for Women & Children in Honolulu. The ultrasound machines utilized by each of these community health centers would be adapted to permit remote viewing of fetuses on both a real-time basis and by store/forward technology. The patient could be scanned in one location; the perinatologists could "see" the imaged fetus from desktop computer monitors in Fetal Diagnostic Center and provide diagnoses and medical advice accordingly. Real-time ultrasound scans could be guided by interactive voice instructions between the perinatologists and primary care providers at the remote sites. In addition, the ultrasound examination rooms within each community health center would be equipped with basic interactive video-teleconferencing equipment to enhance communications between physicians, primary care providers and patients during ultrasound scans or for other consultation discussions.

PROJECT SIGNIFICANCE:

This TIIAP project would serve as a nationally significant demonstration of how distance medicine and linked telecommunications can extend valuable specialty health care services to all Americans, particularly rural, under served citizens. A single exemplary standard of care for high-risk pregnancies would be established across the Hawaiian Islands, eliminating the distinction between technological/medical “haves” from the “have-nots.”

Once the telemedicine network is in place, additional specialty services could be provided to these same under served patient populations, e.g. specialty pediatrics, genetic counseling, subspecialty consultations and emergency triage prior to flying patients to Honolulu.

With this telemedicine network as a base, services for under served, pregnant women could be extended to the Pacific Basin Island American Territories of Guam, Samoa and Saipan.

Other regions of the United States with Native American citizens would regard this project as a model for equal access to health care.

COMMUNITY PARTNERS:

Twelve community-based non-profit partners have joined in support of this grant application.

Partners include Hawaii's nine small, non-profit Community Health Centers, which provide health care for indigent and under served patients:

- (1) Bay/Pahoa/Kau Community Health Center, Island of Hawaii (rural)
- (2) Community Clinic of Maui, Island of Maui (rural)
- (3) Hamakua Health Center, Island of Hawaii (rural)
- (4) Kalihi-Palama Health Center, Island of Oahu (quasi-rural)
- (5) Kokua-Kalihi Valley Health Center, Island of Oahu (quasi-rural)
- (6) Waianae Coast Comprehensive Health Center, Island of Oahu (rural)
- (7) Waikiki Health Center, Island of Oahu (urban)
- (8) Queen Emma Clinics, Island of Oahu (urban)
- (9) Waimanalo Health Center, Island of Oahu (rural)

The majority of Native Hawaiian and Filipino residents seek care in these centers. In 1993, 56,000 were served (most recent data available). The Community Health Centers are located in largely rural areas with limited or no access to obstetrical specialty care. When high-risk pregnancies occur it is often necessary to charter an airplane to transport the women from neighbor islands to Honolulu.

Bay/Pahoa/Kau Community Health Centers are located on the east side of the Big Island of Hawaii. Started 14 years ago as a women's health clinic they expanded to primary care in 1992. The Clinic has three sites, which serve a large rural area, much without paved roads, electricity, telephone service or water. The Kau site opened in January 1997 and serves a sparsely populated area with high unemployment. The Hilo and Pahoa clinics are in designated Medically Under served Areas and are Federal Qualified Health Center look-alikes. The Pahoa Clinic is a health primary service area. These three rural clinics care for 12,000 patients per year. Fifty-four percent of the patients receive medical assistance; twenty seven percent are uninsured. Twenty percent of the patients are native Hawaiians and about forty percent are Asian/Pacific Islanders. The Community Clinic of Maui was founded in 1993. It has a full-time community clinic in Kahului and a part-time clinic in Lahaina. Targeted populations include the

homeless and immigrant farm workers. It is the only community health center on the island of Maui. It serves a Medically Under Served Population and has a USPHS 330 Planning Grant. About 10,000 patients are treated per year. Forth three percent are on medical assistance; forth four percent are uninsured. These patients are sixteen percent Native Hawaiian and thirty percent Asian/Pacific Islander. The Waianae Coast Comprehensive Health Center has six locations. It was established in 1970 and serves the leeward Oahu area. It is the largest provider of Native Hawaiian health care in the state. Waianae serves a Medically Under Served Area and is a USPHS 330 Grant recipient. About 20,000 patients per year receive care of which forty eight percent are Native Hawaiian. Fifth-six percent of these patients receive medical assistance and twelve percent are uninsured. The Waimanalo Health Center is located in windward Oahu in a community dominated by low-income Native Hawaiian residents. It serves a Medically Under Served population and is also USPHS 330 Grant funded. About 3300 patients per year seek health care at this location; fifth seven percent are Native Hawaiians. Each of the Community Health Centers participates in the federal Women, Infants and Children (WIC) programs.

