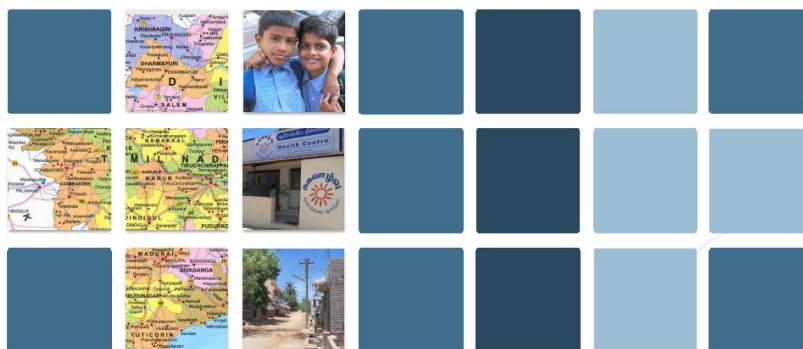**Cornell Institute for Public Affairs**
Professional Report

SUGHAVAZHVU HEALTH NETWORK
SUPPLY CHAIN AND EXPANSION PLANS

Prepared for the
IKP Centre for Technologies in Public Health (ICTPH)
In Chennai, India

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SUGHAVAZHVU HEALTH NETWORK SUPPLY CHAIN AND EXPANSION PLANS

ACKNOWLEDGEMENTS

This document presents a plan for today, not for the future. The objective is to encourage early action. It seeks to build a bridge between decisions made today and their implications in the future. In other words, it encourages acting today thinking on tomorrow.

The need to design the SughaVazhvu Health Network Supply Chain and Expansion Plans originated from an extensive literature review analyzing the feasibility and implications to implement health protocols for nurse practitioners. A continuous training program was necessary to maintain the quality of care and keep nurses updated. Nevertheless, the operational and infrastructure requirements to achieve this goal suggested a broader look: together with training, it was necessary to create a supervision and evaluation program to monitor health centers, and, in order to do so, standards for supply chain management and health technology management were necessary. Creating an effective supply chain was, in fact, a key area for the success of the Health Network. As a result, the focus of the project changed to address this critical challenge. The literature review that originated this report is included in *Appendix 2*.

The plan brings together all support services for medical attention to create a Health Network. Rather than specific instructions, it provides an overview of the network as a whole. The expectation is that specific proposals will be developed in the future, as explicit needs come to light. Each topic is divided into headings and subheading for quick reference, so that further works can use these plans as a guide to identify research areas.

Effort was made to make recommendations according to the current design of SughaVazhvu Health Care. The concept, current infrastructure and operation of the Rural Micro Health Centers are left unchanged. However, it is suggested to create a hub-and-spoke distribution system by incorporating intermediate infrastructure in the future. In other words, the idea is to create a second level of medical units that would operate as distribution hubs to sort and send pharmaceuticals and medical supplies to the Rural Micro Health Centers. The objective is to increase the network's efficiency.

The report was also informed by field visits to and Aravind Eye Care System and the Development of Humane Action (DHAN) Foundation. The field reports are attached in *Appendix 2* and *Appendix 3* respectively.

SUGHAVAZHVU HEALTH NETWORK SUPPLY CHAIN AND EXPANSION PLANS

EXECUTIVE SUMMARY

Reducing the rural/urban inequality of access to health services in India is an issue of great concern. Despite the rapid economic growth of the country in the last decade, more than 716 million people live in rural areas and represent 72% of the total population.[1] According to the World Health Organization, while 74% of births are attended by skilled health personnel in urban areas, only 38% are attended by skilled health personnel in urban areas.[2] Furthermore, the majority of deaths in rural areas are related to preventable diseases such as "infections and communicable, parasitic and respiratory diseases.[3]" Increasing access to healthcare of rural populations is fundamental to improve the health situation of the country.

IKP Centre for Technologies in Public Health (ICTPH) is supporting SughaVazhvu Health Care to establish a health network in rural Tamil Nadu. The proposal is to increase access to healthcare of rural populations through Rural Micro Health Centers (RMHC), or small clinics managed by a local nurse and supervised by physicians. The innovative model incorporates principles of the Primary Health Care model, such as an inherent focus on the community by employing health promoters.

Currently, ICTPH and SughaVazhvu Health Care are piloting and improving the health model in two Rural Micro Health Centers established in the district of Thanjavur. This document proposes a plan to guide the expansion of the current infrastructure including the organizational structure, supply chain and health technology management, supervision-mentoring and continuous training, and evaluation. It brings together epidemiological and operational aspects of health delivery system to create a Health Network. Recommendations are meant to be immediately relevant as well as inform plans for future expansion.

Objective

Provide guidelines for the expansion of SughaVazhvu Health Care towards the SughaVazhvu Health Network, including early actions and plans for future development.

SughaVazhvu Health Model

The SughaVazhvu Health Model follows the preventive and curative approach of primary healthcare. It is meant for rural communities where quality healthcare is not available or highly

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[1] Patil, V.K., K.V. Somasundaram and R.C. Goyal. (2002). Current Health Scenario in Rural India. Australian Journal of Rural Health. Vol. 10. Pp. 129–135

[2] World Health Organization, (2009). World Health Statistics 2009. WHO Press. France. P. 122.

[3] Patil, V.K., K.V. Somasundaram and R.C. Goyal. P. 130.

limited. Curative care and basic diagnosis services are provided by a nurse under a doctor's supervision and outreach activities are performed by health workers from the community.

