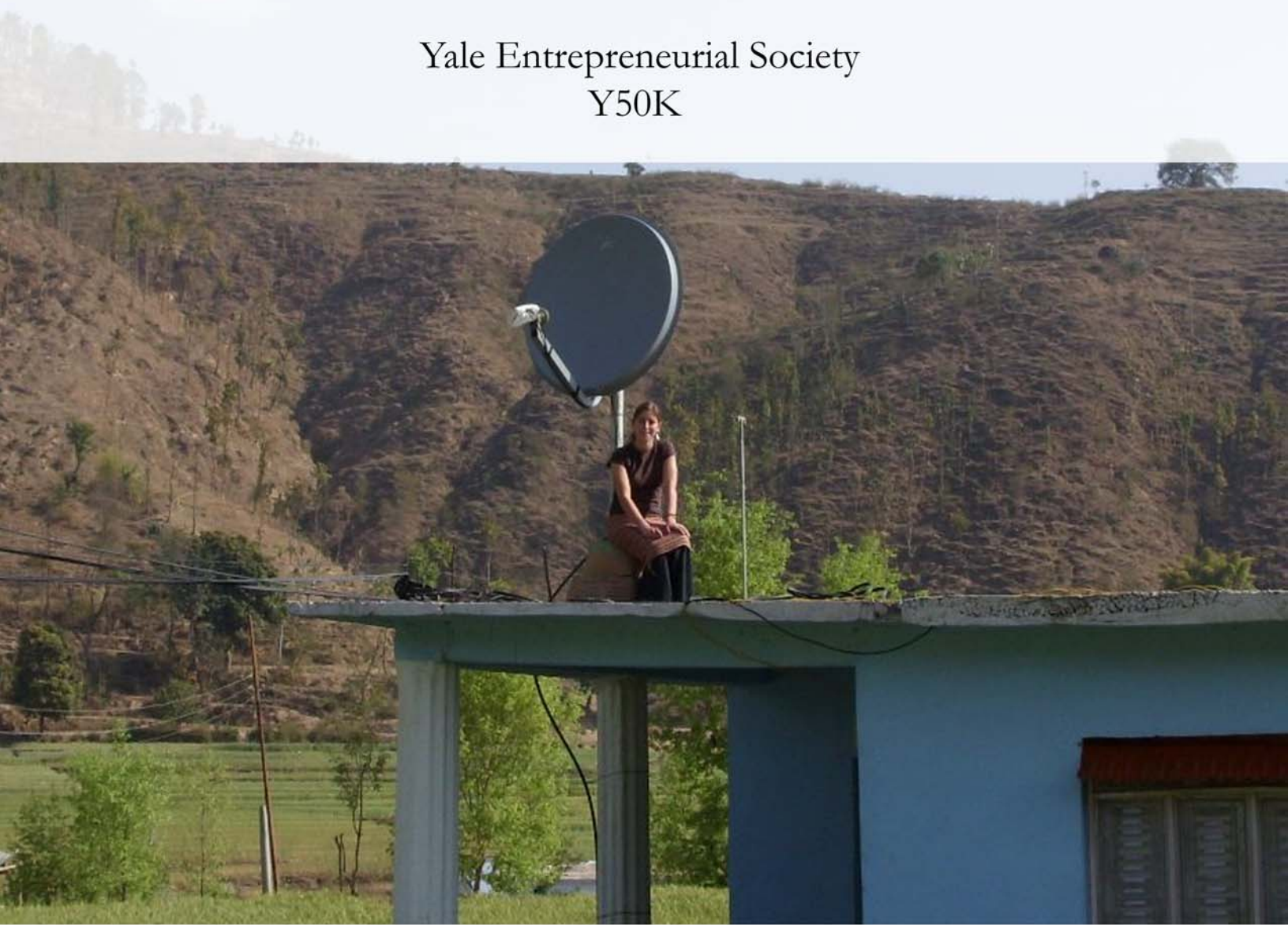


CHWired

Telemedicine for Community Health Workers
Achieving Health Equity and Access in Remote Places

Yale Entrepreneurial Society
Y50K



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I. Executive Summary

Title: CHWired: Telemedicine for Community Health Workers

Public Summary

CHWired deploys user-friendly software applications over an inexpensive Wi-Fi network to assist rural community health workers in poor countries. Through this network, we connect health workers to distant doctors and referral clinics, helping the workers triage and treat patients, obtain training, share experiences, and collect health data.

Opportunity Statement

Training local citizens as paramedics, known as community health workers (CHWs), has been identified by the World Health Organization as a key strategy to achieve healthcare access in underserved, rural communities [1]. CHWs continued to be trained and deployed to rural, poor regions of the world, where most of the world's population resides, but where the brain drain and lack of education have prevented physicians from being available or accessible. However, the full potential for CHWs to offer primary care to rural areas has yet to be realized, largely because these workers lack the support needed to provide effective treatments, receive adequate training, and collect and report epidemiological data. CHWired aims to implement a user-friendly telemedicine program over an inexpensive long-range Wi-Fi network to meet this need.

Market Opportunity and Strategy

The failure to utilize community health worker programs to meet global public health needs has typically been the result of a vast separation between urban and district hospitals and remote villages [2]. Information and communication technologies (ICTs) can bridge this gap and allow CHWs to partner with physicians within a given region. ICT-equipped CHWs can also be more effective at providing data for monitoring program performance and detecting disease outbreaks. Appropriate technologies can be deployed to improve recruitment, training, job satisfaction, and retention of CHWs.

ICT networks remain a work-in-progress, largely inaccessible to the rural poor. In rural communities in Nepal, for example, only 2.1% of households have a landline phone, 2.1% have a mobile phone, and 0.7% have a computer [3]. These numbers are approximately ten times lower than those for urban communities in Nepal, and are lower still in many villages. The challenge and opportunity is to make large, functional leaps in access to medical information through strategic investments in appropriate technology.

To meet this challenge, we are developing a user-friendly telemedicine program for CHWs, implemented over an inexpensive Wi-Fi communications network in rural Achham, a district of Nepal that previously had only one doctor for a population of 250,000 people. Our first collaborating partner is Nyaya Health, a community-based organization which operates a medical clinic and CHW-centered public health outreach project in the district. The program includes:

- 1) **Communication systems between CHWs and health professionals** at a central health facility within the CHW's home district.
- 2) **Communications technology that connect CHWs to each other** for mutual advice, experiential knowledge exchange, solidarity, and support.

I. Executive Summary

- 3) **Data collection and management tools for surveillance.** These include detecting common patterns in reported symptoms for early outbreak identification.
- 4) **A sustainable training system.** By training CHWs to use information technologies (IT), we facilitate sustained transfer of medical knowledge and the development of future generations of healthcare delivery experts.

After our initial pilot phase, we will expand to other districts in Nepal and subsequently to other rural areas in South Asia and beyond. These models will be implemented by Ministries of Health in collaboration with CHWired, utilizing our open-source, free system to promote the rapid diffusion of this innovation

Service Concept and Competitive Advantage

In our area of Nepal, there are presently no competitors for delivering internet access, let alone telemedicine applications. The few private sector medical services that exist are run by poorly trained non-physician practitioners and fail to reach most people in the area because of expensive service fees. Since CHWired works in partnership with the government, our community health workers are part of the public sector system that fills the gap left behind by these private practitioners.

Outside of Achham, our major competition comes from groups focusing on using telemedicine to deliver specialist physician knowledge to patients in remote areas. Although such telemedicine applications can be occasionally useful where no other options exist, they are unlikely to have a significant impact on broader healthcare access or on the acute shortage of on-site, well-trained healthcare workers.

We hope to convince ministries of health to adopt our community health worker-centric approach on the basis of our ability to deliver rigorous, cost-effective services to their citizens. Outcomes to assess the social return on investment include: 1) recruitment of high-quality candidates for CHWs; 2) retention of CHWs; 3) CHW execution and adherence to clinical protocols; 4) geographical expanse of CHW roll-out; and 5) equity with which this expansion occurs with respect to existing socioeconomic inequalities. These will be integrated with the patient outcomes tracking system, which will evaluate: 1) patient health status and demographic statistics; 2) treatment outcomes; 3) treatment demand; and 4) efficacy of preventative health measures.

Our integrated product provides the hardware and software needs to rapidly scale up a telemedicine program for CHWs in rural areas with poor telecommunications infrastructure. Since our product is open-source, governments (namely, the Ministries of Health) will be free to adapt the product to local conditions as they need. After the pilot phase in Achham, CHWired will function primarily to develop solutions and serve as consultants.

Presently, we have secured funding from the CDC and from Advanced Micro Devices and the Open Architecture Network for the initial pilot phase. Additionally, Nepal is a hub of economic studies following its recent move from a monarchy to a democracy. This offers opportunities for long-term revenue streams by outsourcing data collection conducted by our CHW network to epidemiological research groups and developmental economists, who are a major source of cash flow to the region. A major World Bank initiative has already contacted us to facilitate long-term collaboration.

