Strategic Vision and Site Details of a Telemedicine Center for Nyaya Health in Achham, Nepal

Achieving Health Equity and Access in Remote Places

A

Clarifying Brief

Prepared by Nyaya Health

for the

OAN/AMD Competition

Design Teams

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Please note that we will be regularly updating this brief as additional questions are posted by other designers on the OAN FAQ site. Please check the FAQ site regularly and, if indicated on the site, please re-download this brief.

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1 Approach to IT & Telecommunications

Mission Statement of Nyaya Health
Nyaya Health is an international NGO partnering with the Ministry of Health and Population of Nepal to improve healthcare infrastructure in Achham. Achham is a rural agricultural district with some of Nepal's highest poverty, infant mortality, maternal mortality, and HIV rates. Through the innovative application of epidemiological methodologies, information and communication technologies, and accountable community-based management structures, we seek to develop scalable models for expanding health equity and access to marginalized populations. We are currently developing a primary health centre in Sanfe Bagar which is a major transit point in Achham. The clinic focuses on antenatal care, normal deliveries, provision of basic emergency obstetric care, routine laboratory services, prevention of mother-to-child transmission of HIV, and pediatric care. The clinic's all-Nepalese staff include a generalist physician, three midwives, a health assistant, a laboratory technician, and a network of community health workers. Within the next year, we plan on expanding operations to a long-abandoned government hospital in Bayalpada (up a hill about one hour by foot), with the aim of providing comprehensive emergency obstetric care and inpatient services.

Incorporating Information Technology and Telecommunications into this Mission
Our approach to information technology and telecommunications involves incremental deployment of available and appropriate tools to assist our health and community development initiatives. These tools will be utilized to match local epidemiological realities, institutional capacity of the Achham clinic, and local community demand. The fundamental goal for this aspect of Nyaya Health's program in Achham is to use telecommunications as a tool to improve health services delivery.

These telemedicine applications will be the point of departure for our ICT strategy. Eventually, we will empower populations in the area to obtain access to vital resources that will serve as platforms for further educational and economic improvement. Information and telecommunications will be one tool among many used to effectively and appropriately serve the community. Telemedicine applications do not replace professional staff, effective generalist physicians, or an accountable health system; rather, its success relies on these very factors. Similarly, tele-education applications do not replace community involvement, dedicated teachers, and basic school attendance incentive programs. Finally, given that the area where we work is so rural and dispersed, we will aim to develop a system as decentralized as possible.

To meet this vision, we plan to initially develop the following ICT and telemedicine applications:

i. use telecommunications to improve staff morale and decrease their feelings of isolation, with the aim of increasing retention of rural healthcare workers.
ii. integrate telecommunications applications into clinic management structures to improve staff training, quality assurance, and monitoring of job performance.

iii. collaborate with specialist colleagues at universities based at Yale and UCSF and in Kathmandu on the diagnosis of complex patients.
iv. use telecommunications to improve supplies and pharmaceuticals supply chains, integrate telemedicine technologies into the design and daily function of the center;
v. equip community health workers (CHWs) in remote villages with the data and voice applications they need to effectively triage patients and deliver both first-responder and long-term primary care in patients' homes and local communities.
vi. improve the effectiveness of home-based care for chronic diseases such as tuberculosis, HIV, diabetes, and chronic obstructive pulmonary disease by developing easy interfaces for the CHWs to input longitudinal data on their patients and send to the central clinic staff and to external specialists.
vii. develop a digitally integrated health system that can more efficiently and effectively be used for surveillance of emerging diseases, identification of disease and description of patterns of health and disease.
viii. improve data collection and outcomes-based program monitoring through the use of the digitally integrated health system.

On this telemedicine base, we will gradually expand our initiatives to realize the full potential of ICT at facilitating not only equity in health but also in economics and access to knowledge. The overall goal of this is to work to achieve AMD's global goal of *meaningful* access for 50% of the population by 2015 in our region. The following include three broad activities:

ix. explore tele-education applications that effectively reach women, illiterate individuals, and marginalized castes.
x. utilize ICT to pilot microfinance initiatives aimed at inclusive, sustainable development
xi. tap into the power of ICT as a democratizing force for social change and political engagement of ordinary people.

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.

Due to the highly dispersed nature of the site and the location of the poorest villages typically at least 2-4 hours by walk to the clinic, a distributed network of cost-effective technology and personnel is required to ensure equitable access. This is similar to our overall clinical and public health model, in which we use our physician-run clinic as a main referral center for the network of community health workers. As such, the telemedicine building, which houses the main equipment for internet connectivity (internet service provider, ISP) and relay (via Wi-Fi typically) to peripheral sites. Additionally, it should have some community space and community labs for centralized educational activities and experimentation. The community spaces and community labs would be located on the bottom floor; the technology for the ISP would be located on the top floor, along with staff quarters. This approach mirrors our general strategy for expanding healthcare access in the region in which a central clinic provides specialized

services and trainings but the main public health activities happen at the village level. The design should be scaleable to other locations throughout Nepal, in which the telecom hub is centered at a district hospital or primary health centre.

For our purposes, telemedicine center will be located at one of two sites based in Sanfe Bagar within a short walking distance from the clinic. These locations have a line-of-site to the clinic, to the hospital site at Bayalpada, and to another hill that is the location of a proposed CDMA repeater tower by Nepal Telecom (NTC).

2 Telemedicine Center Description

Currently, there are two possible sites. Entries will be judged on the basis of their technical merit and creativity rather than on which particular site is chosen. Site A is the site in the same field as the medical clinic; site B is the site on the hill to the south of the clinic.

2.1 Site Details Pertaining to Both Sites

Sanfe Bagar is a small transit town of about 5000 inhabitants. It houses a bus park that serves as the major exit point for the masses of migrants from Achham and the northern districts to go south to India for work. This is the town in which Nyaya Health is operating a clinic.

The latitude is 29N and longitude is 81E and is a temperate climate with annual variations in temperatures between 3 to 42 degrees Celsius, no snow fall but heavy rains. During the early morning of the winter months 5-10 degrees is typical, but then rises over the day to up to 25. The peak summer months' temperature is typically up to 40 degrees. Rainfall is approximately 1250mm per year. Nepal experiences monsoon rains from June to September. The site is not located in a flood plain, being situated on a small plateau approximately 1200 meters horizontally and 200 meters vertically away from the river.