Infrastructure

The SughaVazhvu Model functions with two infrastructure units that offer similar clinic outpatient care:

- **Rural Micro Health Center (RMHC):** Provides healthcare to a population between 6,000 and 10,000 people. It is staffed by a nurse and a health worker and is the meeting point for a team of outreach health workers.
- **Zone Health Center (ZHC):** Central facility easily accessible from RMHCs. Two doctors support around twelve RMHCs each through a remote connection.

Organizational Structure

The SughaVazhvu Network will be organized in four administration and operation levels. At the top, the central administration oversees the entire network. The second level is the region, where a Regional Team supervises two zones. The next level is the zone, in which one Zone Health Center monitors and supports twenty-four Rural Micro Health Centers (RMHC). At the operational level, in RMHCs, nurses lead the team of health workers.

Supply Chain

The supply chain is based on the Rural Micro Health Center (RMHC) because these are the foundation of the health model. It has the following objectives:

- Ensure timely availability of medicines, medical supplies, and other consumer supplies
- Guarantee safe delivery and storage of goods, particularly those requiring special handling
- Minimize waste, administration and delivery costs

To accomplish these objectives, it will be necessary to manage inventories, create distribution networks, establish purchasing methods, and generate performance monitoring and evaluation systems.

Health Technology Management

Healthcare Technology Management involves human and material resources, organizational structures, and logistics necessary to protect, maintain, update and make the best use of all the hardware. The benefits associated with these activities are:

- Protecting the investment in health technologies
- Service delivery without unexpected interruptions and with the expected results
- Longer equipment lifetimes, properly operated, maintained and stored
- Timely and reliable information available
- Lower maintenance costs by administrating resources efficiently

SughaVazhvu Health Centers will be operating in rural areas, so Health Technology Management is crucial because transportation costs will be high and finding skilled individuals for technical support, maintenance and repairs could become a challenge.

Supervision-Mentoring and Continuous Training

There are two concerns to guarantee quality of care: (1) ensure that the health personnel are doing what they are supposed to, and (2) make sure that they know how to do it. These points are particularly relevant when health personnel work mostly unaccompanied or with limited support from a medical doctor.

- **Supervision-Mentoring:** Based on providing support to improve performance, rather than inspecting and controlling. Supervisors become role-models for nurses.
- **Continuous Training:** Training sessions present an opportunity to deploy seasonal health actions, respond to disease outbreaks, instrument new activities and strengthen strategic areas.

Evaluation

The SughaVazhvu Network would require both internal and external evaluations. Internal evaluations would take place regularly, while external evaluations would be performed in a project basis. Information should be systematically acquired at specific intervals to create exploitable databases. In addition, international tools for program evaluation, such as the logical framework matrix, could be adopted.

Network Growth

Growth will have to be carefully planned to use resources effectively while maintaining quality and control until a fully operational network is reached. Three phases can be foreseen:

- **Phase 1:** The Central Administration performs all activities. The goal is to improve the operation of the RMHC, so data collection systems are put into practice, and protocols and guidelines are developed.
- **Phase 2:** Operations in RMHCs are standardized and economies of scale for supply management become realistic. A Zone Health Center comes to scene to store supplies, and host staff. The Central Administration can still supervise all RMHCs and network operations. The goal is to improve the supply chain, supervision and training plans.
- **Phase 3:** A Regional Team appears to oversee all centers. The goal is to improve the operation of the network, evaluate quality and performance.

After Phase 3 is completed, new Regional Teams will be required according to the number of new zones.

Modeling Supply Chain Expenses

To challenge the implementation advantages of a hub-and-spoke distribution system in the SughaVazhvu Health Network, a dynamic financial model was developed using MS Excel. The model contrasts expenses in a hub-and-spoke model, where supplies are delivered to Zone Health Centers and then distributed to Rural Micro Health Centers, with a model with no hub-and-spoke, in which supplies are directly distributed to Rural Micro Health Centers.

Model Assumptions

The model requires the validation of four groups of assumptions: human resources, equipment, inventories and medical waste, and ratios. The initial three groups are expected to include the main drivers of expenses in the supply chain. For instance, the price of fuel is one of the main assumptions in the model. The fourth group establishes the relationship between Zone Health Centers and Rural Micro Health Centers.

Model Inputs

The model requires six input parameters: the current infrastructure (Regional Teams, Zone Health Centers and Rural Micro Health Centers), the rate of growth of the infrastructure per year, the number of times that RMHCs would be resupplied, and number of suppliers.

Theoretical Example

To illustrate the potential of the model, we analyze the impact of increasing the number of times a Rural Micro Health Center is supplied every year and the effect of increasing fuel prices in the supply chain expenses.

Changing the Supply Interval

Scenarios with three different supply intervals were modeled: one in which RMHCs are supplied once every month, another in which they are supplied every two months, and lastly where they are supplied every three months. As shown in *Table 4*, given the assumptions used in the model, the most cost-effective interval to resupply RMHCs is every two months.