I. Executive Summary

Market Analysis

We established internet connections in the area of Achham, and have no competitors in the region. Since our clinic provides services through mobile health teams that reach villages not traditionally accessed by the health system, we face little or no competition for the delivery of health services to most of our clients. The clients who reach our central clinic are unable afford the private practitioners in the area, who are the only other medical service providers.

Bringing CHWired to scale, however, will require pitching our open-source, free product to governments. There are other telemedicine models, particularly those that focus on delivering specialist *physician* knowledge [4,5]. Such models are our major competition in convincing governments to undertake our community health worker-centric approach. We will sell our product on the basis of our ability to deliver evidence-based, cost-effective services to their citizens. Conducting rigorous research to assess the approach discussed above is critical to this endeavor. Furthermore, the WHO has endorsed our worker-based approach as the major new initiative for the next decade of health service expansion [1], while few physician-centered approaches have worked, largely owing to the brain-drain to wealthier areas [6].

Financial Plan

The initial phase of our project is a nonprofit venture conducted in partnership with Nyaya Health. The prototype development of our application has started and will be completed by June 15, 2008. Subsequently, we will undertake the following steps during the first year of our operations:

- 1) Development of Wi-Fi communication systems to link villages in the district.
- 2) Community assessment to determine where implementation is most feasible and how to best meet demand.
- 3) Development of preliminary communications applications by Nepal-based software developers in collaboration with our team.

We will then take the following steps:

- 4) Equipping CHWs with appropriate technologies, and testing applications in collaboration with CHWs. This is anticipated to require two months.
- 5) Implementation and evaluation will take place over the subsequent year, as we monitor and improve the program.
- 6) Scaling up and replicating the model and forming linkages with other health programs in Nepal and beyond.

Over three years, we aim to incrementally expand our program to eventually cover the district of Achham. Over three years, we aim to incrementally expand our program to eventually cover the district of Achham. The approximate budget for start-up and one-year costs to pilot the project in 15 villages is \$59,504. Scaling up this process to cover the entire district over the subsequent two years will require an additional \$431,328. The major expenses arise from human resources needed to improve the healthcare access in the region. These costs will be feasibly met by our current and projected revenue streams, particularly through grants and foundations and academic collaborations.

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II. Mission Statement

CHWired deploys user-friendly software applications over an inexpensive Wi-Fi network to assist rural community health workers in poor countries. Through this network, we connect health workers to distant doctors and referral clinics, helping the workers triage and treat patients, obtain training, share experiences, and collect health data.

III. Unmet Need

3.1 The global need to equip Community Health Workers

Disparities in access to quality health services represent among the greatest humanitarian injustices present in the world today. Each day, countless lives are needlessly destroyed by medical conditions that can be easily prevented or treated with basic health interventions. The result is a seemingly endless cycle of poverty and illness that cripples poor societies.

Training local citizens as paramedics, known as community health workers (CHWs), has been identified by the World Health Organization as a key strategy to achieve healthcare access in underserved, rural communities [1]. CHWs continued to be trained and deployed to rural, poor regions of the world, where most of the world's population resides, but where the brain-drain and lack of education have prevented physicians from being available or accessible. The full potential for CHWs to offer primary care to rural areas has yet to be realized, however, largely because these workers lack the support needed to provide effective treatments, receive adequate training, and collect and report epidemiological data.

The failure to utilize community health worker programs to meet global public health needs has typically been the result of a vast separation between urban and district hospitals and remote villages [2]. Information and communication technologies (ICTs) can bridge this gap and allow CHWs to partner with physicians within a given region. ICT-equipped CHWs can also be more effective at providing data for monitoring program performance and detecting disease outbreaks. Appropriate technologies can be deployed to improve recruitment, training, job satisfaction, and retention of CHWs.

Information and communication networks remain a work-in-progress, however, largely inaccessible to the rural poor. In rural communities in Nepal, for example, only 2.1% of households have a landline phone, 2.1% have a mobile phone, and 0.7% have a computer [3]. These numbers are approximately ten times lower than those for urban communities in Nepal, and are lower still in many villages, such as those in the Nepalese district of Achham, where we work. The challenge and opportunity is to make large, functional leaps in access to medical information through strategic investments in appropriate technology.

3.2 Achham, Nepal: A Paradigm of Rural Underdevelopment

In partnership with the medical relief organization Nyaya Health, the CHWired project will initially serve the medical needs of patients living in rural communities of Achham, Nepal. Achham is a district in the far western region of Nepal with a population of approximately 250,000 people. It is one of the poorest districts in Nepal and has been severely affected by war and poverty. Currently, the entire district is served by a single doctor located five hours away, and subsequently it suffers from some of the highest maternal and child mortality rates in South Asia. 99.5% of babies in Achham are delivered outside of a health center, and 1 out of every 125 deliveries results in the death of the mother. Additionally, 60% of children are chronically malnourished.

III. Unmet Need

The annual per capita income in the district is less than \$150. The majority of inhabitants in target communities generate income through farming. Illiteracy is particularly high among women, with 76% in a recent survey being illiterate. About 45% of men in these families migrate to work in India [7]. Limited or no communication with family members while in India is the norm. Migration has fueled an HIV epidemic with 8-10% of returning migrants testing positive for HIV.

Despite the dire state of health in the district, public sector healthcare infrastructure is minimal. This is a result of the absolute poverty and remoteness of the area, the disempowerment of the citizens, and a decade-long civil conflict. As is typical for much of South Asia, about 80% to 90% of healthcare activities are performed by private medical practitioners. Most of the other 10% includes vaccines, tuberculosis (TB) treatment, and occasional healthcare camps [8].

The complex problems of Achham are similar to those faced by poor, rural communities throughout the world. Achham thus provides an ideal testing ground for developing programs aimed at providing appropriate technologies for CHWs.

IV. Solution

Despite the immense challenges described above, there are reasons for optimism. In recent years, major progress has been made in addressing global health disparities. Donations from individuals and governments have increased substantially, giving NGOs resources at levels never previously seen. Innovative models, such as those used by Partners in Health, have provided high quality health care in some of the world's most resource poor settings, challenging conventional ideas of what is possible [9]. A central component of these models is the community health worker (CHWs).

The CHW model has been proven to improve health outcomes at low costs to resource poor communities. CHWs also address many of the problems associated with delivering care through the classical clinic-based model, including an inability to draw target patients to the clinic and an emphasis on symptomatic care over preventative care. Additionally, the CHW approach empowers individuals and communities to play a greater role in their own healthcare, by training individuals to serve their local communities and facilitating the diffusion of knowledge through communities. This allows CHWs to serve as a catalyst for revitalizing and expanding access to health services and help ensure continuity of care in settings where there are few health professionals, where travel is difficult, and where chronic diseases require complex treatment regimens and ongoing monitoring [9].

Within current CHW models, CHWs typically work alone, often travel great distances, and rely completely on their own knowledge and the most basic of resources which they carry with them. In operating under these rudimentary conditions, only a small fraction of the potential for CHWs to impact their communities is realized. By equipping CHWs with innovative technologies tailored for local communities, CHWired aims to create a sustainable, scalable healthcare delivery system capable of addressing the most critical and immediate medical needs of Achham, Nepal. To achieve this, we will partner with the community-based organization Nyaya Health, which has requested our services to meet the tremendous healthcare needs in the area.

IV. Solution

4.1 Overview and Summary of Goals

We are developing a user-friendly telemedicine program for CHWs, implemented over an inexpensive Wi-Fi communications network in rural Achham. The program includes:

- 1) **Communication systems between CHWs and other health professionals** within the CHW's home district. This includes other CHWs for mutual advice and experiential knowledge exchange, solidarity, and support.
- 2) **Data collection and management tools for surveillance.** These include detecting common patterns in reported symptoms for early outbreak identification.
- 3) **Communication systems linking CHWs to timely medical information.** To deliver up-to-date care, CHWs will benefit greatly from access to internet-based medical resources on a regular basis to better treat and triage patients.
- 4) **An integrated, sustainable training system.** By training CHWs to use information technologies (IT), we facilitate sustained transfer of medical knowledge and the development of future generations of healthcare delivery experts.

The principles we follow in implementing this system are shown in Box 1. This is distinct from the physician-centered approach currently being pursued by most developing country governments.

Box 1

Principles of ICT Implementation among CHWs

Decentralized. Systems should be decentralized to ensure ownership and access in geographically dispersed communities.

Centered Locally. ICT applications should be developed to facilitate dialogue among CHWs and district-based physicians to provide each other with technical and social support. External specialist systems are critical, but locally-focused ICT is the base.

Open-source. Software and operating systems that are open-source should be utilized.

Connected affordably. Connectivity solutions that minimize usage fees and provide ICT access to the widest population should be pursued.

Focused on equity. Care should be made to ensure employing and equipping of CHWs from the most marginalized and impoverished communities.

Sustainably financed. Mechanisms should be deployed to ensure sustainability through community cost- and risk-sharing.

Applications for minimally literate populations. Applications should prioritize access to CHWs with minimal literacy.

Protocol-based. ICT should be used to deliver medical and public health knowledge in a fashion that is based upon standardized clinical protocols.