The average transportation time to the clinic/telecomm center is about 2 hours by foot, though some patients must travel 4 hours or more. This is not because the clinic is located in an out-of-the-way location but rather because of the nature of the remote, hilly geography with poor transportation infrastructure. Though most persons are accustomed to these long walking distances, community healthcare workers are being trained and equipped with communications technology to develop an effective triage and mobile home-based service system. The hospital at Bayalpada is similarly remote; its location does not make it any more or less accessible to the communities. The Sanfe Bagar location was selected, however, because of its logistical convenience in transporting supplies, as it lies at the end of the paved road (Bayalpada lies after this, up a dirt road that becomes very difficult to pass during the rainy season).

Local occupations engage in almost exclusively agriculture and migrant work. Some individuals based in village centers are additionally involved in shopkeeping, teaching, and restaurant ownership. Please see our rapid health assessment and our clinic-based health economics survey for more details about the general health and economic status of

the region. The Sanfe Bagar townspeople have the highest socioeconomic status in the area; while still probably living on an average of 1-2$ per day, they exhibit relative power over their even more remote village neighbors. This is an important point in that if we are to achieve access to the poorest in the villages, we need to develop a distributed, local network in the villages. The Sanfe Bagar relative elites may be more or less happy about having poor migrants from the North or from dalit communities come to the clinic. Sanfe Bagar was decided upon as the most convenient location logistically as the clinic location and the telemedicine center, but for this reason it does present some challenges for us to ensure equitable access.

Other salient points pertaining to both sites:

- The site is about 200 meters from a civil engineers office. They are building roads and have free time and will help us.
- Both sites are in range of current CDMA signal, but the signal is weak and allows for only 10 kbps at off-peak hours. NTC is planning a repeater for CDMA shortly on a hill about 1200 meter as the crow flies from the site.
- Landline phone currently is not available.
- The prevailing wind is SW to NE, strongest in February through July, this is largely unaffected by the hill.
- The hill does not obstruct sunlight to the plot, although surrounding trees do provide some cover.
- A small water pump may be required to pump the water up to the roof, where most likely we would place a 1000 L black-colored water tank (that's what is typically done, but certainly other designs can be undertaken).
- The site layouts for both can be found online at the Nyaya Health sketchup site: http://sketchup.google.com/3dwarehouse/search?uq=13801887529798628529
- Photos of the area can be found at: http://picasaweb.google.com/nyayahealth

2.2 Site A

The proposed site is on an approximately one acre parcel (4000 square meters) of flat farmland in Sanfe Bagar, to the North of the Sanfe Bagar clinic about three minutes by a footpath. Note that the sketchup drawing is approximately one-half acre; we suggest that this size be accommodated in the initial phases. There is adjacent room for long-term expansion, however.

- The site is a three minute walk via footpath from paved road where there is parking space for equipment trucks to unload stuff.
- The site is 20 meters from nearest electricity pole.
- The plot of land is loose soil currently with grassy/bushy vegetation and some trees. This plot has minimal terracing that would is easily leveled.
- The site will require 200 meter of piping from nearest freshwater source (water provided for free).
- There is a line-of-site to the clinic (North; 200 meters) and Bayalpada hospital (East; 1800 meters; important for placing Wi-Fi).

- The site is in an open area surrounded by farmland that is frequently crossed by farmers.
- The site is located about 10 meters vertically and 100 meters north/northeast of the small stream at the bottom of the south-sloping-upwards hill.
- The entire plot of land available for long-term planning is about one acre (40,000 sq. meters) would cost approximately 900,000 Nepali Rupees (~USD$14,200). The plot displayed on the Sketchup Site for present development is about ½ acres (20,000 sq. meters). The price of a smaller plot would be scaled accordingly. The designers may design for as little or as much of the space as they feel appropriate.

2.3 Site B

The proposed site is on an approximately one-acre (2000 sq meters) parcel of wooded area in Sanfe Bagar, to the North of the Sanfe Bagar clinic about seven minutes by a footpath. Note that the sketchup drawing is approximately one-half acre; we suggest that this size be accommodated in the initial phases. There is adjacent room for long-term expansion, however.The site is a 4 minute walk via footpath from paved road where there is parking space for equipment trucks to unload stuff.

- The site is 50 meters from nearest electricity pole.
- The plot of land is well-packed soil currently with grassy/bushy vegetation and some trees. Although it is terraced, it is possible to level the land or to use the terracing into existing designs.
- The site will require 150 meter of piping from nearest freshwater source (water provided for free). A small water pump may be required to pump the water up to the roof, where most likely we would place a 1000 L black-colored water tank (that's what is typically done, but certainly other designs can be undertaken).
- There is a line-of-site to the clinic (North; 600 meters) and Bayalpada hospital (East; 2000 meters; important for placing Wi-Fi).
- The site is in a generally wooded area that is isolated from houses. Very little traffic passes by the footpath, but it is highly accessible from sanfe.
- The site is located on a hill about 25 meters above a small stream.
- The entire plot of land available for long-term planning is about one acre (40,000 sq. meters) would cost approximately 400,000 Nepali Rupees (~USD$6400). The plot displayed on the Sketchup Site for present development is about ½ acres (20,000 sq. meters). The price of a smaller plot would be scaled accordingly. The designers may design for as little or as much of the space as they feel appropriate.
- The soil contains about 50 centimeters of loose top-soil; the terraces as shown are drawn accurately but re-terracing for design purposes is quite achieavable.

2.4 Building Layout

Please note that these are suggestions only, and that we are excited to work with any design teams' suggestions as to how to exactly layout the buildings. Throughout this

brief, we provide some philosophies, goals, and guidelines for you to work creatively to try to meet. That said, we will give one version

As noted above, the main focus of this building is to create a telemedicine hub that serves as an ISP for our clinical staff and the community and as an experimental center for major community computing and microfinance activities. It does not serve as the point-of-telecom-contact for the vast majority of community members, since it is located far a way from most (particularly the most marginalized).

Our staff had suggested that a two-story building might be an appropriate building for the center. The primary consideration was to have some degree of separation for the staff quarters. That said, a single one-story structure or two structures can work as well. Even the division of these "sets" is flexible. The first set of rooms would be the community rooms (large community hall, two lab rooms, one bathroom, telemedicine training room, private counseling rooms). The second set of rooms would be an admin office, room for server, and staff quarters (approximately eight to ten bedrooms plus kitchen, common living space, bathroom, and an administrative office. The staff quarters should facilitate communal living while respecting the need for appropriate cultural separation of men and women. The total indoor footprint can be decided upon by the design team; 175 square meters is a reasonable starting point. Note that space should also be allocated for an approximately 25 foot Wi-Fi tower and for an underground septic/sewage tank (~7'x12'x7'deep should suffice).