Table 4: Comparison of Expenses with Different Supply Intervals

		Year				
Total Expenses Hub-and-Spoke:		1	2	3	4	5
Supply interval:	One month	$ 426,939.48	$ 482,627.78	$ 562,248.13	$ 790,264.18	$ 885,697.69
	Two months	$ 387,477.38	$ 436,051.72	$ 507,456.26	$ 740,661.72	$ 825,745.23
	Three months	$ 431,740.86	$ 489,075.91	$ 580,200.71	$ 843,321.91	$ 949,043.71
Total Expenses No Hub-and-Spoke:		1	2	3	4	5
Supply interval:	One month	$ 956,569.98	$ 1,111,915.07	$ 1,402,645.90	$ 1,598,387.58	$ 1,938,652.92
	Two months	$ 598,553.79	$ 740,745.53	$ 937,950.95	$ 1,102,198.59	$ 1,361,469.06
	Three months	$ 554,841.64	$ 692,535.68	$ 880,237.40	$ 1,061,891.18	$ 1,331,841.38

* All values calculated using a supply chain financial model in MS Excel.

When comparing the hub-and-spoke system with a system with no hub-and-spoke, it is interesting to note that as the supply interval increases, the system with no hub-and-spoke becomes less expensive.

Forecasting Different Fuel Price

To evaluate the impact of different fuel prices in the supply chain, a scenario with gas prices of 35 rupees per liter was contrasted with a scenario of 60 rupees per liter. These scenarios were combined with supply intervals of once a month and twice a month. As expected, the increment in the fuel price increases the cost of delivering goods to RMHCs (see *Table 5*). Then again, it is important to highlight that the system with no hub-and-spoke is affected by the increase in fuel prices by a greater magnitude. Since each supplier has to visit each RMHC independently, more fuel is necessary in an aggregated level.

Table 5: Comparison of Expenses with Different Fuel Prices

				Year		
Total Expenses Hub-and-Spoke:			1	2	3	4
Supply interval:	One month	Gas Price: 35 rupees	$ 426,939.48	$ 482,627.78	$ 562,248.13	$ 790,264.18
	One month	60 rupees	$ 460,689.75	$ 523,494.25	$ 611,723.71	$ 849,956.06
	Two months	35 rupees	$ 407,969.69	$ 460,862.00	$ 538,234.09	$ 778,689.91
	Two months	60 rupees	$ 440,369.69	$ 500,012.00	$ 585,484.09	$ 835,389.91
Total Expenses No Hub-and-Spoke:			1	2	3	4
Supply interval:	One month	Gas Price: 35 rupees	$ 956,569.98	$ 1,111,915.07	$ 1,402,645.90	$ 1,598,387.58
	One month	60 rupees	$ 985,631.39	$ 1,147,030.94	$ 1,445,027.13	$ 1,649,245.06
	Two months	35 rupees	$ 623,358.34	$ 770,717.70	$ 974,124.26	$ 1,145,606.56
	Two months	60 rupees	$ 639,558.34	$ 790,292.70	$ 997,749.26	$ 1,173,956.56

* All values calculated using a supply chain financial model in MS Excel.

Limitations of the Model

Even when the model is a useful tool to evaluate how each parameter affects the supply chain, it is not exempt from limitations. The model does not intend to provide precise estimates for each parameter, but rather show the main cost drivers in the supply chain as well as to provide general guidance for critical parameters. The strength of the estimation is highly dependent on the validity of the Assumptions, so it is advised to use more precise methods in further stages.

Recommendations

- *Organizational Structure*
  - o Develop a human resources strategy that considers all support services, so that a few individuals can perform multiple tasks
- *Supply Chain*
  - o Assess the adequacy of a hub-and-spoke supply chain distribution system.
  - o Consider storage space requirements and supply chain logistics when building new infrastructure and purchasing new equipment
  - o Develop and implement inventory management tools and guidelines with special focus on cold chain requirements, expiry dates, and restocking
  - o Implement bio-medical waste management procedures and incorporate collection to the supply chain
  - o Create plans to respond to special circumstances, such as increased demand of supplies in specific health centers, seasonal epidemics, and emergencies
  - o Develop procedures to receive payments, store and deposit cash, and keep track of all transactions
  - o Establish the responsibilities and interactions of the different levels of the organization (central, regional, zone, and operation)
- *Health Technology Management*
  - o Incorporate long term impact when selecting health technology management solutions, such as human resource requirements (availability, skill level, and reliance) and technology's relative significance for medical attention
  - o Establish an organizational system that addresses the needs for operation, support and planning of health technology
  - o Develop a maintenance program to provide regular service and keep track of equipment, and to monitor contractual agreements with manufacturers

- *Supervision-Mentoring and Continuous Training*
  - Establish a supervision-mentoring program to constantly monitor and improve the quality of care in health centers, considering comprehensive reviews as well as the frequency and duration of the visits
  - Implement a continuous training program to improve the educational level of the personnel, create team spirit and evaluate past performance
- *Evaluation*
  - Create systems to record and store health and performance information at specific intervals, in particular data related to international indicators
  - Prepare program evaluation tools to monitor and improve the performance of the network, and to publicize its progress
- *Network Growth*
  - Anticipate the growth of the network to determine procedures to transfer responsibilities, build new infrastructure and hire human resources

Conclusion

The creation of a Health Network can generate several benefits, including improved healthcare quality, lower costs and more efficient operation. Nevertheless, containing costs and logistics will be a big challenge. Careful planning will be critical for the success of the Network, not only for healthcare delivery, but also for all the associated support services.