The tenth partner in this project is the Harry and Jeannette Weinberg Foundation. This private, non-profit trust is based in Baltimore and Honolulu. Its mission is to provide funds, which will benefit the indigent and under served. Weinberg Trustees have selected telemedicine as a priority for Hawaii. Under their auspices, health care facilities statewide are being provided with PictureTel Concorde video-teleconferencing equipment. The Community Health Centers are among the designated recipients.

The eleventh partner is the University of Hawaii John A. Burns School of Medicine. The Department of Defense recently awarded the University a grant to design telemedicine education curriculum for physicians. Technical personnel from this grant will be donated by the University to the TIIAP remote fetal ultrasound project.

The twelfth partner for this project is Kapi'olani Medical Center for Women & Children. Kapi'olani is the only tertiary care obstetrics hospital in the state of Hawaii and the Pacific Basin. A department within Kapi'olani Hospital, Fetal Diagnostic Center is the only site in Hawaii and the Pacific Basin where tertiary level, specialty care is available for women with high-risk pregnancies. Five perinatologists provide care for about 15,000 patients per year. High-resolution ultrasound is the primary tool utilized for treatment of high-risk pregnancies. Fetal Diagnostic Center will contribute the expertise of these five physician specialists to the TIIAP project. The physicians would be responsible for interpreting fetal ultrasound scans and providing diagnoses and medical advice. In addition, Fetal Diagnostic Center's five ultrasound technologists will assist in training technologists at remote sites to assure optimal scan results.

PROJECT FEASIBILITY:

The project is based on a sound set of technologies and practices overwhelmingly suited to telemedicine. There are probably few situations where care practices, technologies and business cases are so well integrated.

Interoperability/Scalability: There are in essence two underlying systems to this proposal. (1) for standard teleconferencing purposes (e.g. dialogue between the perinatologist and referring primary care provider and patient), PictureTel units would be placed in the hub location (Fetal Diagnostic Center, Kapi'olani Medical Center for Women and Children). (2) for the

transmission of ultrasound video images, equipment from a consortium of vendors headed by Acuson, would be implemented.

Standard Teleconferencing: We are proposing to use PictureTel teleconferencing equipment. We plan to use a combination of PictureTel Venue 2000 Model 30, PictureTel 950 and PictureTel 550 equipment. During the past year, the Henry and Jeannette Weinberg Foundation, a private philanthropic foundation in the State of Hawaii, has offered every hospital in the state \$200,000 to purchase PictureTel Teleconferencing units (PictureTel Concorde 4500). All the State Hospitals and most of the other major institutions in the state have now purchased PictureTel equipment and had it installed by General Telephone and Electric (GTE) of Hawaii. PictureTel equipment is T.120, H.323 and H.320 compliant. PictureTel and its associated vendors provide a wide range of products from inexpensive desktop systems to full conference center services. Thus, we can scale equipment within the project to match the needs of each participant. For Teleconferencing we can utilize the existing state hospital SONET high speed network as well T1 networks maintained by the Ka Ola project which links many of the community health centers. In those cases where there are currently no existing high speed networks, we will install 3 ISDN lines for full motion video transmission. We have determined that GTE can link all our sites for ISDN transmission. We are currently funded from the Department of Defense for a Telemedicine Training Contract and some of the Community Health Centers will be connected via funding from this grant.