The first set of rooms will more specifically have the following spaces:

- One single large multi-purpose meeting room/break room capable of meetings up to 50 to 100 people. This can be used for community activities, meetings, trainings. It may also house a small library. An energy-efficient wood stove should suffice for heating needs during the coldest periods. Ceiling fans should suffice for cooling needs.
- two community computer lab spaces.
- one small storage room.
- one bathroom.
- one AV telemedicine consultation/training room
- two counseling rooms

The second set of rooms will more specifically have the following spaces:

- one server room housing up to three server computers.
- one administrative office
- eight to ten staff quarter sleeping rooms. These are for permanent staff of the clinic or of the telecomm center itself.
- one kitchen space.
- one common living space area.
- one bathroom with bath and shower.
- one small storage room.

While there are two "counseling rooms" that may be used for patient interactions or otherwise for one-on-one financial or educational counseling, typically no patients would be treated at this location. Rather, clinicians utilize telemedicine applications locally at clinic sites (via bandwidth provided by the telemedicine hub). Most patient interaction rooms would be located at the existing clinic and satellite sites. That said, we are open to any possibilities that maximize efficiency, scalability, and patient care. If designers have developed such rooms, then we are more than happy to entertain such possibilities. The reasons that we are hesitant to include patient interaction rooms are as follows. The first is the issue of scalability, or the ability to incorporate the design into existing clinics and hospitals. In most cases in Nepal, the shortage is not of hospital beds or spaces for patients but rather for staff trained and willing to work there. Also, where the clinic settings are relatively small, designing a telemedicine center where patients would actually be seen but where community activities would also take place seemed to present issues in patient comfort and confidentiality without much benefit. Since it costs so little to get the connectivity from the clinic (just a little cords or Wi-Fi), there is less of a benefit to actually seeing patients at the telemedicine center. All the technology can be deployed on-site at the existing clinical structures. The third issue is it allows for increased functionality, in that having some distance from the clinic facilitates the community and ourselves to better achieve multiple functions for the space by relieving the constraints of being built into a clinic/hospital.

2.5 Construction Considerations

i. Nature and cost of local construction materials: most traditional houses (see pics on our picasa site) are built with clay and have thatch or tin roofs; clinic and hospital are made of cement and brick, both of which need to be transported from Dhangadi, a city to the South about 10 hours drive. Tin roofs are also common, and tin is readily available.

ii. Style: the building does not have to be in keeping with the "traditional" design per se, nor does it need to incorporate mud technology. Most citizens do not expect facilities, particularly those pertaining to health, to be made of clay and thatch materials. That said, there are a few good reasons to use mud technology: 1) it decreases transportation costs; 2) local people can be more easily employed in construction; 3) there may be an aesthetic appeal for some. The most important factors are that the building is structurally sound, clean, and functional, and that the design is potentially scaleable to other locations. Particularly indoors, floor tiles and wall tiles (up to four feet off the ground, or even to the ceiling) are very helpful for facilitating sweeping and cleaning. Although no shoes will be allowed inside the building (as is typical of many houses and buildings in Nepal), dust and mud are major impediments to keeping the place clean. Designers during their site visits may hold design workshops to ensure that these assumptions are correct.

iii. Local contractors: construction contractor with building engineer will likely need to be found in Dhangadi (10-12 hour bus/jeep ride away) for all but the most basic designs; local labor will mostly be used to the extent possible.

iv. Cooling: Sufficient air flow, appropriate use of natural ventilation and shade, and proper insulation for cooling during summer (temperatures up to 110 degrees F).

Apart from proper energy efficient design, fans are probably the only additional machines needed; AC, space heaters, central heating are not necessary. Use of design strategies to minimize the need for fans are of course welcome.

v. Heating: Appropriate solar positioning, proper insulation, and use of natural heating sources for warming during the winter (night time temperatures down to 3 degrees C). A single energy-efficient wood-burning stove or biomass heater (or other technology) can be considered for use primarily for early morning and evening events during the winter.

vi. All rooms, particularly that housing the serve, should be designed appropriately to protect equipment from excess moisture and extreme temperatures.

vii. Energy generation: Our 5 kW diesel generator will provide sufficient, reliable power for the entire small hospital and telecommunications center, but at significant environmental and financial cost. This is supplemented by the grid, which is very unreliable (maybe 25% of the time). As such, consideration of more efficient or renewable energy sources is important. You can see some preliminary thoughts, including energy usage estimates on our wiki.

3 Connectivity

3.1 Internet Connectivity

We are currently defining the scope and cost of possible connectivity applications. This is a major challenge, as in Sanfe Bagar there had been no reliable phones; we established the first internet connection via CDMA. The following briefly outlines some of the options.

Wireless CDMA is the option that shows the highest potential. It is highly affordable, with usage costs approximately $0.05 per MB. However, the nearest CDMA towers in Silgadi and Mangalsen are located 40 km away. Currently, with a 12 dB antenna and fixed wireless terminal, a reliable phone and spotty internet connection has been established. A 800-900MHz yagi antenna and wireless booster for the area had previously failed to improve (or even establish) connectivity. We are dialoguing with Nepal Telecom (NTC) about developing a tower in Bayalpada where the future hospital and telecommunication center is located.

There are no landlines over which to dial into the NTC roaming network. To effectively utilize landlines, we would need to work with NTC to lay additional lines, which is a significant bureaucratic challenge. Usage costs also can be high, since they are charge on a per-minute basis.

Satellite is superior to CDMA in terms of reliability and speed; however, the usage cost is quite high. A Broadband Global Area Network (BGAN) system costs approximately $1000-$3000 in capital costs, and usage through Inmarsat costs US$6 per MB. Very Small Aperture Terminal (VSAT) costs $5000 in capital costs and then, through

Sustainable Networks (a consortium pooling bandwidth among hospitals and NGOs in Nepal), costs an additional $300 per month for 80 kbps guaranteed bandwidth.

3.2 Intra-District Connectivity

Communication between the villages and the clinic will facilitate outreach to remote villages, and enhance the performance of effective triage. Many of the villages in the catchment area are 2-4 hours by foot from the clinic site. Many of the problems encountered by community healthcare workers (CHW) can be effectively addressed in the village with some over-the-phone clinician support. Additionally, we can use the same technology to use what internet connection we establish in Sanfe as an internet service provider to connect the remote villages.