SUGHAVAZHVU HEALTH NETWORK SUPPLY CHAIN AND EXPANSION PLANS

OVERVIEW

Reducing the rural/urban inequality of access to health services in India is an issue of great concern. Despite the rapid economic growth of the country in the last decade, more than 716 million people live in rural areas and represent 72% of the total population.[4] According to the World Health Organization, while 74% of births are attended by skilled health personnel in urban areas, only 38% are attended by skilled health personnel in urban areas.[5] The inequality is also observed in the coverage of vaccination campaigns. Measles immunization coverage among 1-year-olds (%) reached 72% of the urban populations against 54% of the rural populations.[6] Furthermore, the majority of deaths in rural areas are related to preventable diseases such as "infections and communicable, parasitic and respiratory diseases.[7]" Increasing access to healthcare of rural populations is fundamental to improve the health situation of the country.

Addressing this issue is not a simple task. Three quarters of the current public health infrastructure are located in urban areas,[8] and the private sector only recently began reaching out to the rural sector. Yet, the lack of adequate infrastructure is just part of the problem. There are also other obstacles such as communication and language barriers, high penetration of spurious drugs, and lack of access to skilled workers, including both medical and non-medical personnel.[9]

One of the major challenges is to create an effective and efficient supply chain. Healthcare providers need to make sure that drugs and other supplies reach customers without compromising their quality. Since manufacturers in India "do not retain control over the multi layered distribution system, the cold-chain management process continues to be difficult and expensive.[10]" The supply chain is fragmented with more than 550,000 retail pharmacies in the country. Even

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[4] Patil, V.K., K.V. Somasundaram and R.C. Goyal. (2002). Current Health Scenario in Rural India. Australian Journal of Rural Health. Vol. 10. Pp. 129–135

[5] World Health Organization, (2009). World Health Statistics 2009. WHO Press. France. P. 122.

[6] Ibid, P. 123.

[7] Patil, V.K., K.V. Somasundaram and R.C. Goyal. P. 130.

[8] Price Waterhouse Coopers. (April 2010). Global pharma looks to India: Prospects for growth. Pharmaceuticals and Life Sciences. P. 7.

[9] Ibid, P. 14.

[10] Kelkar, A. and E. Langer. (October 2008). Pharmaceutical Distribution in India: Drug Manufacturers struggling to improve fragmented network. Biopharm International. P. 5.

when the number of distributors and retail pharmacies is increasing, the distribution is not efficient.[11]

In this context, IKP Centre for Technologies in Public Health (ICTPH) is supporting SughaVazhvu Health Care to establish a health network in rural Tamil Nadu. The proposal is to increase access to healthcare of rural populations through Rural Micro Health Centers (RMHC), or small clinics managed by a local nurse and supervised by physicians. The innovative model incorporates principles of the Primary Health Care model, such as an inherent focus on the community by employing health promoters.

Currently, ICTPH and SughaVazhvu Health Care are piloting and improving the health model in two Rural Micro Health Centers established in the district of Thanjavur. This document proposes plans to guide the expansion of the current infrastructure including the organizational structure, supply chain and health technology management, supervision-mentoring and continuous training, and evaluation. It brings together epidemiological and operational aspects of health delivery to create Health Network. Recommendations are meant to be immediately relevant as well as inform plans for future expansion.

OBJECTIVE

Provide guidelines for the expansion of SughaVazhvu Health Care towards the SughaVazhvu Health Network, including early actions and plans for future development.

SUGHAVAZHVU HEALTH MODEL

The SughaVazhvu Health Model follows the preventive and curative approach of primary healthcare. It has been envisaged to operate in rural communities where quality healthcare is not available or highly limited, and where low-complexity interventions can have substantial effects on the well-being of the population. Curative care and basic diagnosis services are provided by a nurse in the health center under the supervision of a doctor, who remotely monitors consultation sessions. The nurse is part of the community and speaks the local language. In addition, the RMHC works as an outreach post for preventive interventions through a team of health workers. Each health worker visits and monitors around 1,000 households, screens for health risks and provides health counseling. Doctors are able to monitor a greater number of patients while living in communities with better services and infrastructure.

INFRASTRUCTURE

The SughaVazhvu Model operates in two unique infrastructure units that offer similar clinic outpatient care. The medical unit close to rural communities where nurses provide health services

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[11] Prabhu, S. (January 2011). Pharma distribution in India. Famantra Newsletter. Barcelona, Spain.

is the Rural Micro Health Center (RMHC), and the unit where doctors are stationed is the Zone Health Center (ZHC).

RURAL MICRO HEALTH CENTER (RMHC)

The Rural Micro Health Center (RMHC) provides healthcare to a population between 6,000 and 10,000 people. It is staffed by a nurse and a health worker, and serves as the reunion point for the team of outreach health workers. The facility has two rooms of around five squared meters each: a waiting room and a consultation room. The space is enough for a fridge, the nurse's desk, a computer with electronic health records, a treatment table, a medicine rack, a sink, and other equipment. The pharmacy has about 35 medicines to treat low complexity health problems.

ZONE HEALTH CENTER (ZHC)

The Zone Health Center (ZHC) is a facility in a location easily accessible from RMHCs. In them, doctors connect remotely to the RMHCs and provide care to about 150,000 people. The Centers have two consultation rooms in which a doctor oversees the performance of 12 RMHCs, so each ZHC is connected to about 24 RMHCs. There is a waiting area where the doctors are able to receive walk-in patients, a pharmacy, and a clinical laboratory. Additionally, each ZHC has a warehouse to store supplies for itself and for its 24 RMHCs, a bio-medical waste collection room, and a multipurpose room with enough space to accommodate 30 people.