Data-driven. Rigorous epidemiological monitoring should be developed to assess effectiveness of the various components of ICT interventions.

Integrated with surveillance systems. Surveillance systems for detection of emerging diseases and other outbreaks is only as good as its data input. ICT-facilitated CHW networks should form the backbone of such systems.

IV. Solution

The targeted interventions undertaken by the CHWs in our primary healthcare program in Achham include prenatal, perinatal, neonatal, and pediatric care, as well as specific treatment packages focused on HIV, tuberculosis, and sexually transmitted diseases (see Appendix II). Depending upon the local epidemiological and socioeconomic context, these or other health domains may be the focus of the CHW's work.

These interventions can be accomplished effectively in the villages by a team centered around CHWs, provided they are sufficiently supported for referral, consultation, and training by our physician- and midwife-operated clinic.

4.2 Communications technology that connect CHWs to each other

The unique communication strategy of CHWired depends upon CHWs' ability to communicate with other with each other and other health professionals within a geographic region. To achieve this, specific hardware and software was selected emphasizing the ease of use for CHWs, speed of data transfer, cost effectiveness, ability to send varied data including high resolution images, ease of setup and maintenance, and the ability to encrypt confidential health records.

Communication between CHWs and other colleagues within the district will occur over a WiFi network that is setup using WiFi-based Long Distance Networks (WiLDNet), relay devices to access the WiFi network. The central hub of the WiFi network will be situated at the Nyaya Health Telecommunication Center, which will serve as the access point to medical information and patient databases. Since WiFi access towers and their power sources are the greatest costs of this system, we have chosen to create a decentralized WiLDNet network which offers connectivity ranges of 10-100km, as compared to 1-2km for standard CDMA450 systems, and which allows speeds of up to 6Mb/second, enabling high-quality video-conferencing at 300-500Kbps per stream. WiLDNet was shown by Technology and Infrastructure for Emerging Regions (TIER), a group at Stanford University, to outperform conventional bandwidth technology in low-user density regions, which characterizes the Achham and Doti regions of Nepal. An additional advantage of WiLDNet is that it allows Intranet access, i.e. peer-to-peer communication, without requiring internet accessibility.

In each village, there will be shared PC laptops to receive training materials and maintain databases and patient records. Each CHW will be equipped with a multi-purpose PDA which allows the use of sophisticated software for store-and-transfer of clinical data, training modules, and communication. The PDA will be equipped with Wi-Fi-enabled data transfer and VOIP capabilities, as well as a digital camera used for transmitting clinical images. When considering the weight of the device in addition to diagnostic equipment carried by CHWs over large distances, durability, memory, software and storage capacities, and cost, PDAs offer the most value compared to other WiFi-compatible devices.

In the instance of link failures or power outages that render the network unusable, an alternative communication method which uses low bandwidth backchannels, such as Short Message Service (SMS), will be essential to be able to transmit data. In addition, surveillance tools that are independent of the primary network will assess network functionality. Ping tests continuously test the network and relay that information to the centrally located network administrators.

IV. Solution

4.3 Data collection and management tools for surveillance

Each PDA will come equipped with software necessary for communication and epidemiological data collection. Pathopic and iPath are free, open services that provide diagnostic training and diagnoses, respectively, through medical images that CHWs can send and store with PDAs. These services will have to be adapted to address the specific needs of the Accham population. The full program suite will include:

- Communication message boards which can be used by CHWs to share experiences, report important occurrences and for advocacy purposes. Posts to these message boards will encompass different media types, including type, photo and voice messages.
- Data collection tools. In conjunction with Rural Health Online Nepal, we will create a program to collect, store, standardize and transmit patient records that is suitable for CHW use.
- Email, VOIP and Instant-messaging-based systems that will allow CHWs to specifically request help in triage, diagnostics or procedures from professional health workers based at the telemedicine center. If a doctor at the telemedicine center is unable to address the problem, further communications with urban specialists will follow using this software over the VSAT system.
- Software for accessing and playing e-learning training modules. These modules will be integral for improving the communications system, improving health protocols and increasing literacy.

4.4 Communication systems linking CHWs to timely medical information

The interaction between the CHWs and timely medical information is a critical part of our telemedicine strategy. To deliver up-to-date care, CHWs will benefit greatly from access to internet-based medical resources on a regular basis to better treat and triage patients. Due to the vast distances involved and challenging landscape, the best solution to this need is setting up a communications link via the internet. Based on our analysis and previous successful implementations by various NGOs, we have decided that VSAT (Very Small Aperture Terminal) provides us with the best solution.

VSAT systems offer several advantages over competing technologies, such as dedicated cable lines or CDMA links, in providing internet connectivity in rural locations. The most beneficial quality of VSAT is its unrestricted and unlimited reach to almost any location on earth. This is accomplished through a comprehensive set of orbiting satellites which communicate with ground based VSAT systems. VSAT

systems also have high reliability, up to 99.9% [10], which is essential for providing dependable healthcare support. Another consideration for our application is the ability to scale-up our network without major restructuring as new clinics are introduced to the area.

Table 1. Overview of VSAT Performance

Application	Incoming	Outgoing	Quality of Service
Email between Physicians and CHWs	No minimum	No minimum	No Issues
Instant Messaging between Physicians and CHWs	<1 kbps	<1 kbps	VSAT latency causes delay, which can hamper real time messaging
Audio Conferencing (Skype)	11 kbps	11 kbps	VSAT latency introduces delay and jitter during conversations
Data Collection and Surveillance Application	56 kbps	56 kbps	No Issues

IV. Solution

VSAT systems can be easily modified to accommodate additional clinics and reconfigured to build multiple network configurations, including ad-hoc, broadcast, and hybrid networks for multiple applications.

Furthermore, VSAT technology is readily scalable. As we add new clinics, the VSAT satellites at each clinic can be configured into a meshed network [11]. The mesh network will have a main VSAT hub, the central clinic, and remote VSAT satellites which can all communicate with the central hub. The central hub will be responsible for processing and recording all CHW and patient data from the remote locations, while simultaneously broadcasting valuable information to the remote clinics.

VSAT technology is offered in several variations depending upon the specific application and communication needs. One of the primary contributors in determining the specifications of a VSAT system is the quality of service, and bandwidth required by the end user. The quality of service and bandwidth requirements drive the antenna design, modulator design, power requirements, and access scheme. During our analysis we conducted a bandwidth study to understand the needs of the telemedicine network system. Table 1 summarizes the bandwidth requirements of our system per an end user connection [12]. We anticipate the addition of future clinics will require a significant increase in bandwidth, most importantly for the central hub clinic. The quality of service level will be dependent on the future applications we plan to adopt, specifically video web conferencing and voice over internet protocol (VOIP).

4.5 An integrated, sustainable training system

A central component of the WHO's call for expansion of CHWs in poor communities is improving training programs. Much of the training will consist of interactions between CHWs and other health professionals while discussing patients on the job. The continuous exchange of information, ideas, and feedback will provide ongoing opportunities for training and support. Additionally, online e-learning applications mentioned above will be used to efficiently and cost-effectively provide continuing medical education across our distributed network of CHWs. District officials and program planners can utilize our data collection system to assess CHWs' adherence to clinical protocols and provide suggestions to rectify any weaknesses that they identify. Together, these strategies provide for an integrated, sustainable training system.

4.6 Product Expansion

After our initial pilot phase, we will expand to other districts in Nepal and subsequently to other rural areas in South Asia and beyond. These models will be implemented by Ministries of Health in collaboration with CHWired, utilizing our open-source, free system to promote the rapid diffusion of this innovation. In each of these applications, we hope to provide a model for care delivery in rural areas by effectively providing equitable access to world-class medical knowledge in one of the most remote places on earth.

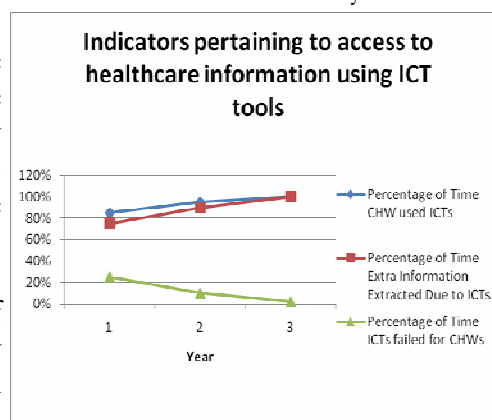
V. Social Return on Investment (SROI)

To assess the social return on investment, we utilize a value-added methodology that compares the cost-savings generated by CHWired to the current standard for meeting the medical needs of Achham and nearby villages [13]. In the short-term (first five years), we will focus on performance markers that assess the scope and operational effectiveness of our approach. In the long-term (five-ten years), as our program expands and is replicated, we will begin to assess its impact on health outcomes such as maternal mortality, malnutrition rates, and tuberculosis control. To assess the incremental cost-effectiveness of these measures, we will assess the increase in each parameter gained by the costs obtained.