Four options for this support include: (i) telephone landline; (ii) CDMA phone; (iii) two-way radio; and (iv) Wi-Fi. Telephone landlines may tap into existing infrastructure to minimize capital expenditures, but landlines are currently unavailable at our clinic's town or in most of the outlying villages. CDMA phone is still unreliable in remote areas. We are pursuing costing for a two-way HF radio system, but receiving bureaucratic approvals from the government for the HF range may be a long process. It also does not allow for data transfer. As such, Wi-Fi is looking to be the best option. It is currently being piloted by the Ministry of Health's programs. That program requires an ~US$300 Wi-Fi antenna and a laptop or skype phone on either end of the communication chain. It allows data and voice. An intranet VOIP would eliminate any usage fees for communicating between our CHWs and the clinic. It also requires a line-of-sight, which is a challenging prospect in our hilly area, though our clinic site is on elevated land. We can of course use relay antennas to achieve this. The 2.4GHz range is deregulated, so there is no bureaucratic obstacle.

4 Staffing

At least two leadership positions are critical to the effective implementation of the telecomm center. Other workers may be hired as our needs assessment and reviewers are conducted, but these two positions form a core leadership team at the telecommunications center. Both of these positions are salaried and will be Nepalese citizens. We have actively begun to recruit for these positions, knowing that identifying these leaders will be critical to effective and innovative implementation.

4.1 Telemedicine Director

Rationale: This individual will provide overall management and strategic direction for the telecommunications center. The director will also run the telemedicine program.

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 center. Provide vision and strategic direction to the 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.

4.2 Tele-development Program Manager

Rationale for Posting: To make optimal use of the telecomm center for the community, a dedicated personnel will be on-site to manage educational and economic initiatives.

Qualifications: Background in education and computing, particularly among illiterate populations. Fluency in written and spoken English and Nepali. Strong familiarity with computers and networks. Passionate about development in Nepal. Leader, able to inspire others to effective action. Ability to engage with community members in an effective group leadership capacity.

Duties: Oversee operations of educational and economic programs developed out of the center. Assists telecomm director in all tasks. Performs outreach to neighboring communities. Key elements may include designing and implementing community education activities and organizing community meetings and teach-ins.

5 Design and Implementation Process

5.1 Evaluating Design Entries

The following aims and goals are of particular interest to Nyaya Health when considering design entries from the OAN/AMD competition:

i. Appropriate design to facilitate both telemedicine needs and community educational initiatives.
ii. Integration with surrounding hospital structures.
iii. Adaptability for multiple and unforeseen uses.
iv. Energy-efficient for all seasons; ability to accommodate and integrate with alternative energy sources in the future.
v. Structurally sound for possible small earthquakes or landslides.

5.2 Outstanding Concerns

Engineering support

We have entered into discussions with Nepal's branch of Engineers without Borders, to determine if potential supplementary engineering skills to support construction contractors may be of assistance. The cost of employing these services would only include travel and living expenses (~$300 per consultant per year).

Engaging illiterate individuals in the process

AMD's vision 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. This challenge is important to consider during the design period, since it will be a Nyaya Health goal for early use of the telecomm center.

Machine Maintenance in a Remote Setting

Personnel and back-up systems are two considerations for machine maintenance in this setting. Some equipment that require 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.

5.3 Tasks and Timeline for Implementation

Developing institutional and local capacity: Ongoing

Prior to the opening of the telecommunications center, 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:

i. engage community members in telecommunications so they can participate in the design process from a more informed perspective.
ii. develop institutional experience to better inform designers and planners of the specific needs of the community and clinic.
iii. ensure institutional involvement in the long-term to ensure sustainability.
iv. develop human resources capacity and leadership to effectively implement the programs.
v. relieve the financial burden of AMD/Open Architecture donors and free up funds for expanded activities by using Nyaya Health's own financial resources and networks.
vi. 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.

Facility Design and Planning: April 1, 2008-July 1, 2008

The design process will involve community members via local meetings and video conferences. As mentioned above in section 4.3, an important criterion in selecting a winning design entry will be the team's willingness and ability to travel to the clinic site and participate in design workshops and planning meetings. These site visits should be made over an appropriate period of time—at least two weeks would be ideal—to allow for sufficient time for the team to learn about the site and the community and adapt to local conditions that may not be encountered in the team's home area.

During the design period, a detailed, three-year budget will be prepared. This will be completed by May 1, 2008 to allow for sufficient time pre-construction to ensure the financial viability and sustainability of the project. As mentioned above, Nyaya Health will, to the extent possible, utilize its own fundraising resources to develop the telemedicine center. During this time period, we will also perform a baseline assessment of the perceived knowledge, attitudes and behaviors of clinical staff and community members around the issue of perceived telecommunications, computing and information technology needs. Furthermore, we will determine the associated training requirements that new technology would require for both staff and community members.

Facility Construction and Outfitting: July 1, 2008-January 31, 2009

A major challenge for this phase will be to create an open and transparent bidding process for construction teams. While there are contractors in Achham, many of these may not have the resources or experience to design a complex telecommunications center. As such, contractors may have to be recruited from the closest semi-urban center, Dhangadi. The issue there is developing trust and real involvement by the community members, and maintaining costs at a minimum. Dhangadi is approximately ten hours from the site by uncertain roads, and transportation costs alone can get expensive.

An additional challenge will be the permitting process. Nyaya Health has re-worked our project agreement with the Ministry of Health to provide us with a free hand in developing the center. Essentially, the current agreement allows any renovations and management decisions to made at the hospital site by the Nyaya Health team. We will continue to work with and put pressure on the government to ensure that there are no further hurdles in construction.

Full Technology Deployment: February 1, 2009-March 31,2009

As discussed in the previous paragraphs of this section, technology deployment will proceed in a step-wise fashion, developing institutional IT capacity at the Sanfe Bagar clinic even while the Telecommunications Center is being planned and built in

Bayalpada. Full technology deployment for the telecommunications center will be pursued subsequent to the construction. This will involve site visits from technical support and IT deployment crews, preferably recruited from within Nepal. Most of the required technical assistance can be found within the major technology hubs of Kathmandu and Biratnagar. Utilizing Nepalese staff and consultants is important to ensure long-term sustainability; to minimize travel and visa costs; and to an interest in rural development among urban technology Nepalese leaders.

6 Itemized List of Infrastructure

These are a very preliminary outline of our actual ICT materials needs. We will be developing these over the next few months even as the final design is being finalized.