ORGANIZATIONAL STRUCTURE

The SughaVazhvu Network will be organized in four administration levels. At the topmost, is the central administration in charge of dictating strategies and policies, centralized purchasing, updating software and communication materials, and the overall management of the network. The next level is the region, conducted by the Regional Team, in charge of the operation and supervision of two zones —each with one Zone Health Center and twenty-four Rural Micro Health Centers (RMHCs). At the zone level, every Zone Health Center has two doctors that monitor and support twelve RMHCs each. In every RMHC, the nurse leads the team of health workers in conducting outreach.

The head of the Regional Team is the Clinical and Outreach Supervisor, a professional doctor with public health knowledge. He is supported by two technicians, one for Bio-Medical Technology and one for Information Technology, a Supply Chain Manager and a Multipurpose Driver. The Zone Health Center is directed by one of the two doctors, or the Head Zone Doctor, and advised by his colleague, or the Advisor Health Doctor. They are supported by a Pharmacist, who runs the pharmacy and warehouse, a Laboratory Technician, and an Administrative Assistant. In Rural Micro Health Units, nurses follow doctors' instructions and share them with health workers (see *figure 1*).

Figure 1: SughaVazhvu Organizational Structure

Legend:
- Regional Team
- Zone eHalth Center
- Rural Micro Health Center
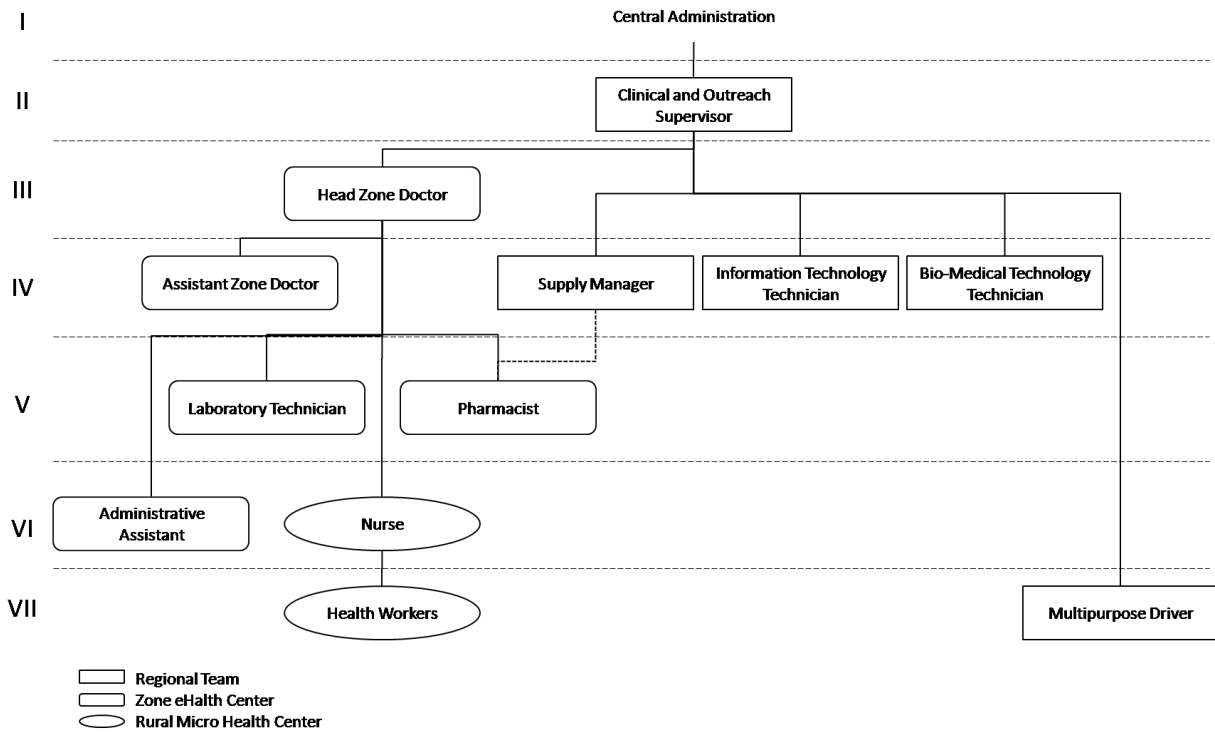
SUPPLY CHAIN

A crucial component for the integration of the SughaVazhvu Health Network is a dependable supply chain. A strong supply chain creates an efficient network to connect the point of purchase to the point of usage in the health center. It makes sure that enough resources are available when they become necessary, while at the same time minimizing waste and transportation costs. Once the number of SughaVazhvu Health Centers increases, creating an efficient supply chain will gain relevance to manage operations effectively and use resources efficiently. However, many of the critical links have to be built into the system in the initial development stages because incorporating them in a later will become both costly and complex. An early implementation opens ground for testing, staff training and improvements, without compromising expensive resources.

The base of the supply chain is the Rural Micro Health Center (RMHC), as it is the foundation of the SughaVazhvu Health Model. RMHCs are envisioned as highly efficient delivery units, so their storage capacity is based on their daily operations. The quality of the service will depend on the availability of medicines and medical consumables. A RMHC with no supplies is an obsolete health center, especially for rural conditions where there might not be another place to acquire them. Nevertheless, storage limitations do not leave ground for overstocking, and, even if feasible, it increases the risk of waste due to expired medicines and the operation costs of the centers. Besides, as RMHCs will operate with small profit margins, transportation has to be very efficient to keep running costs down, without disregarding special handling that some supplies, such as vaccines, may require. In this context, the supply chain will accomplish three objectives:

- Ensure timely availability of medicines, medical supplies, and other consumer supplies
- Guarantee safe delivery and storage of goods, particularly those requiring special handling
- Minimize waste, administration and delivery costs

In order to achieve these objectives, it will be necessary to manage inventories, create distribution networks, establish purchasing methods, and generate performance monitoring and evaluation systems.