5.1 Performance Markers

The performance indicators below will be used to measure the effectiveness and utility of CHWs equipped with ICT tools. These will be tangible metrics that will facilitate quantifying impact on healthcare in the region. The indicators will be scaled up due to the increase in the number CHWs, capacity of CHWs, and incumbency advantages such as learning economies, innovation advantage and patient loyalty [14]. Year 0 represents the baseline level in Achham prior to the implementation of CHWired.

Based on UNICEF's guide to Integrated Management of Childhood Illnesses (IMCI) and guidelines developed by WHO and the Ministry of Health of Nepal, Nyaya Health has developed a protocol to guide the work of CHWs [15]. These indicators measure the adherence to protocol to deliver care to mother and child. These indicators were chosen to capture health interventions of the highest importance and relevance to Nyaya Health's Maternal and Child Health Primary Care Center. Below, we provide an overview of these measures.

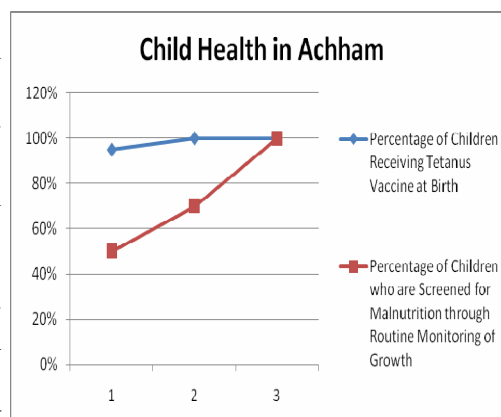


The first set of indicators pertains to utilization of healthcare information using ICT tools. These include the following:

- Absolute amount and percentage of time CHWs used ICTs
- Absolute amount and percentage of time extra information extracted due to ICTs
- Absolute amount and percentage of time ICTs failed for CHWs

The next set of indicators pertains to adherence to protocols delivering essential medicines in target communities in which CHWired assists existing Nyaya Health activities:

- Percentage of children receiving tetanus vaccine at birth
- Percentage of children who are screened for malnutrition through routine monitoring of growth



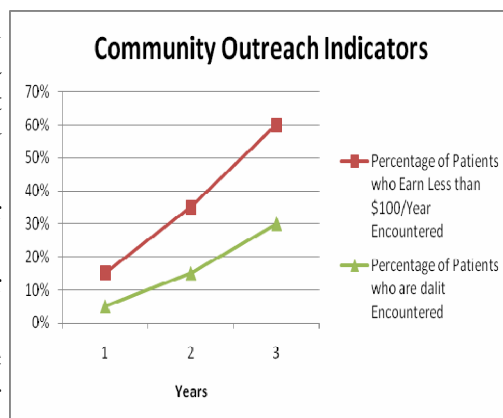
V. Social Return on Investment (SROI)

The next set of indicators pertains to prenatal care and maternal health in:

- Percentage of pregnant women receiving iron tablets
- Percentage of pregnant women receiving folate tablets
- Percentage of deliveries attended by trained healthcare worker
- Percentage of trained midwives passing basic skills assessment test

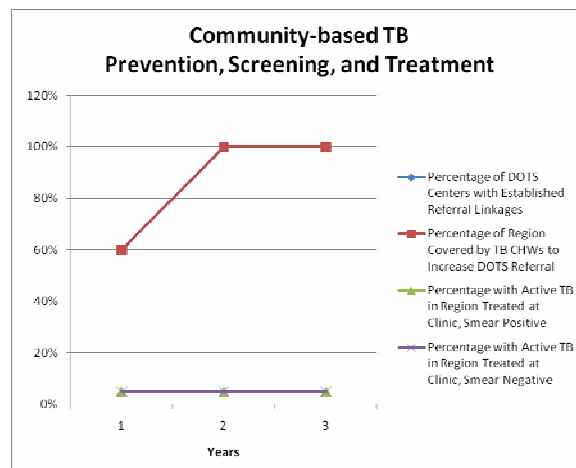
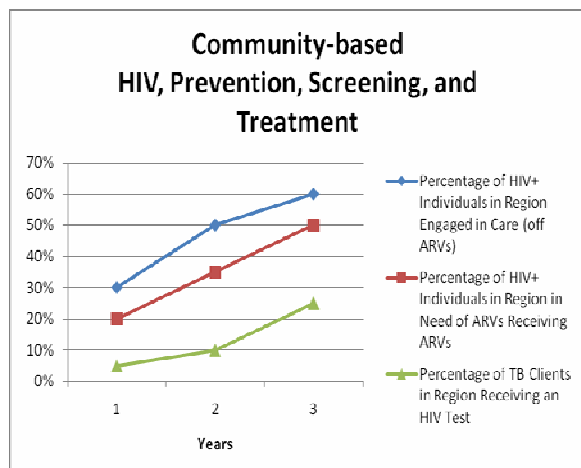
The fourth set of indicators pertain to the geographic and socioeconomic reach of CHWired-facilitated Nyaya Health programs, particularly with respect to the most marginalized, poorest, and *dalit* (“untouchables”, still very much a discriminated population in Nepal) communities:

- Percentage of citizens earning less than \$100/year who are reached by our services
- Percentage of citizens *dalits* who are reached by our services
- Percentage of citizens from villages greater than three hours from the clinic center who are reached by our services



The final set of indicators pertains to our HIV and tuberculosis control programs in the district:

- Percentage of HIV-infected individuals engaged in care (not on antiretroviral therapy)
- Percentage of HIV-infected individuals in need of ARVs
- Percentage of TB Clients receiving an HIV Test
- Percentage of Directly Observed Therapy-Short Course (DOTS) centers with Established Referral Linkages
- Percentage of district covered by TB CHWs to increase DOTS Referrals
- Percentage with active TB treated at the clinic, smear-positive
- Percentage with active TB in treated at the clinic, smear negative



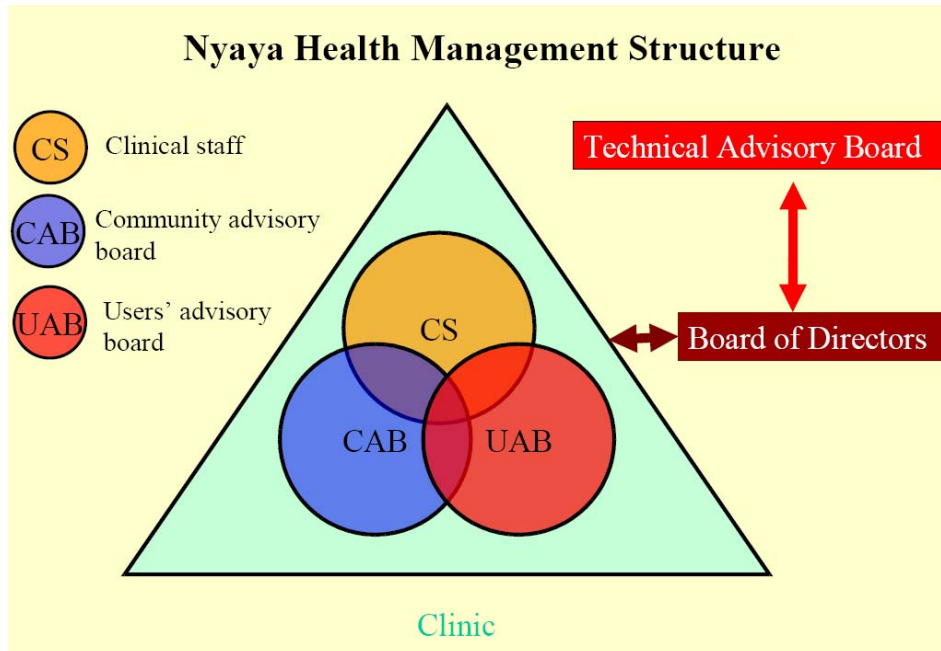
V. Social Return on Investment (SROI)

In addition to these short-term performance markers, it is paramount that we evaluate long-term impact measures in the future considering how our program has affected malnutrition, infant and maternal mortality, and TB control. These go beyond performance markers to assess the ultimate public health impact of CHWired. Such measures require sustained commitment and a rigorous epidemiological approach. These measures include key public health indicators in the district including rates of: childhood malnutrition, vaccine-preventable childhood diseases, infant and child mortality, maternal mortality, HIV, and tuberculosis.

VI. Organizational Management

6.1 Organization Structure

CHWired will be implemented within the organizational framework of Nyaya Health, which is governed by four interacting components, each centered around the Nyaya Health Clinic in Achham: clinic management board, technical advisory board, board of directors, and community advisory board. More details about this structure are provided in Appendix IV.



6.2 Personnel for Implementation

Here, we focus on the on-the-ground Nepali personnel that form the core of the CHWired program. In the appendix we provide the biographies and roles of the expatriate technical advisors who help to develop the program but who defer daily management responsibility to the on-the-ground team.

At least two leadership positions are critical to the effective implementation of CHWired. Other employees may be hired as our needs assessment reviews are conducted, but these positions form a core leadership team for the telecommunications strategy as well as a base of users that are CHW's. All of these positions are salaried and will be Nepalese citizens.