Ultrasound transmissions: A consortium of vendors headed by Acuson, Inc. will be providing the equipment for the combination of still and full motion video ultrasound transmissions. Acuson is the leading manufacturer of ultrasound capture and storage equipment. In all, seven of the eleven participating sites have Acuson ultrasound machines already in place. Acuson, Inc. also manufactures add-on component equipment that can be used to capture, store and transmit ultrasound still images and short clips. The add-on components (QV150 devices) can be added to almost any recently manufactured ultrasound machine, irrespective of brand. All seven Acuson machines plus the two non-Acuson machines within the eleven connectivity sites have been identified as upgradeable with the QV150 units. In some cases, back plane components within the ultrasound machines will have to be upgraded first, but in no case is there a serious issue surrounding the retrofitting of an ultrasound machine. The multiple QV150's in the remote clinics would further be connected via Acuson's application software known as the Aegis System. That software allows for remotely generated ultrasound stills and short video clips to be submitted to a central data collection system. The central system provides (1) coordination of the medical record reports that would be associated with the still images and video clips, (2) retrieval and playback of collected ultrasound stills and clips, and (3) storage and archiving services. For full motion real time transmission of ultrasound images, Acuson has partnered with another company named R4 to supplement the image capture performed by the QV150 unit. The R4 supplied equipment will serve specifically to provide diagnostic quality video images at a standard 640 X 480 ultrasound picture resolution generated at a rate of 30 frames per second. The R4 equipment uses a compression algorithm that is based on pixel replacement of only the changed portion of the image and is non-lossy in nature. The signal needs only a 384K fractional for transmission. This technology does use a proprietary compression routine to achieve the performance transmission standards as those standards, especially DICOM, are finalized and accepted by the medical industry. For purposes of this project, all eleven sites would be outfitted with the R4 equipment and full interoperability among all sites would be achieved for ultrasound transmissions. Scalability of this technology is not particularly at issue in that the transmissions being proposed are already at standard diagnostic quality. The only caveat on the quality is that fast or jerky movements of the handheld transducer under this scenario may generate streaking or shadowing on the screen.

Thus, the "ultrasonographer" (ultrasound machine operator) on the source side of the transmission must be cognizant of the hand held transducer's movement and through training and experience, minimize streaking. If additional line speed is available, there are possibilities that the compression can be reduced and thus, minimize streaking. In that sense, scalability of the transmission line may have a modest impact. Technology upgrades would be provided by the vendor at no cost to the project, when the vendor was able to reduce compression issues with higher line speeds.

How the System Would Work: High risk mothers would make appointments at any of the eleven local clinics, and staff would arrange a live remote ultrasound exam to be directed by a perinatologist in the Honolulu based Fetal Diagnostic Center. Connectivity would be initiated through three separate modes. First a standard voice line (POTS) would be used to establish coordination communication. Second, the Aegis System software for collecting stills and clips into the medical record would be initiated through the QV150 data collection device associated with the source ultrasound machine, and third, the full motion continuous video connection via the R4 utilities would be linked into the process. Both the Aegis System software using the QV150 connections and the R4 video system could use the same high speed connection, and if that connection were close to T1 speeds, then both systems could be used simultaneously. The perinatologist directing the activity from Honolulu would use the POTS phone line to direct the ultrasonographer's actions at the remote site. The ultrasonographer would first engage the R4 full motion video feature and allow the perinatologist to direct a general overview scan of the fetus. No recorded information would be collected during this period. As the perinatologist encountered items that were clinically relevant, he/she would direct the ultrasonographer to snap stills of the image, take screen measurements, or initiate full video clips. The QV150/Aegis System components would be used to submit this information into the central ultrasound data collection system in Honolulu. There would be compression of the video clip collected through this procedure, but the compression would not be as great as the compression used in the real time video portion. Thus, there may be delays measured in minutes before the QV150/Aegis System would have that information fully transmitted and accumulated. In the meantime, the perinatologist and the ultrasonographer would be using the full motion live video to continue with the remote exam. Full motion is critical in this type of examination as subtle nuances are important in detecting over 6,000 birth defects and characteristics through ultrasound. Because the examination would be conducted in real time, if the perinatologist was not satisfied with the quality of the live video due to streaking caused by abrupt movements of the transducer (by the ultrasonographer), the perinatologist would simply ask to see certain movements re-performed. A variation of this scenario would involve the PictureTel equipment. If instead of connecting via a POTS line, the initial connection was established via video link (ISDN or T1), the patient and perinatologist might use the early portion of the interaction to establish rapport and to collection additional clinical information via live report. With this bandwidth the verbal connection could be left live during the examination as well. As the likely bandwidth would be ISDN, that connection would probably be dropped during the exam (relying again on POTS to direct the ultrasonographer's activity). At the end of the exam, the video conferencing features could then again be engaged to allow the perinatologist to report on the preliminary indications of the exam and to coordinate additional care regimes.

How it Operates with Other Systems: The ultrasound remote examination and data collection mechanisms form a fairly complete system and need not inter-operate with other systems to any large extent. While there are some proprietary connection features with the Aegis System and R4 video utilities, all are being provided by the Acuson Company, which very much dominates this market. Further, the Acuson Company has assured interfacing to many other

ultrasound machines for initial data collection activities. Thus, the system is quite open in its ability to incorporate additional clinics or locations which already own non-Acuson equipment. On the generic video conferencing side, this project is open to accepting the dominant technology to be used in the Hawaii market place, which at this time is PictureTel.