If pharmaceutical companies are able to distribute medical supplies to RMHCs in a regular basis, the need for an internally managed supply chain may decrease. This may not happen, however, unless the distribution system is already operating for other medical centers and pharmacies near RMHCs; which is unlikely considering that a large proportion of the rural population does not have access to medicines.[12] The demand generated by the RMHC may not be enough to justify opening new delivery routes, especially to remote areas. Another concern would be the reliability of the external supply chain. Pharmaceutical distribution at present depends on different levels of stockists, sub-stockists, and forwarding agents that could delay supply and encourage overstocking. Furthermore, the quality of the products could be compromised if the intermediary is not aware of temperature control requirements of biological supplies.[13] Finally, a supply chain for other equipment and materials, such as health promotion materials for health workers, would still be required.

Considering these points, this document proposes the creation of an internal supply chain. The expectation is that some of the costs of logistics could be offset by obtaining medical supplies at lower prices, something that could be achieved by negotiating directly with manufacturing companies.[14] The objective is to create economies of scale by clustering RMHCs and employing a hub-and-spoke distribution system.

RURAL MICRO HEALTH CENTER INVENTORY MANAGEMENT

The Rural Micro Health Center is the most important link in the supply chain, as it is the closest point to the client where results become visible. At the RMHC it is not only necessary to know the amount of medicines available, but also to establish storage procedures to keep supplies suitable and ordering procedures to maintain the flow of resources. Inventory management procedures are used to control inventory levels to reduce costs while maintaining quality levels required by clients. It depends on forecasting the expected demand of medical supplies and the prices of products.[15]

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[12] Langer, E and A Kelkar. (2008, September). Pharmaceutical Distribution in India. India Today. *BioPharm International.* 4.

[13] Idem.

[14] Idem.

[15] Hugos, M. H. (2003). *Essentials of supply chain management.* Hoboken, N.J: John Wiley & Sons. 58.

   The first step begins with storage at the RMHC. It is necessary to develop storage guides so that medical supplies are adequately kept. According to guidelines created by the World Health Organization (WHO)[16], medicines should be stored according to their route of administration and form of preparation. Classification groups are: externals, internals, and injectables; shelving tablets with capsules, and liquids with ointments. Some substances, such as narcotics, may require special storage in locked cabinets, depending on national regulations. To decrease the risk of spoilage due to leaks, supplies should be stored in shelves as shown in *table 1*, and never on the floor. Each medication should be stored in alphabetical order according to the chemical name of the substance with the shelf properly labeled.

Table 1: Storing Medical Supplies in Shelves

Top Shelves	Store dry medicines (tablets, capsules, oral rehydration packets). Use airtight containers.
	If top shelf is near the ceiling or out of your reach , use that shelf to store items that are NOT sensitive to heat and are NOT used regularly.
Middle Shelves	Store liquids, including injectables and ointments.
	Do NOT put dry medicines below them. If liquids leak, medicines may spoil.
Bottom Shelves	Store other supplies, such as surgical items, laboratory supplies, condoms and labels.
	Remember, do NOT store anything directly on the floor.

Source: World Health Organization (WHO). (2006*). Handbook of Supply Management at First-Level Health Care Facilities.* 1st version for country adaptation. WHO/HIV/2006.03. 8.

   Supplies with expiry dates should be arranged according to the "First Expiry First Out" method. Items should be arranged so that those which expire first are at the front, and those that expire later at the back. For items without expiry dates, the "First In First Out" method should be used, placing newer products at the back and older products at the front.[17] When an item is used at the health center, front items will be used first. Therefore, these methods promote that inventories remaining in the health center have the longest expiry dates possible; which, in turn, decreases waste due to expired medicines and helps make sure patients receive quality supplies.

   It is important to standardize the way in which supplies are stored. If the same procedure is followed in all centers, all the personnel, independently of their RMHC will be able to find any supplies; a significant issue if, for example, the staff has to be temporally substituted.   Then again, standardized storages will ease the supervision visits to RMHCs and it will be possible to evaluate and improve storage procedures.

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[16] World Health Organization (WHO). (2006*). Handbook of Supply Management at First-Level Health Care Facilities*. 1st version for country adaptation. WHO/HIV/2006.03. 8.

[17] Idem, 9-10.

INVENTORIES.

The second step is to keep track of inventories by creating stock cards. Stock cards are paper or electronic records that track important information about each item in the inventory. On the one hand, they are a quick guide for quantities and expiry dates, and, on the other hand, they help control inventories by tracking movements and people responsible. The basic information that stock cards should contain is listed below[18]:

- Top of the card:
  - Health Center Name and Address;
  - Item, product name with strength and form;
  - Code number, if there is a number to identify the product;
  - Unit and size, container type (bottle, tube, blister) and amount of item in container;
  - Price, cost per unit;
  - Reorder level, minimum units required before placing a new order.
- In columns:
  - Date, when item was received or removed from storage;
  - Received From, supplier name;
  - Quantity Received, number of units received at storage;
  - Issued to, destination of the supplies from storage;
  - Quantity used, number of units removed from storage;
  - Balance in Stock, quantity remaining in storage;
  - Remarks, information about movements of the item, expiry dates, and other;
  - Signature, initials of person recording the movement of the item.