VI. Organizational Management

We have actively begun to recruit for these positions, knowing that identifying these leaders will be critical to effective and innovative implementation of CHWired.

6.2.1 Program Manager

Overview: This individual will provide overall management and strategic direction for the telecommunications center. The director will also run and work to implement the telemedicine strategy.

Qualifications: Background in Hospital Management. Fluency in spoken and written English and Nepali. Strong familiarity with computers and networks. Passionate about health and economic development in Nepal. Leader, able to inspire others to effective action.

Duties: Oversee operations of the telemedicine efforts. Provide vision and strategic direction towards the clinic and telemedicine center. Maintain equipment in good working condition and ensure adequate supply chain as necessary. Develop connections with consultants who will serve to respond to the clinicians' requests. Improve connectivity between outlying villages and the hospital.

6.2.2 Community Outreach Coordinator

Overview: This individual will oversee the development of programs aimed at expanding the utilization of health care services by assessing the medical needs of the community and directing local individuals to available services to meet their needs. This individual will also be involved of the planning and implementation of new services to meet currently unmet medical needs in the community.

Qualifications: Fluency in spoken and written Nepali. Outgoing, able to organize and present information in a clear and coherent background to diverse groups of people. At least 2 years of experience in healthcare related fields.

Duties: Perform basic needs assessment of communities within service area, and develop solutions to meet needs, within the capacity of the Nyaya health system. Engage local community leaders in order to increase utilization rates of healthcare services by local communities.

6.2.3 Community Health Workers

Overview: Community health workers use CHWired technologies in the field to deliver high quality medical care, directly to patients in their own communities.

Qualifications: Health professional background, such as nursing, physician assistant, or emergency medical technician; excellent communication skills, fluent in Nepalese. Excellent interpersonal skills, prior patient care experience.

Duties: CHWs are mobile health workers who visit patients in their local communities to administer basic health needs. These needs include patient education, preventative care and follow-up, acute medical care, basic emergency care, as well as supportive emotional and psychological care. CHWs in the CHWired model will communicate to each other via tailored ICTs that allow workers to share knowledge and expertise and provide support and guidance to their fellow CHWs. CHWs will also triage patients with more complex medical needs that cannot be addressed in the field to the new clinic in Sanfe Bagar.

VII. Operating Plan

7.1 Overview

The prototype development of our application has started and will be completed by June 15, 2008. Subsequently, we will undertake the following steps during the first year of our operations:

- 1) Development of Wi-Fi communication systems to link villages in the district.
- 2) Community assessment to determine where implementation is most feasible and how to best meet demand.
- 3) Development of preliminary communications applications by Nepal-based software developers in collaboration with our team.

We will then take the following steps:

- 4) Equipping CHWs with appropriate technologies, and testing applications in collaboration with CHWs. This is anticipated to require two months.
- 5) Implementation and evaluation will take place over the subsequent year, as we monitor and improve the program.
- 6) Scaling up and replicating the model and forming linkages with other health programs in Nepal and beyond.

Here, we outline the key steps involved. Many of these steps will be critical to other groups in deploying similar programs, and in fact developing the knowledge base to address these challenges is part of the model.

7.2 Developing institutional and local capacity

Prior to the opening of the deployment of the CHWired Project, Nyaya Health will develop the personnel, financial, and technology infrastructure to pursue basic applications. Many of the activities described in the appendices can be pursued without major financial or human resources deployment. These activities will serve the following purposes:

- engage community members in telecommunications so they can participate in the design process from a more informed perspective.
- develop institutional experience to better inform designers and planners of the specific needs of the community and clinic.
- ensure institutional involvement in the long-term to ensure sustainability.
- develop human resources capacity and leadership to effectively implement the programs.
- better understand the most appropriate and cost-effective technologies for connectivity, user interface, and file transfer.

These initial activities will be implemented as rapidly as can be achieved in an effective and appropriate fashion. This will provide as much information to the design team and the community during the design process. Additionally, all appropriate authorizations from the central government will be pursued at this time so that there are no bureaucratic delays in the project.

VII. Operating Plan

7.3 Development of Wi-Fi communication systems

The WILDNet communication system can be installed and introduced irrespective of the Internet connection installation at the NyayaHealth telemedicine communications center. It will be introduced in stages to assess the efficacy of placement of relay towers in remote villages within the parameters of delay, usable bandwidth, data loss and reliability. Nepal Wireless, an organization aiming to bridge the 'digital gap' in Nepal, has volunteered to do a GPS assessment of the Achham area to determine the best locations of Wifi repeaters. With the goal of achieving over 20km ranges per antenna, we forecast a need of thirty repeaters.

7.4 Community assessment

Our community assessments will build off our previous health surveys in the district [7,8]. Preliminary focus groups will be conducted by network designers and planners with the medical staff at NyayaHealth, CHWs and village leaders to ensure that specific needs are met. In addition to regular communications among CHWs and between CHWs and health experts, the CHWired program manager will engage CHWs in semi-regular conferences, in person or via teleconferencing, to identify improvements that can be made to the CHWired system. The Community Outreach Coordinator's specific duties include monitoring access to health improvements and equity within the community.

7.5 Development of preliminary communications applications

Several programs have been identified that could serve as the platform for CHW communications. Since most available programs are geared towards health experts who may be bilingual and have greater specific health knowledge than trained CHWs, the software will have to be adjusted to reflect those changes.

7.6 Equipping CHWs with appropriate technologies

CHWs will acquire all the necessary diagnostic and data gathering equipment during training sessions. Their cache of equipment will include a handheld PDA that includes a camera and VOIP to be used during fieldwork. While CHW to CHW communications in the realm of advocacy and sharing of experiences may be best captured by message boards, VOIP will be critical for providing immediate aid between CHWs and health professionals. Healthposts will be equipped with laptops essential for training programs and health updates, in addition to providing reliable data transfer to the telecommunications center in case remote patients' locations do not have WiFi network access.

7.7 Implementation and evaluation

The success of the CHWired telemedicine network depends fully on the communication between the Technical Advisory Board, the Users Advisory Board, the Program Manager, the Community Outreach Coordinator and the CHWs, themselves. During the pilot phase of the program, there will be extensive discussions, both online and in person with key players, to evaluate the launch of the program and to make improvements. After the pilot phase is launched, evaluations will mostly occur via online evaluation forms and criteria, and through message board discussions. It is the primary role of the Program Manager to facilitate these discussions, to compile evaluations and make necessary changes. An evaluation of data compiled and patient outcomes will be critical to understanding whether improvements are reaching patients. Site visits to villages to work closely with CHWs will allow the Project Manager to identify problems that may go undetected by evaluations or online communications.

VII. Operating Plan

7.8 Scaling up and replicating the model

Scale-up of the model will commence incrementally within the district over the first three years, followed by replication outside of Nepal. The handheld devices of the model should be readily scalable to other regions, owing to their portability and low cost. Collaborations with local software developers will be required to translate the interfaces to accommodate local languages and conditions. Since VSAT systems have good flexibility and scalability, the replication of this aspect of the model in other areas is very feasible. Depending on the number of total clinics, it would be beneficial to have a central network hub to control all information flow between remote clinics. Each new clinic would then link up to the central hub via their own VSAT system and form a meshed network. Most of the additional clinics in the initial expansion phases will be centered in South and Southeast Asia, therefore the environmental dependencies of the system design will remain similar to the system in Achham. However, we will conduct a review of each system's requirement prior to expanding the network to new areas.

7.9 Critical Challenges, Risks, and Contingency Plans

There are several critical challenges that we will address during the course of implementation.

7.9.1 Engaging illiterate individuals in the process

Our vision is for 50% internet access by 2015 sets a solid goal for our work. A key challenge to achieving this goal in Achham is female illiteracy; ~80% of the female population in the area will require literacy education.

Currently, there are no usable telemedicine programs available for illiterate CHW use. Since some CHWired CHWs will be illiterate, once the final data gathering programs are chosen and validated, we will employ computer programmers to include audio and non-text based data entry modules that interface with the selected software. In addition, since VOIP may become more important for illiterate CHWs, CHWired will have to adjust accordingly to meet the increased VOIP needs.

7.9.2 Machine Maintenance in a Remote Setting

Personnel and back-up systems are two considerations for machine maintenance in this setting. Some equipment that requires regular maintenance may necessitate on-site staff trained to fix the equipment. Other equipment may only require an occasional outside contractor in case of malfunction. All equipment should have trained personnel within Nepal who can repair the device. Portable and common technologies may be effectively transported to Kathmandu and serviced at common repair centers.

7.9.3 Empowering disempowered communities

Based on our experience with people who have been denied agency for almost all of their lives, we realize that it can be challenging to have them speak out against the status quo and actively make demands. We are actively developing strategies to empower people who may be poor, illiterate and have been continually denied opportunities to protest against atrocities. We are attempting to transcend the perceived power hierarchy that is further amplified by the facts that Nyaya is an international organization and that our management consists of experts in health, a sector traditionally accepted to be esoteric and elitist.