6.1 General Infrastructure

Community desktop computers: 8 simple PCs with commonly-used software; consider pursuing one-laptop-per-child program for child education programs. Digital cameras and microphones may facilitate income-generating programs (see Appendix B).

Telemedicine desktop computers: 2 machines, requiring graphics capability suitable for radiology and pathology applications and adequate storage space for large graphics files. See Appendix A for further details about equipment linked to telemedicine computers.

Software: To the extent feasible, we employ home-grown software from Nepal and opensource software. Essential applications will include: Fedora or equivalent, OpenOffice, Mozilla Suite, RARzilla, WinRAR, video and chat software, FileZilla. Additional software for telemedicine computers: OpenRAD radiology suite, Beckwith HMS open source pathology suite, e-medicine communication suite from www.ruralhealthonlinenepal.com, supply chain management from msupply.com.nz.

Peripherals: Monitors, keyboards, mice, power strips, cables.

6.2 Connectivity

Here we provide the infrastructure requirements for each connectivity strategy, although currently we are most likely to go with CDMA plus VSAT for internet and a Wi-Fi intra-district network. We have pursued each option to varying degrees, and it is instructional to list their requirements here.

Wi-Fi Strategy

Infrastructure: Wi-Fi dish with line-of-sight relay chain from ISP. Currently ISP is unavailable, such that this strategy may not be feasible for connectivity in the short-term.

However, the frequency has been de-regulated, removing potential bureaucratic hurdles.
Usage costs: As per ISP; usage will be cheap.

CDMA Strategy

Infrastructure: Antenna/Booster plus CDMA internet device. This requires construction of a tower in Bayalpada by NTC.
Usage costs: ~3 Nepali Rs. per MB.

BGAN Strategy

Infrastructure: No further Infrastructure is required beyond the existing BGAN system.
Usage costs: ~375 Nepali Rs. per MB, though subsidies are currently being actively pursued.

VSAT Strategy

Infrastructure: $5200 for 1.2 meter VSAT terminal plus technician, cords, router
Usage costs: Through Sustainable Networking consortium (servicing NGOs and hospitals), usage rates are $285 per one month of unlimited usage at bandwidth of 80 kbps. Additonal speed can be purchased at a linear cost addition.

Telephone Strategy

Infrastructure: Landlines can be routed from the center of Bayalpada to the hospital. NTC must lay the landline.
Usage costs: The per-hour rate with NTC is ~30 Nepali Rs. per hour.

Two-way HF Strategy for Intra-district telecom

Infrastructure: HF bandwidth permission is required from the Ministry of Information. Central receiver based at the clinic; hand-held transmitters, one per CHW.
Usage costs: None after the licensing has been obtained

7 Telemedicine Outline

This is a rough outline of our initial telemedicine applications. Some of these applications we have already developed considerably and placed on the wiki.

7.1 Principal activities

Telemedicine activities will be progressively expanded with clinical capacity. The initial services will include:

i. Cytopathological assessment of Pap smears for cervical cancer, via transmission of images through digital microscopy;
ii. Interpretation of complex ultrasound or X-ray images for direct patient care, training, and quality assurance;
iii. Reading of complex microscopy slides for patient care, training, and quality assurance;
iv. Email-based communication with specialists regarding complex patients as issues arise;
v. Voice-based communication with specialists on complex patients, potentially even in emergency scenarios;
vi. Communication from clinicians at the center clinic with Community Health Workers in the villages, for assistance with triage and treatment.
vii. Integration of these activities with epidemiological monitoring, to improve disease surveillance, public health monitoring, and evaluation of programs
viii. Development of computer-based practical clinical reference tools to improve the quality of care.

A consultancy network of providers is being established currently, involving Kathmandu-based consultants who are preferred for most integrative tasks to allow for sustainability and within-Nepal health resource expansion as the Ministry of Health is ultimately responsible for clinical service delivery. However, a back-up network of expert physicians at Yale University is also being established under the leadership of the Yale Cancer Center. As incentive for US-based physicians to participate in the program, Yale has setup privileges to the university's medical journal subscriptions, internet portals and associated services, and faculty privileges (including entertainment and leisure vouchers), which are attracting physicians to the program.

7.2 Overview of materials requirements

Pap screening:

i. microscope with digital camera (see below)
ii. standard swabs for liquid culture, cold storage, and slides
iii. online scheduling system for collaborating pathologists to read slides within 2-4 weeks of their electronic receipt

iv. referral or periodic camp-based system for colposcopy/ablation or further referral of patients who screen positive

Radiology:

i. ultrasound with digital storage capacity
ii. standard digital camera
iii. X-Ray machine (Panoramic PC-1000 or equivalent) and developer (AllPro Imaging 100 or equivalent)
iv. standard X-Ray display box
v. online scheduling system for consulting radiologists

Microscopy:

i. microscope (Olympus BX2 series or equivalent) equipped with a digital camera (Olympus DP series or equivalent)
ii. online scheduling of pathologist reading and reporting times
iii. designated personnel with schedule for cleaning and repair, capturing of pathology slides, and transmission of data

Email consultancy:

i. www.ruralhealthonlinenepal.com system; this is free software used throughout Nepal.
ii. "on call" schedule for consulting physicians

Voice consultancy

i. telephone or VOIP connection
ii. schedule for consulting physicians

Intra-district communication

i. telephone,VOIP, or HF radio connection (as above)
ii. salaried community healthcare workers

8 Budget

PROJECT BUDGET	Costs
Operational Expenses (Year 1)	
Staffing and Personnel: 2 Leadership Positions	$24,000
Staffing and Personnel: 2 mid-level lab instructors	$12,000
Staffing and Personnel: 25 CHW training+salaries	$20,000
Staffing and Personnel: 20 KTM-based physician consultants	$5,000
Bank and credit card fees	$300
Insurance	$1,000
Postage/Delivery/Shipping	$1,020
Printing / Photocopy	$100
Professional Fees (Legal/Financial)	$500
Office Supplies	$200
Telephone / Fax / Internet	$3,200
Water (free)	$0
Electricity and Generator Fuel	$2,000
Total Operational Expenses	$68,300
Facility Construction and Outfitting	
Land acquisition	$5,500
Site preparation	$500
Labor	$4,000
Construction materials	$10,000
Furniture, Finishings and Equipment	$1,500
Construction of repeater tower at Badalgada (payment to NTC)	$7,000
One ISP server	$1,200
8 desktop computers for community center	$1,600
2 desktop computers for telemedicine (located at clinic)	$500
35 towers, average 25 feet high ($15 per foot)	$14,000
35 Wi-fi antennae	$7,500
25 VOIP phone plus low-cost computer	$5,000
10 desktops for community center	$2,000
miscellaneous cables/cords, voltage stablizers, etc.	$500
Digital camera	$300
Ultrasound with 3.5 MHz convex transducer	$7,500
Digital X-Ray Machine and Supplies	$11,000
Digital Microscope	$3,000
Total Construction Costs	$82,600
TOTAL PROJECT BUDGET	$150,900