If medical supplies come in different forms (tablet, liquid or ointment), strengths (substance contents per unit) or packaging (number of pills per container), a different card should be used for every item.

If pills or tablets are placed separately in a medicine rack, it is necessary to keep track of the movement in the stock card. The expiry dates of these units should be recorded in the medicine rack. It is very important not to mix units with different expiry dates. All pills or tablets should be finished before new pills or tablets are placed. Even when it may be practical to use a medicine rack, it is important to consider that once medicines are separated from the original packing, they may lose market value and it may not be possible to return them to the supplier.

A fundamental process when tracking inventories is the reception of goods. A reception procedure has to be established to make sure someone takes responsibility for the delivery and receipt, as well as to review the quality of the supplies being stored. It is necessary to check that the items in the requisition form correspond to the items received, and that all boxes and packages are in good condition. For instance, clear liquids should have no particles that reflect light, tablets should not be broken or powdery, and items requiring refrigeration should be in adequate containers (to keep them cold with cold packs or climate controls). The reception procedure

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[18] Idem, 14-15.

should also ensure that supplies with special handling requirements, such as temperature control, are stored first.[19]

The next step is to forecast inventories to keep supply levels. The simpler method is to estimate inventory levels based on monthly consumption of previous years. This number is obtained by adding the number of units issued every month from stock cards, and divide them between the total number of months. Then, for small health facilities, a basic procedure is to multiply the average consumption by a reorder factor to calculate the reorder level. The reorder factor is a multiplier used to calculate the level of inventories required for the following month plus a safety stock depending on the frequency of deliveries per month[20] (see *table 2*). The reorder level is the minimum level of inventories after which an order has to be placed. As data becomes available and the need for more efficient operations increases, more complex methods to forecast inventory levels could be implemented. The objective is to forecast the number of units per delivery that minimized the order costs and transportation costs associated with each order. For instance, if inventories are inexpensive and gas prices highly variable, it may be desirable to increase inventories to reduce the number of distribution visits.

Table 2: Recommended Reorder Factors

Delivery Frequency	Supply Interval (months) x 2	Reorder Factor
Once a month	1 x 2 = 2	2
Every 3 Months	3 x 2 = 6	6
Every 6 months	6 x 2 = 12	12

Adapted from: World Health Organization (WHO). (2006). *Handbook of Supply Management at First-Level Health Care Facilities.* 1st version for country adaptation. WHO/HIV/2006.03. 23.

BIO-MEDICAL WASTE.

Together with these measures it is important to establish procedures to manage bio-medical waste. Bio-medical waste is defined as "any waste, which is generated during the diagnosis, treatment or immunization of human beings...[21]" It is part of the supply chain because any waste that cannot be treated in the RMHC itself will have to be transported for proper disposal. Each RMHC should be equipped with containers with proper color coding according to their contents: yellow for human anatomical waste (requiring deep burial or incineration); red for microbiology and biotechnology waste, soiled waste and solid waste (requiring chemical treatment, autoclaving, and micro waving); blue or white translucent for waste sharps and solid waste (requiring autoclaving, micro waving and mutilation); and, black for discarded medicines and cytotoxic

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[19] Idem, 45-49.

[20] Idem, 21-24.

[21] Environment Protection Training and Research Institute (EPTRI). (2009?). Bio-Medical Waste Management Self-Learning Document for Doctors, Medical Superintendents and Administrators. Supported by the World Health Organization (WHO), India Country Office, New Delhi. Gachibowli, Hyderabad, Andhra Pradesh. 3.

drugs, incineration ash and chemical waste (destruction and disposal in secured landfills). [22] Containers should be accordingly marked and the staff properly trained to handle waste. National regulations dictate that all waste should be stored inside the RMHC, and has to be tracked and reported for facilities treating more than 1,000 patients a month. Collection and transportation is a particular challenge, as bio-medical waste can only be transported in authorized vehicles.[23]

RESPONSE TO SPECIAL CIRCUMSTANCES.

For extraordinary situations, such as disease outbreaks, where an atypical increase in demand of supplies is observed, special plans could be created. Special order procedures could be setup to replenish RMHCs with increased frequency. Furthermore, RMHCs could communicate between each other to share supplies, which could also help manage outliers in the system.

RECEIVING PAYMENTS.

The final step, although not directly linked with inventories, is to establish procedures to receive payments in RMHCs (if required). Managing payments, and particularly cash, adequately is fundamental for the performance of the organization, as well as to guarantee the safety of personnel and assets. Other than the normal control mechanisms, such as keeping track for every transaction, the biggest challenge would be to handle cash. Due to distance and time constrains, it may not be possible to make bank deposits every day, so it will be necessary to establish methods to store money properly. A convenient solution could be to reach an agreement with Pudhuaaru Financial Services Private Limited (PFS) to deposit cash in their centers. However, if this is not possible, other solutions should be considered so that only change funds are available in RMHC for the day-to-day operation, while the rest is kept safely and transported properly.

ZONE HEALTH CENTER INVENTORY MANAGEMENT

The Zone Health Center (ZHC) is a distribution hub of medical supplies for twenty-four Rural Micro Health Centers (RMHC) and also supplies itself. It is expected that this added demand for supplies, together with storage of inventories for a longer period, will create an economy of scale. Therefore, pharmaceutical manufacturers and suppliers will be encouraged to provide lower prices and deliver goods directly to ZHC.