VII. Operating Plan

7.9.4 Changing Needs

Communities will change as a result of several factors, including the work of CHWired and its collaborators. Our goal is to identify new needs efficiently through a responsive management structure. With management team continually monitoring and evaluating the strengths and weaknesses of our programs, we will be posed to implement changes to address these needs. Even within a district, different villages may have vastly distinct health and ICT needs. Nyaya Health will benefit through ICTs by rapidly responding to changing needs in Achham.

VIII. Financials

Over three years, we aim to incrementally expand our program to eventually cover the district of Achham. The approximate budget for start-up and one-year costs to pilot the project in 15 villages is \$59,504. Scaling up this process to cover the entire district over the subsequent two years will require an additional \$431,328. These costs will be feasibly met by our current and projected revenue streams.

Presently, we have secured funding from the CDC, Advanced Micro Devices and the Open Architecture Network for the initial pilot phase. Since our goal is maximizing social benefit through the diffusion of technology via an open-source, open-access model, the long-term costs will be borne largely by the implementing agencies of our product (namely, the Ministry of Health).

On the following pages, we provide further financial details as to our projected income statement, projected cash flows, and projected balance sheets.

VIII. Financials

CHWired Income Statement

Year	2008	2009	2010
Scope			
Total Population Covered	30000	60000	250000
Number of CHWs	15	30	125
Expenses			
<i>Human Resources</i>			
Salary support for program manager	\$7,500	\$8,000	\$9,000
Salary support for community outreach coordinator	\$4,500	\$5,000	\$5,500
Salary Support for CHWs	\$15,000	\$30,000	\$125,000
Employer's Insurance	\$810	\$1,290	\$4,185
Health Insurance and Pensions	\$2,700	\$4,300	\$13,950
Certified Payroll Professional Fees	\$540	\$860	\$2,790
Workers' Compensation Board Fees	\$270	\$430	\$1,395
<i>Professional Fees</i>			
Fees for Kathmandu-based web portal design consultants	\$5,000	\$5,000	\$5,000
Payment of local data entry technician	\$500	\$1,000	\$1,500
<i>Equipment</i>			
One lightweight laptop per village	\$3,000	\$6,000	\$25,000
One VOIP cell phone per village	\$900	\$1,800	\$7,500
One Wi-Fi antenna per village plus wiring, mounting	\$3,750	\$7,500	\$31,250
Equipment Depreciation	\$0	\$765	\$1,530
<i>General Administration*</i>			
VSAT Phone Service	\$360	\$360	\$720
VSAT Internet Fees	\$1,781	\$3,563	\$14,844
Office and presentation supplies	\$800	\$1,600	\$2,000
Electricity and Generator Fuel	\$1,000	\$1,000	\$1,000
Water	\$0	\$0	\$0
Bank Charges	\$300	\$400	\$550
Accounting and Legal Fees	\$250	\$500	\$1,000
<i>Travel Costs</i>			
Air travel to Kathmandu for Program Managers	\$400	\$800	\$800
Travel stipend for walking weekly to the clinic	\$2,250	\$4,500	\$18,750
<i>Miscellaneous Supplies</i>			
Supplies and food for three 5-day training courses	\$2,250	\$4,500	\$18,750
Food for community forums	\$2,400	\$4,800	\$20,000
<i>Tax Expense (13% on purchases)</i>	\$3,242	\$5,731	\$19,525
Total Expenses	\$59,504	\$99,699	\$331,539
Revenue			
<i>Revenue to date</i>			
CDC Telemedicine Grant	\$15,000	0	0
Open Architecture Network/AMD	\$35,000	\$0	\$0
<i>Anticipated Revenue</i>			
Outsourcing of data collection to academics	\$0	\$20,000	\$100,000
Additional Research/Service Grants	\$10,000	\$80,000	\$250,000
Bank Interest	\$100	\$30	\$17
Total Revenue	\$60,100	\$100,030	\$350,017
Net Income	\$596	\$331	\$18,478

* CHWired shares administration expenses with other Nyaya Health programs. No rent is paid on facilities already owned by Nyaya Health. Nyaya Health has purchased the VSAT terminal with other funds for use by the CHWired program.

VIII. Financials

CHWired Cash Flow

Year	2008	2009	2010
Cash Revenues			
Revenue from Grants and Foundations	\$60,000	\$80,000	\$250,000
Revenue from Academic Collaborations	\$0	\$20,000	\$100,000
Revenue from Bank Interest	\$100	\$30	\$17
Total Cash Revenues	\$60,100	\$100,030	\$350,017
Cash Disbursements			
Human Resources	\$31,320	\$49,880	\$161,820
Professional Fees	\$5,500	\$6,000	\$6,500
Equipment	\$7,650	\$16,065	\$65,280
General Administration	\$4,491	\$7,423	\$20,114
Travel Costs	\$2,650	\$5,300	\$19,550
Miscellaneous Supplies	\$4,650	\$9,300	\$38,750
Taxes Payable	\$3,242	\$5,731	\$19,525
Total Cash Disbursements	\$59,504	\$99,699	\$331,539
Reconciliations of Cash Flow			
Opening Cash Balance	\$0	\$596	\$331
Total Cash Revenues	\$60,100	\$100,030	\$350,017
Total Cash Disbursements	\$59,504	\$99,699	\$331,539
Closing Cash Balance	\$596	\$927	\$18,809

VIII. Financials

CHWired Balance Sheet

Year	2008	2009	2010
Assets			
<i>Current Assets</i>	\$0	\$0	\$0
Cash in Bank	\$0	\$596	\$331
Petty Cash	\$0	\$0	\$0
Net Cash	\$0	\$596	\$331
Inventory*	\$0	\$0	\$0
Accounts Receivable	\$0	\$0	\$0
Prepaid Insurance	\$0	\$0	\$0
Total Current Assets	\$0	\$1,193	\$662
<i>Fixed Assets*</i>			
Land	\$0	\$0	\$0
Buildings	\$0	\$0	\$0
Less Depreciation	\$0	\$0	\$0
Net Land & Buildings	\$0	\$0	\$0
<i>Equipment</i>	\$0	\$7,650	\$16,065
Depreciation Costs	\$0	\$765	\$1,530
Net Equipment	\$0	\$6,885	\$14,535
Total Assets	\$0	\$8,078	\$15,197
Liabilities			
<i>Current Liabilities</i>			
Accounts Payable	\$24,941	\$43,323	\$148,664
Wages Payable	\$27,000	\$43,000	\$139,500
Employers' Insurance	\$810	\$1,290	\$4,185
Certified Payroll Professional	\$540	\$860	\$2,790
Workers' Compensation	\$270	\$430	\$1,395
Health Insurance and Pensions	\$2,700	\$4,300	\$13,950
Sales Tax (13% VAT)	\$3,242	\$5,632	\$19,326
Total Current Liabilities	\$59,504	\$98,834	\$329,810
<i>Long-Term Liabilities</i>			
Long-Term Loans	\$0	\$0	\$0
Mortgage	\$0	\$0	\$0
Total Long-Term Liabilities	\$0	\$0	\$0
Total Liabilities	\$59,504	\$98,834	\$329,810
Equity			
Revenue from Grants and Foundations	\$60,000	\$80,000	\$250,000
Revenue from Academic Collaborations	\$0	\$20,000	\$100,000
Revenue from Bank Interest	\$100	\$30	\$17
Total Earnings	\$60,100	\$100,030	\$350,017
Total Equity	\$120,200	\$200,060	\$700,033
Balance (Equity minus Liabilities)	\$60,696	\$101,225	\$370,223

VIII. Market Analysis

The competitive landscape for our proposition is evaluated by adapting the framework developed by Michael Porter for the corporate sector to the nonprofit sector [16,17].

9.1 *Industry Participants*

We define the industry that CHWired is in as one that serves the medical needs of rural communities in Nepal. In this scope, the existing rivalry in this industry is modest at best with the major “competitor” being the government of Nepal. Furthermore, the rivalry in this industry is not characterized by the head-to-head competition typically found in the corporate world, but rather active cooperation between both entities maximizing the delivery of healthcare in the region. In the area of Achham, our organization became the first to implement Internet access, giving us virtually a monopoly in ICTs along with resulting advantages associated with being the first mover [14].

9.2 *Barriers to Entry*

An entry barrier in the nonprofit realm is a phenomenon that circumvents other organizations from entering the market and becoming economically viable [16]. Barriers to entry to consider in the nonprofit sector include reputation, access to distribution channels, economies of scale, and government regulation. Through its collaboration with the government of Nepal, Nyaya Health has further enhanced its reputation as a trustworthy NGO addressing the health concerns of the area, while facing minimal regulation from the Ministries of Health. Access to distribution channels is increased, albeit not to the level that a government of an entire country possesses, through Nyaya Health’s multiple partnerships with foundations, academic institutions, and NGOs working in the US, India, and Nepal. Economies of scale will be realized as the installed base using ICTs deployed via CHWired will grow year to year and will be less likely to switch to a less familiar technology [18].