Appendix A Tele-development for community members

Although our initial focus is rightfully on expanding health equity and access in Achham, the long-term vision must incorporate expanding ICT to other domains. In fact, we aim to achieve, on a micro-scale in the Achham district, AMD's goal of 50% internet access by 2015. The key challenge addressing literacy rates as low as 20% among women in the district. Here we outline a few strategies to provide some fuel for research and dialogue.

A.1 Initial activities

Our initial community-based activities will include:

i. a health literacy program for both literate and illiterate populations
ii. an educational program to enhance literacy among women, for which we plan to engage the Ministry of Education of Nepal
iii. general adult literacy program
iv. computer literacy and job training for youths

Many of these activities will require coordination with local schools to obtain personnel who may make use of this center as a common community congregation point. These activities are currently in the planning phase.

A.2 Educational Activities

Qualified English, Science and Mathematics teachers do not visit or teach in Achham because of its undesirably remote location. Tele-education can be used to connect qualified teachers in larger cities to classrooms in Achham, as successfully accomplished by the Nepal Wireless Networking Project in the remote eastern villages. By integrating teaching of basic computer skills and English, villagers, both young and old, in Achham can be connected to the rest of the world, and vice versa. The internet will also provide opportunities for the community members to become pen-pals with individuals in English-speaking countries, enabling them to improve their English, share their culture and expose their pen-pals to the unique set of problems Achham faces.

A.3 Economic empowerment activities

Microfinance

Currently, several locally managed co-operatives ("coops") exist in the many villages in the region. These pools of money are raised from the locals and are used to disburse incidental loans to members at irregular interest rate and payment schemes. In addition, there are barriers to accessing these loans based on gender, caste, socioeconomic status and knowledge gaps. Instead of trying to create a parallel micro-loan system we will expand and integrate the coops by training the managers on efficient disbursements,

streamlining the application process to eliminate access barriers and connecting the local coops allowing villagers in need from one locality to tap resources from another. We will engage donors with the capability to expand the capital of the coops, thus increasing the scope from incidental loans to micro-finance. Training on how to create and submit microcredit loan applications can also be delivered via tele-education from qualified teachers abroad and in larger cities within Nepal. The mission will be expanding and connecting these isolated capital bases, increasing efficiency, improving management and decreasing barriers to accessing these loans.

Agricultural Support

Connecting farmers to information related to weather patterns and market changes will become an increasingly important use of the community center for this population. Further access to new technologies and banking will allow for consideration of microcredit enterprises. We are pursuing education about microcredit and its possible application to this center under the advisorship of Dean Karlan of Yale University. This option may be pursued by linking individual loaners to persons at Achham through the protective and ensured services at kiva.org.

E-Entrepreneurship

Income generation and entrepreneurship will be an integral part of making the center useful to the community. A component of this will involve Nepali language instruction from Achham to the outside world, over the internet. InterLangua (www.interlangua.com) currently serves as a successful model from Guatemala. Digital cameras and microphones attached to the computers in the facility, and night-time scheduling, may allow for early deployment of this income-generating activity.

The community telecommunications center can also be used to globally market products resulting from microenterprise ventures. For example, handmade goods can be placed on sale on a global marketplace via the internet, similar to venders such as https://shop.thehungersite.com/ or http://www.worldofgood.com/. Eventually, the clinic can incorporate global marketing of locally made goods into a community-based insurance system. Villagers who are able will donate a minimal amount of time (roughly one day a month) to producing handmade goods that can be sold online to provide funding for clinic costs. While the majority of the revenue will directly go to the artists, a portion of the funds raised can go towards funding clinic operational costs. In addition to providing income, this project will both ensure the financial viability of the clinic and give direct ownership of the clinic to the community it serves. This combination of community-based health insurance and microenterprise will be under the advising of Professor Hong Wang of the Yale school Public Health.

Appendix B Nyaya Health IT and Telecom Leadership Team

Jason Andrews, MD. *Co-Founder and President.* Dr. Andrews developed the initial vision for Nyaya Health after his work in Nepal from the years 2000-2006. He established Nepal's first community-based antiretroviral (ARV) therapy program in Kathmandu, serving injection drug users and others who were marginalized from the standard healthcare sector. Dr. Andrews and his wife, a documentary film producer, later interviewed HIV-infected widows in Achham in 2006, and recognized the great need for intervention in this population. This formed the basis for what later became the Saphe Bagar clinic. Dr. Andrews is a recognized expert in HIV-TB interactions, having published widely on the issues of drug-resistant tuberculosis and antiretroviral treatment. He received his training from Yale and the University of California San Francisco, where he currently treats patients at the San Francisco General and Moffitt Hospitals.

Duncan Smith-Rohrberg Maru, MPhil. *Co-Founder and Executive Director***.** Mr. Maru is an epidemiologist who has published widely on the interactions between HIV, community-based care, and poverty. He oversees clinical staff and procurement at the Saphe Bagar clinic. Mr. Maru also co-founded equityedit.org, a major fundraising mechanism for Nyaya Health that uses the emerging market for medical research editors to raise funds that go to patient care. He received his training at Harvard University prior to arriving at Yale, where he is now completing his MD/PHD dissertation from Nepal.

Sanjay Basu, MSc. *Co-Founder and Chief Operating Officer.* Mr. Basu directs Nyaya grants and finances. He previously co-founded United Trauma Relief and Universities Allied for Essential Medicines (UAEM), two international pharmaceutical procurement and budgeting mechanisms. He has also serves as a senior economic and financial advisor for pharmaceutical programs at Oxfam UK, Britain's largest charity. Sanjay received his training at MIT and at Oxford University, where he was a Rhodes Scholar.