Technological Alternatives that have been Examined: The current alternative involves sending the four perinatologists on rounds to remote clinics and transporting patients via airplane to the central Fetal Diagnostic Center at Kapi'olani Medical Center for Women and Children in Honolulu. This transport is obviously inappropriate in many circumstances due to the known difficulties associated with problem pregnancies and air flight. Thus, the perinatologists spend large amounts of unproductive time in travel and lost time due to missed appointments where the options to perform other work at the remote clinic are minimal. Worse yet, some patients do not receive care due to travel logistics and costs. A compromise technology is also in use where ultrasound exams are videotaped on VHS tape and mailed to Fetal Diagnostic Center. Without control over the actions of the ultrasonographer, the perinatologists may spend inordinate amounts of time watching unproductive views and have little knowledge of when the clinically relevant view may appear on the tape. Even as that happens, the perinatologists may not get the exact view required or movement away from the view may happen at the wrong time. Often these tapes simply result in a request for a live examination.

Long-term viability of Project: After initial funding for this project concludes, the likelihood of long-term viability of this telemedicine service to pregnant Native Hawaiian women is strong. Acquisition of equipment would provide the crucial boost. Recent legislation in Hawaii mandates that health insurance companies and health management organizations cover the cost of telemedicine services. The standard hourly wage paid to a perinatologist is \$156. A perinatologist performs an average of 4 ultrasound scans per hour; average reimbursement is \$55 each or \$220 per hour. The \$64 profit per hour multiplied by the most conservative estimate of 2,000 high-risk scans per year provides a net income of \$128,000. This amount would be sufficient to replace telemedicine equipment as needed after the conclusion of the TIIAP funding. There will be a relatively high percentage of patients who do not have health insurance. However, it is worth noting that by long convention, medical services provided to uninsured patients by the non-profit Kapi'olani Medical Center for Women and Children is most often considered charity care.

EVALUATION / OUTCOMES MEASUREMENT:

The purest outcome measurement of this telemedicine project would be an increase in the number of high-risk, pregnant, under served women who receive specialty care through fetal ultrasound services. Presently, the nine Community Health Centers refer about 3,000 women per year to perinatologists at the itinerant clinics. However, the number of women not being served is estimated to be 7,500 (based on pregnancy rates and pregnancy complication rates in Native American and Southeast Asian populations).

A second measure of the impact of this project would be a decrease in rates of birth defects as assessed by the State of Hawaii Birth Defects Monitoring Program. Timely medical intervention in uncontrolled maternal diabetes, malnutrition, substance abuse, anemia, etc. will result in optimal birth outcomes. Every infant born in Hawaii is included in the Birth Defects Monitoring database; within eighteen months, birth outcomes would be available by ethnic group and geographic area.

Two formal evaluation studies suitable for publication are proposed for this project.

Study #1: Compare the accuracy of remote telemedicine ultrasound scans with in-person ultrasound scans. For the remote scans, the interpreting physician will be located in Honolulu, at Fetal Diagnostic Center. In-person scans refer to those conducted with the physician and patient in the same room, usually at one of the itinerant clinics. A group of fifty randomly selected pregnant patients will be "seen" both ways – with remote consult and same-site consult. The two scans will be temporally and physically separated; double-blind format will be employed. A group of three perinatologists who did not conduct either scan will review both results and compare them. The hypothesis is that scan results will be essentially identical. Beard and associates reported in *Investigative Radiology* in 1993 the results of a similar five-week pilot study in England. They concluded that remote fetal ultrasound functioned well (*Invest Radiology* 28:732-734, 1993). Fisk et. al. Reported similar success with a telemedicine service for detecting fetal abnormalities (*Journal of Telemedicine and Telecare* 1(1):38-44, 1995 and 1(2):117-122, 1995). Results will be submitted to peer-reviewed professional journals and posted on the Kapi'olani Medical Center for Women & Children web site.

Study #2: Using a cost/benefit model, the economic viability of telemedicine for pregnant women will be assessed. The hypothesis is that additional studies done using the telemedicine system will pay for the cost of the equipment, ISDN time and personnel. In addition, health care dollars saved through reduced airplane trips to Honolulu, fewer hospitalizations for mothers and newborns, etc. will be considered. Results will be submitted to peer-reviewed professional journals and posted on the Kapi'olani Medical Center for Women & Children web site. It should be anticipated that results of this study would be widely sought; cost/benefit information in management of high-risk pregnancies is scant.