9.3 *Substitute Products*

The ability of a nonprofit to garner funds or clients depends on the availability of substitutes. The substitute for receiving medical treatment from a CHW equipped with ICTs is care provided by a physician at a government hospital. It can be argued that this a poor substitute for ICTs because of the far greater access to healthcare CHWired provides. Furthermore, the scale economies realized by a CHW serving an entire village, rather than an entire village traveling long-distances to a remote hospital make the substitutability of ICTs difficult.

9.4 *Demand Side: Users and Donors*

The two groups of customers in the nonprofit sector are the users who utilize the services being provided and the donors who receive satisfaction from their altruistic actions. Our users, the members of Achham and nearby villages, do not have another substitute for health services other than to trek to the distant government hospital, and thus, they have essentially no buyer power. Our donors exert minimal power due to our funding coming from multiple avenues ranging from foundations and grants to individuals.

9.5 *Supply Side*

The suppliers in a nonprofit generally consist of its employees and volunteers. For CHWired, the employees will be paid substantially higher than most jobs in the area lowering the labor power.

VIII. Market Analysis

In addition, our employees and volunteers receive compensation in the inherent benefit drawn from serving a community in desperate need for healthcare.

9.6 Summary

Adapting the competitive forces as suggested by Oster in the nonprofit sector, CHWired is in an industry characterized by the following:

- Modest rivalry with its only competitor being the government of Nepal, which is cooperating and collaborating with CHWired's primary partner, Nyaya Health
- Relatively high barriers to entry circumventing the entry of new organizations into this niche
- No readily available substitutes for health services, particularly ICTs
- Low buyer and supplier power

This analysis illustrates that CHWired has a strong competitive position, high program attractiveness, and low alternative coverage. According to MacMillian, an agency that finds itself in this rare, but coveted position, should concentrate on expanding its program as rapidly as possible and consolidate its strong position by building up its capabilities [19].

X. Marketing

Currently, patients in Achham seeking medical care travel significant distances to reach urban centers. There, patients receive free medical care in hospitals financed primarily by the Nepalese government. This places a significant financial burden on a Ministries of Health of Nepal (MHN) already severely constrained in its resources and ability to provide medical care to its citizens.

While the end-user of the CHWired service will be patients in Achham served via the trained CHW, the primary customer for the service is the MHN. To this customer, CHWired offers an innovative and scalable service that can deliver improved healthcare at substantially less costs to the population in Achham and nearby rural communities compared to current system run by the MHN.

In order to effectively communicate this value proposition to the MHN, it is important to provide it with clear and robust data on the cost savings and improved health outcomes generated by the service. As Nyaya Health already has established a partnership with the local MHN, we have a direct line of communication to pass information to our customer. CHWired includes real-time data collection that will allow us to keep the MHN well informed on the project with up-to-date results.

Since the CHWired program will be implemented as a part of Nyaya Health's existing healthcare delivery system, patients accessing the system will be exposed to the new technology offered by the project. Additionally, the CHWs hired for the project will be members of the small rural communities in which they work. This format will allow for rapid diffusion of information about the availability of the new service for patients, ensuring high utilization rates of the technology for a maximum social return on investment. This also negates the need for spending resources on traditional marketing methods to the end user.

X. Marketing

We intend to publish results of our work in Achham widely in leading medical journals, to ensure that other government and non-government organizations may follow the success of our model. We anticipate that this will lead to future opportunities for partnerships, as we scale up our model in Nepal and beyond.

We also intend to disseminate information and results on our work through the Nyaya Health website, and collaborative online communities focused on improving the health of communities in need. Information about CHWired will also be spread through the annual report distributed to Nyaya Health supporters. The resulting increase in awareness of our work will likely lead to additional donor support for the CHWired program.

XI. Partners and Collaborators

11.1 Partners

Government of Nepal, Ministry of Health and Population District Health Office of Achham (www.moh.gov.np) Nyaya Health is registered with the Social Welfare Council of Nepal and has an agreement with the Nepal Ministry of Health and Population to provide medical services in Achham district of Far Western Nepal. With the approval of the District Health Office of Nepal, Nyaya Health operates a primary care centre with all Nepali staff, including a physician, health assistance, auxiliary nurse midwives, and community health workers.

Sano Paila. Sano Paila ("a little step") is a Nepali NGO which provides information dissemination and behavior change expertise in preventing and addressing HIV and tuberculosis in border areas. Over the last two years, they have engaged in several effective prevention activities in border areas in the Terai region. Nyaya Health and Sano Paila collaborate on HIV and tuberculosis control programs.

Rural Health Online Nepal (www.ruralhealthonlinenepal.com)

Rural Health Online Nepal is a site developed and maintained by Health & Environmental Services Solukhumbu. It allows doctors and health workers in remote hospitals to provide treatment to patients after discussions with their colleagues & medical specialists from elsewhere.

11.2 Collaborators

SATELLIFE : The Global Health Information Network (www.healthnet.org)

SATELLIFE created and supports HealthNet knowledge networks in six countries including Nepal. These locally owned and managed organizations provide a variety of services to their local health communities, including free or low-cost email, computer literacy training, health data collection, and information resources. AED-SATELLIFE works within capacity to support diverse technology and information initiatives driven by local needs. Nyaya Health and Satellife have begun to collaborate and research methods to help equip CHW's with effective telemedicine hardware and software.

Nepal Wireless (www.nepalwireless.net) Nepalwireless develops internet solutions for rural areas through Wi-Fi repeaters. They will assist with identify optimal placement of our Wi-Fi system.

Appendices

Appendix I. Leadership Team

Anup Patel (point of contact: anup.patel@yale.edu). *Executive Director.* Mr. Patel is a current MD/MBA student at Yale University. He co-founded Cents of Relief which aims to fight human trafficking and disease in red-light areas in India and interned in the U.S. Senate working to give senior citizens prescription drug coverage.

Robert Stavert. *Medical Director.* Mr. Stavert is a current MD/MBA student at Yale University. He is a former recipient of the Harvard Center for Public Interest Careers Fellowship which he used to study patterns of HIV infection among the homeless in San Francisco as part of the UCSF REACH project.

Sanjay Basu, MSc. *Director of Operations.* Mr. Basu is currently a 5th year MD/PhD student at the Yale School of Medicine and the COO of Nyaya Health. He has extensive experience in international health and development, having co-founded United Trauma Relief and Universities Allied for Essential Medicines (UAEM), two global pharmaceutical procurement mechanisms.

Duncan Smith-Rohrberg Maru, MPhil. *Associate Director.* Mr. Maru is an epidemiologist in the MD/PhD program at the Yale School of Medicine. He is the CEO of Nyaya Health travels frequently to Nepal to work on staffing, protocol development, supply chain management, telecommunications, and strategic direction for their operations in Achham.

Bibhav Acharya. *Director of Community Outreach.* Mr. Acharya is a first year student at Yale School of Medicine. He is the Vice President of Nyaya Health. He has extensive experience working with CHWs in Pokhara, Nepal and has also studied public health programs in Thailand and in the US.

Rina Patel, MS. *Director of Information Technology.* Ms. Patel received her BS and MS in computer science from the University of Florida. She has worked in End-user Services as an IT education specialist for the software company PTC and co-founded Cents of Relief which aims to fight human trafficking and disease in red-light areas in India.

Ilana Brito. *Director of Wi-Fi Networks.* Ms. Brito is a PhD candidate in the Biology department at MIT. She has worked on malaria in Mali, West Africa and has worked for several HIV/AIDS initiatives.

Ben Amendolara. *Director of Community-based Telemedicine.* Mr. Amendolara is an undergraduate at Haverford College studying pre-medicine, likely to major in English. He works in Drexel's Medical School's neurology department, where, under the auspices of ALS Hope Foundation, he performs research on mice to determine the role of the SOD1 gene in ALS. His focus is Nyaya Health is on researching strategies to equip community health workers with the tools of telemedicine.

Achal Sakaria. *Director of Internet Technologies.* Mr. Sakaria received his BS and MS in electrical engineering from Georgia Tech. He currently works as a scientist in the advanced systems division of SAIC, where he conducts research in the areas of electromagnetics, energetic materials, and chemical agent neutralization.

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Salman Fasih Khan, MBBS (MD). *Associate Director of Internet Technologies.* Dr. Khan is currently a Postdoctoral Associate in Cardiothoracic Surgery research at Yale University School of Medicine. He is a medical graduate of the Aga Khan University in Pakistan. He has extensive experience in global public health in Pakistan and Iran, having worked with GlaxoSmithKline's Central Nervous System and Pakistan's largest charity, the Edhi Foundation.

Ali Batouli. *Director of Healthcare Finance.* As an undergraduate at Stanford University, Mr. Batouli developed incentives-based systems for increasing the retention and efficacy of diabetes management courses at local community clinics, as well as helping develop an electronic chronic disease tracking system for these clinics. He is currently pursuing medical studies at Yale.

Maria May. *Director of Healthcare Delivery.* Ms. May graduated from Harvard College in 2006 with an A.B. in Sociology and a certificate in Health Policy. She is a case writer for the newly formed Global Health Delivery Project, a collaborative endeavor between Harvard Business School and Medical School aimed to improve health systems in resource-poor settings.