Bijay Acharya, MBBS. *Director of Medical Planning.* Dr. Acharya is a graduate of B.P.Koirala Institute of Health Sciences, Nepal. He worked as a volunteer physician treating HIV-infected patients for the local NGO Naulo Ghumti. He also worked as medical advisor for Friends of Hope, a support group for HIV-infected former drug users in Pokhara. Dr. Acharya is involved in designing the clinical protocols and addressing governmental regulations to maintain effective operations at the Saphe Bagar clinic. He is well recognized by many physicians in the healthcare community in Nepal, and by health ministry members. Dr. Acharya also works in New York City, at Harlem United Community AIDS Cliinic.

Bishnu Kattel, MBBS *Director of Medical Services.* Dr. Kattel received his medical training from the B.P.Koirala Institute of Health Sciences, Nepal. He subsequently served as a medical officer at Kathmandu Medical College and as a visiting surgical instructor in China. He sees patients and oversees the medical staff at the Sanfe Bagar clinic.

Tenzing Tekan, *In-Country Director (starting February).* Mr. Tekan has worked with the World Bank and with Goldman Sachs as a financial analyst in the healthcare sector. He helped to direct funds and enhance services for numerous medical programs treating patients in India. He will be working in Achham on the operational details of program

management and community-based engagement. He is fluent in both Tibetan and Nepali, and will be developing outreach programs for the hard-to-access migrant workers from the north who speak a Tibetan dialect.

Manindra Malla, *Director of Electronics Systems.* Mr. Malla is a Kathmandu-based electronics manager who directs our IT programs. He has operated a successful VOIP business with clients in Canada, the United States, and Qatar. He has also managed an inverter and stabilizer factory. He received training in business management and information technology from Tribhuvan University, Kathmandu, Nepal. He has extensive experience within the Ministries of Education, Information, Industry, and Health.

Bibhav Acharya. *Director of Strategic Oversight and Outcomes.* Mr. Acharya monitors the progress of Nyaya's operations. He previously worked in Pokhara, his hometown, where he established an HIV services organization. As a Howard Hughes Science and Society Scholar, he studied the organization and efficacy of public health programs in Bangkok and Phitsanulok in Thailand. He has also worked at the New York State Department of Health, determining how best to manage HIV-infected patients with poor outcomes. His research led to the development of indicators for the National Quality Center tracking the effectiveness of HIV care. Mr Acharya received his training at Haverford College and is now pursuing medical studies at Yale.

Rina Patel, MS. *Director of Information Technology.* Mrs. Patel received her BS and MS in computer science from the University of Florida. She has worked in End-user Services as a IT education specialist for the software company PTC. She provides technical oversight on connectivity issues and on the use of IT for educational purposes. She co-founded Cents of Relief which aims to fight human trafficking and disease in red-light areas in India.

Ana Serralheiro, MSc, *Director of Logistics.* Ms. Serralheiro is a specialist in engineering and logistics. She completed her Master's from Cranfield University, UK, and received her *Licenciatura* in Biotechnology Engineering from the Algarve University, Portugal. She currently oversees waste management, laboratory services, and supply chain maintenance at the Saphe Bagar clinic.

Stephanie Wang, MSc, *Director of Economic Development Services*. Ms. Wang is a recognized international expert in the economics of microfinance, having setup microfinance and economic development services for agricultural districts in South and East Asia. She has consulted with several international institutions to direct microfinancing and pro-poor development infrastructure, as well as to establish indexes to assess the efficacy of development funds. She is currently developing the strategic plan to engage the Saphe Bagar community in economic development activities linked to the community care mission of Nyaya Health. She received her training from MIT and Princeton Universities, and is now in the Department of Economics at Caltech.

Ali Batouli, *Director of Healthcare Finance.* Mr. Batouli provides technical assistance to Achham-based staff in the area of healthcare finance. As an undergraduate at Stanford University, he developed incentive 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. In addition, he managed the Stanford Scientific Magazine and conducted research on issues ranging from the use of the internet as a tool for political dissent against authoritarian regimes to designing automated neurosurgical applications for surgical robots. He is currently pursuing medical studies at Yale.

Sally He, *Director of Microfinance Intiatives.* Ms. He is currently a second year MPH student at Yale School of Public Health with a track in Social and Behavioral Sciences. She has worked in Helping Hands, an outpatient clinic for low-income patients, in Kathmandu, Nepal. She is developing the research base for Nyaya's health financing initiatives, including information on microfinance and community-based financing.

Alma Ata in the Digital Era: Telemedicine for Community Health Workers
[Draft Manuscript in Preparation]

Introduction

The Alma Ata declaration thirty years ago this September laid out a vision for primary healthcare for all (1). Today, its promise remains incomplete. Recent, rapid advances in information and communication technologies (ICTs) have led to exciting opportunities to apply telemedicine to help realize this ideal by improving healthcare equity and access in developing countries. Nearly all current telemedicine strategies, however, are focused on delivering information and expertise in one direction, namely from specialists based in urban centers in wealthy areas to physicians based in poorer communities. While these applications are important and useful, the greatest gains of ICTs for improving population health will come from getting the tools into the hands of mid-level practitioners and community health workers (CHWs; alternatively denoted village health workers, indigenous health workers, or *accompagnateurs)*. CHWs are the foot soldiers of Alma Ata, and they have a growing evidence base to support their work (2, 3). They should be the focus of a public health and social justice approach to telemedicine in resource-poor areas.

The failure to bring CHW programs to meet the needs of global public health has typically been the result of a vast separation between urban and district hospitals and remote villages (4). 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 the surveillance for monitoring trends, programme performance, and the emergence of epidemics. Appropriate technologies can be deployed to improve recruitment, training, job satisfaction, and retention of CHWs. Telemedicine undertaken in this fashion is a dialogue and exchange of information within resource-poor settings, as opposed to a unidirectional

arrow of information from North to South or wealthy to poor. This, in our mind, should form the foundation of telemedicine applications upon which to build external specialist links.

Like the CHW networks, information and communication networks remain a work-in-progress and 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 (5). 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 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. The fundamental questions do not center around technology but pertain to who will use the tools and for which populations.

Alma Ata provides a relatively straightforward answer: the full potential of ICTs will be realized best by training and equipping CHWs to utilize them and share them with their local communities. While few programs have been piloted and many research questions remain unexplored, several basic principles are likely to be followed by any effective ICT/telemedicine programme for CHWs [box 1]. These principles follow the fundamental vision of Alma Ata: that medical knowledge should be decentralized, accessible, and affordable. They integrate nicely with many important social movements within ICT, which emphasize open access to information (6), universal internet access (7), and the use of open-source software (8).