Appendix II. Overview of Nyaya Health Clinical Programs

Nyaya Health is currently developing a primary health centre focusing on antenatal care, normal deliveries, provision of basic emergency obstetric care, prevention of mother-to-child transmission of HIV, and pediatric care. The following are the primary components of this approach, focused on the domains in which the CHWs can feasibly and effectively contribute.

Prenatal and Perinatal Care, adapted from the Averting Maternal Disease and Disability Program

- Prenatal evaluation of anemia and provision of folic acid and iron, vaccination with tetanus toxoid, anti-helminth treatment with albendazole, and macronutrients, where necessary
- Routine prenatal check-ups
- Routine delivery attended by trained midwives or doctor
- Promotion and support of immediate postpartum breastfeeding when appropriate
- Prevention of mother-to-child-transmission of HIV program with routine antenatal HIV testing
- Intravenous and oral antibiotics for perinatal infections
- Referral to the central clinic for postpartum hemorrhage, perinatal seizures, preeclampsia, retained products of conception, retained placenta, and obstructed labor.

Neonatal Care, adapted from WHO's Integrated Management of Pregnancy and Childbirth

- Resuscitation of asphyxiated neonates
- Prevent and treat hypothermia
- Neonatal ocular prophylaxis
- Recognize and treat neonatal infections

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Pediatric Care, adapted from WHO's Integrated Management of Childhood Illness

- Treatment of pneumonia, with appropriate use of antibiotic and bronchodilators
- Management of diarrheal diseases, with low-osmolarity Oral Rehydration Solution and use of antibiotics for bloody diarrhea
- Evaluation and expansion of vaccination programs and Vitamin A supplementation
- Screening and treatment of helminthic infections with albendazole and mebendazole
- Promotion of breast feeding where appropriate
- Screening and treatment of micronutrient deficiencies
- Screening and treatment of failure to thrive/macronutrient deficiencies
- Treatment of otitis media with appropriate antibiotic use
- Management of pediatric fever, with evaluation and management of malaria, meningitis, measles, and other infectious processes

Appendix III. Additional Technological Issues

Other Options Considered for Interconnectivity

During our analysis of competing technologies, we considered a variety of options, including dedicated cabling, CDMA access and BGAN (Broadband Global Area Network). The first option, a dedicated network cable, was determined to be impractical because of extremely difficult and costly installation setup in the mountainous terrain around Achham, Nepal. Another option we considered was a CDMA based network, but the lack of CDMA towers in the area hindered this setup. While we were able to connect to the internet via CDMA, the lack of communications towers significantly reduced the signal strength, which made the network very unreliable. Finally, we examined the possibility of installing a BGAN system. The BGAN did satisfy the technical requirements of the project, but at a higher cost and limited availability. We expect the cost and availability of BGAN to improve over the coming years, which could possibly give us a better network solution in the future. Based on these findings, we determined that a satellite based VSAT link provides the best solution today for our clinics, while the BGAN system serving as a possible future option.

VSAT System Specifications

A system trade study was conducted to determine the system options and specifications of the network. Table 2 summarizes the options and rationale for our system design [12].

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System Specifications	Options	Option Selected	Rationale	Required?
Look Angle	20° - 160°	Satellite Specific	Look Angle must be linked to orbiting satellite and face the open sky	N/A
Band	C, Ku, Ka	Ku	1. Less Vulnerable to Rainfall than Ka 2. Smaller Antenna 3. Easy Installation	Yes
Weather Considerations	Rail Tolerant Option, Wind Guards, Lightning Protection	Rain Tolerant, Wind Guards	Nepal's climate has high precipitation and wind	Yes
Power Supply Backup	UPS, Fuel Power Generator, Solar Power Generator	UPS and Fuel Power Generator	Indoor equipment associated with the VSAT are very sensitive, therefore require a UPS backup power supply. Fuel based Generator would be easiest to maintain and procure.	Yes

The system trade study was used to determine the configuration of our VSAT system. The components of the system and equipment list are listed below, along with price ranges [20] in Table 3. The larger system antenna size, BUC and Modem was chosen to accommodate future bandwidth increases as new clinics are brought online.

System Equipment	Specific Configuration	Expected Price
Antenna	1.8 m Ku Band Antenna	\$1,000
Pedestal	1.8m Mount Support System	\$500
BUC (Block Up Converter)	3-Watt Ku Band BUC	\$1,000
LNB(Low Noise Blocker)	Ku Band compatible Frequency LNB	\$300
Modem	18 Mbps Down/4.2 Mbps Up Broadband rate Satellite Modem	\$1,500
Cables	150 ft	\$500
Router	Commercial 8-port router	\$250
Total		\$5,050

Regulatory Considerations

The Nepalese government does require a VSAT user to obtain a VSAT End User License. This license is available through the Nepal Telecommunications Authority (NTA) at a price of 250,000 NRs (~\$3,800). Also, the VSAT provider and Internet Provider are required to be licensed. Therefore, the expected cost of equipment and service can vary due to local regulation and restrictions [21].

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Appendix IV. Nyaya Health Organizational Structure

Accountable, transparent and responsive management structure

Nyaya Health recognizes communities as heterogeneous and dynamic assemblies of people with varying beliefs and needs. Within poor communities, there are disparities based on gender, class and other categories that hinder our ability to reach those with the greatest need. We aim to create management structures that will engage the members of the community we serve allowing us to:

- Clearly identify the needs of our target population.
- Gain a deep understanding of socio-cultural complexities in the region.
- Create management advisory boards with proper representation from the community to influence Nyaya's management and policy.
- Hear and understand the needs of the most marginalized people and meet those needs.
- Be accountable to the community we serve.
- Utilize local resources to provide services.
- Respond to the changing needs of the community.
- Facilitate maximum transparency and gain trust of the community.
- Increase the ownership of our work among community members.

Clinic Management Board

The role of the clinic management board is to ensure the smooth operation of the clinic. It is led by the medical director, the program manager, and the logistics director. These members additionally sit on the board of Nyaya Health and to provide strategic direction to the Nyaya Board to guide grantwriting and fundraising efforts and sit in via conference calls to Nyaya meetings. The clinic supervisor does not sit on the international board but sits on the clinic management board. They are full-time staff, although depending upon schedules and resources, rotations do occur, and some will be unpaid.

Community Advisory Board

The CAB represents social workers, teachers, leaders in several political parties, government institutions and key NGOs in public health in the area.

- CAB meets at least 4 times a year (more frequently in the beginning). A member of the UAB (see below) and Program Manager of the clinic will attend at least the quarterly meetings of CAB.
- Members of the board act as liaisons between the clinic and their respective organizations and the community.
- Provides feedback and advises the clinic management on the latter's quarterly reports, current services and long-term plans. A member of the CAB will directly communicate with a contact person on the Board of Directors of Nyaya Health.
- Engages the community to help improve services and infrastructure of the clinic.
- Advises the clinic on ways to engage the community and meet its needs.

Users Advisory Board

The UAB represents ethnic minorities, women, patients from low-income families and remote parts of our target area.

- Given that the focus of the clinic is MCH and given the marginalization women face, at least 80% of the UAB is female.

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- UAB meets at least 4 times a year. A member of the CAB and Program Manager of the clinic will attend at least the quarterly meetings of UABa.
- Members provide direct feedback to the clinic on clinical and public health services and the long-term plans of the clinic.
- Members are responsible for promoting the clinic's services in their area of residence. They form a network of contact persons across the clinic's target area and support any outreach and public health work in their communities.
- One member of the UAB will be in direct communication with a contact person on the Board of Directors of Nyaya Health.

Technical Advisory Board and Board of Directors

Both of these structures work together as part of the international team whose primary goals are to fundraise, write grants, provide technical assistance, procure equipment outside of Nepal, provide general strategic advice, and recruit volunteer physicians and technicians. The main mechanism by which Nyaya Health members outside of Nepal contribute is through working groups in which we develop the knowledge base, potential interventions, and funding sources that can then be implemented by the Nepal-based team. Ideally, these members will travel frequently to Nepal to assist in implementation. More about the work groups is found here: <http://nyayahealth.pbwiki.com/WorkingGroupGuide>.

Appendix V. References

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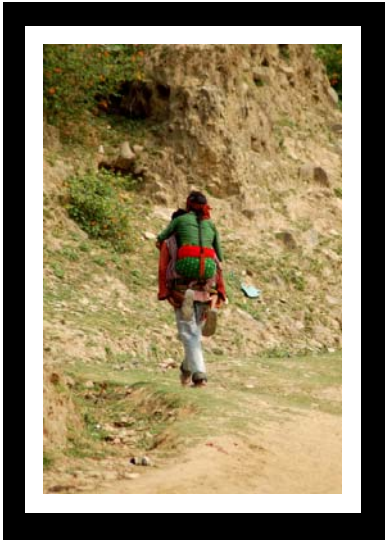
VSAT terminal on the roof of the Nyaya Health medical clinic



Achhami woman carrying firewood



Nyaya Health medical clinic in Achham



Man carrying his wife to the doctor



Achhami mother and daughter

CHWired

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Map of Nepal