Applications

Telemedicine is commonly associated with doctors in cities providing advice and even surgical care to patients in remote areas. Although such telemedicine applications can be

incredibly useful and can effectively deliver specialist medical care where no other options exist, they are unlikely to have a significant impact on broader healthcare access. Our experiences in developing a telemedicine program in rural Nepal (9) have suggested that the most powerful applications of technology—and the ones most consistent with Alma Ata's mantra—are those that decentralize ownership of the information and effectively expand the pool of “experts”. This is by no means a critique of the important and effective initiatives aimed at supporting rural physicians. Physicians are a key component of the health system, and they need to be connected with information. We would argue, however, that greater attention needs to be made towards developing applications centered around the CHW.

These include: 1) data and voice communication systems between CHWs and doctors or other health professionals at hospitals and primary health centres within a CHW’s home district for support in diagnosis, treatment, and triage; 2) voice communication among CHWs for social support, knowledge exchange, solidarity, and shared experiences; 3) simple data collection and management tools for surveillance using straight-forward interfaces with minimal literacy requirements; 4) similar data applications for quality assurance and programme monitoring; 5) integration of these data applications with early response systems for disease detection; and 6) targeted data- and voice- applications for communication with urban-based specialists outside of the district. Such applications directly support the CHW’s fundamental mission of achieving local access to essential primary care.

The good news is that much of the software, data, and specialist networks are in fact in place or rapidly developing. The technology is there; the next step is to adapt it to be effectively utilized by CHWs. Innovative social entrepreneurs like Dimagi are working to

get health technologies and electronic record-keeping into the hands of non-physicians (10). Straightforward internet interfaces like Rural Health Online Nepal facilitate communication among mid-level practitioners, rural doctors, and specialists (11). Translations into local languages and for semi-literate populations need to continue to be developed. Databases such as the Global Infectious Diseases and Epidemiology Online Network (GIDEON) provide critical repositories of up-to-date knowledge useful to health practitioners (12). Non-profits such as Satellife have developed networks and internet portals of health-related resources used throughout the developing world(13). A similar network, Réseau en Afrique Francophone pour la Télémédecine (RAFT) has been developed for francophone Africa in continuing education for physicians (14). Consultancy networks such as the Swinfen Charitable Trust provide intellectual support to doctors in rural areas (15). These are incredibly effective at delivering information to physicians, but adapting them for CHWs is in the very early stages. Google.org, the philanthropic arm of the information titan, is developing ICT-based solutions for responding to emergencies and disasters (Innovative Support to Emergencies, Diseases, and Disasters, InSTEDD) (16). For such applications to effectively reach the most poor and remote places that are the focus of Alma Ata—and indeed respond in a timely manner to disease outbreaks—they must be made accessible to non-physician providers.

Programme Evaluation

Few models have been developed that detail the staffing and management requirements necessary to ensure effective communication between CHWs and district-level hospital- or clinic-based staff. Indeed, the next steps in this endeavor include piloting and assessing scalable models of telemedicine programs for community health workers. Randomized controlled trials are important in testing specific hypotheses about efficacy, and are certainly needed in identifying optimal strategies for utilizing technology for CHWs (2).

They are, however, only one piece of a larger strategy for developing effective policy (17). Case studies and cohort designs can contribute programmatic knowledge. Also, many of the innovations will come from social entrepreneurs and business leaders. Partnerships between these creative forces and academicians will be critical to developing equitable and evidence-based solutions.

Important outcomes include: 1) retention of CHWs in their postings; 2) recruitment of high-quality candidates for CHW postings; 3) skills assessment of CHWs; 4) CHW adherence to clinical protocols; 5) CHW job satisfaction and retention 6) geographical expanse of CHW roll-out; and 7) equity with which this expansion occurs with respect to existing socioeconomic inequalities. The rationale for the first five outcomes is that maintaining motivation, confidence, and skills is critical to developing an effective CHW network (18). This is emphasized by recent task-shifting guidelines promulgated by the WHO in their focus on training, recruitment, and retention of CHWs (19). As the task-shifting policy document appropriately states, while providing sufficient financial incentives are a necessary part of maintaining a professional and effective CHW work force, additional incentives are needed. It will be important to test hypotheses as to the extent to which providing basic communications technologies and computing skills to CHWs might be able to improve job satisfaction and retention. ICTs, for example, may partially alleviate the problem of marginalization and lack of opportunities for upward mobility for many CHWs. ICTs offer new skills for CHWs and can help integrate them into the established health system. This in turn may help attract higher quality CHWs who feel excited about their job and are able to perform more than a few rudimentary tasks.

The fifth and sixth outcomes noted above present serious challenges of measurement. While there are certain quantitative outcomes—the number of citizens covered per

geographic area, the percentage of women as trained and ICT-equipped CHWs, the involvement of programs of lower socioeconomic groups—truly addressing the phenomena of equity and access is immensely complex. Still, this is fundamental to the endeavor laid forth by Alma Ata of democratizing healthcare and knowledge through CHWs and ICTs. Healthcare and information access for all runs up against a wall of still-massive illiteracy rates and entrenched cultural biases against minorities, females, and the poorest citizens. In some of the villages where we work in Nepal, for example, illiteracy rates among women exceed 75% and are several times higher than among those for men (9). In these settings, although ICTs have the potential to break down these socioeconomic barriers, they can also reinforce them if attention is not paid to who gains access. This is why developing sophisticated tools to evaluate programme impact on all sectors of society is so important.

Assessing how these outcomes are affected as programmes are brought to scale is critical (4). Any program needs to answer whether it can overcome political, logistical, and financial barriers to expansion on a national or international level. This is indeed the fundamental question underlying the potentials and pitfalls of ICTs: can they really assist in bringing to scale the huge promise of CHWs?

Conclusions

ICT will not save impoverished communities from the deficit of trained rural healthworkers, the lack of political will to build effective people-centered rural health systems, or entrenched discrimination with respect to gender, caste, or economic status. Still, effective expansion of these technologies among CHWs can help to expand access to effective health care among the rural poor. Such tools are not the panacea, but they must be part of any modern, comprehensive solution aimed at achieving the vision of Alma Ata.

Contributions and Conflicts of Interest

The co-authors work with Nyaya Health, a non-profit organization based in rural Nepal working on health infrastructure development. Part of this work involves training and equipping a network of community health workers. DSRM conceived the piece and wrote the first draft. All co-authors actively participated in the writing and research for the piece. The authors have no conflicts of interest to report.

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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.

Focussed 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.