STORAGE.

The storage space required in the ZHC will depend on the amount of inventories and frequency of replenishments. It is expected that orders for medical supplies would be placed every 3 to 12 months. This may depend on expiry dates and cost of medicines, as well as on the costs of ordering and reliability of suppliers. Higher lot sizes would signify purchase discounts and lower administration and handling costs,[24] and higher control over inventories; although it will also imply less liquidity of the organization and higher risk related to inventories.

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[22] Idem, 10-11.

[23] Idem, 78.

[24] Franzelle, E. (2002). *Supply chain strategy: The logistics of supply chain management*. New York: McGraw-Hill. 94.

Additional measures are required to store and manage inventories in ZHCs, because of the number of supplies handled. It is necessary to create stock cards, track movements and to develop storage procedures. However, large quantities of goods will be received from one or more external suppliers, so these will have to be evaluated by careful sampling. And, supply requests from RMHCs will have to be filled and packed internally, which generates an important logistical challenge. In addition, deficient management of the "First Expiry First Out" method will signify increased costs. There will also be a higher risk of vermin and harmful humidity, so stricter storage measures should be followed. Therefore, it is necessary to develop a warehouse manual that describes effective procedures to fulfill these tasks.

HUMAN RESOURCES.

The added human resources required to manage the warehouse will be covered by the pharmacist. The pharmacist will manage the warehouse and operate the pharmacy in order to offset the costs of additional personnel. These pharmacies could be stocked with an increased number of medicines to fill outside prescriptions. As a special service, pharmacies could even be prepared to handle requests from residents near RMHCs, which could be filled through the normal distribution chain. The pharmacist will be trained to pack supplies according to their handling needs, and prepare cold packs for items requiring climate control.

The pharmacist will also keep track of waste going into and out from the bio-medical waste storage room. Simple records with information about number of bags, procedure, arrival date and departure date, together with any other information required by law, will have to be generated. It is her responsibility to keep the room secure and to clean and disinfect it after every collection.

REGIONAL TEAM SUPPLY CHAIN SUPPORT

The Regional Team is in charge of supervising the supply chain, distribution of goods and collecting waste, as well as monitoring purchase orders and inventories. Each Regional Team is responsible for two Zone Health Centers and their respective Rural Micro Health Centers —or a total of around 48 RMHCs.

For this task, the Regional Team has one vehicle that is also used to transport and distribute supplies. The Regional Team performs a visual inspection to review adherence with storage guidelines, "Fist Expiry First Out" and "First In First Out" methods, humidity and cleanliness. Then, an in-depth revision is performed to a sample of supplies to check stock cards, inventories versus prescriptions, expiry dates and waste. The Regional Team suggests corrective measures to resolve any issues detected. Findings are reported every trimester to the Central Administration.

CENTRAL ADMINISTRATION SUPPLY CHAIN MANAGEMENT

The Central Administration is responsible for the Central Purchasing System. Most supplies are purchased from manufacturers or intermediaries in pre-arranged contracts to ensure year supplies. The role of the Central Administration is to make sure that the supply chain is working efficiently at the lowest costs possible. Therefore, it periodically supervises Zone Health Centers

and Rural Micro Health Centers in the entire network, and makes sure that Regional Teams are performing their duties as expected. The Central Administration monitors performance indicators such as medicine waste, delivery costs, and others.

PROCUREMENT, DISTRIBUTION AND COLLECTION SYSTEM

The Procurement, Distribution and Collection System describes how Rural Micro Health Centers, Zone Health Centers, Regional Teams and the Central Administration work together to create the SughaVazhvu Supply Chain. Different supplies will have to be distributed along the chain, each one with particular transportation requirements. Some of the expected supplies will be:

- Medical Equipment: such as autoclaves and glucose meters, which could be heavy, large and fragile
- Medical Consumables: medications, vaccines, cotton, and others, which are usually fragile, may require temperature controls and protection against humidity, heat and direct sunlight
- Bio-Medical Waste: including used syringes, expired medications, used cottons, and others, requiring transportation according to national regulations
- Outreach Health-Educational Materials: posters, leaflets, charts and models, especially vulnerable to humidity and water leaks
- IT Equipment: computers, printers, modems, electric backups, which are heavy, large, fragile, and cannot be exposed to heat and direct sunlight
- Money: cash received in health centers, unsafe to carry large quantities
- Other supplies: cleaning materials, office supplies, and others, which may not require especial handling

Considering the range of different supplies, the distribution of goods is an important challenge. Vehicles require a covered cargo box with capacity to carry large medical equipment, such as autoclaves, but should also be light enough to maneuver easily in rural areas and have high fuel efficiency. A temperature controlled cargo box may not be necessary if cold chain supplies are properly stored with cold packs; nevertheless, ventilation or insulation could be necessary.

The system is expected to generate savings by creating economies of scale and by lowering purchase, administration and transportation costs. This is achieved by a Central Purchase of inventories one to three times a year that is sent directly from producers or intermediaries to the ZHCs. Supplies are stored in ZHCs for periods between 3 to 12 months, and sent in small quantities to RMHCs as they are demanded. RMHCs store 1 month worth of supplies plus a safety inventory, and request ZHCs for restocking once a month (see *figure 2*).

Figure 2: Supply Chain Inventory Management
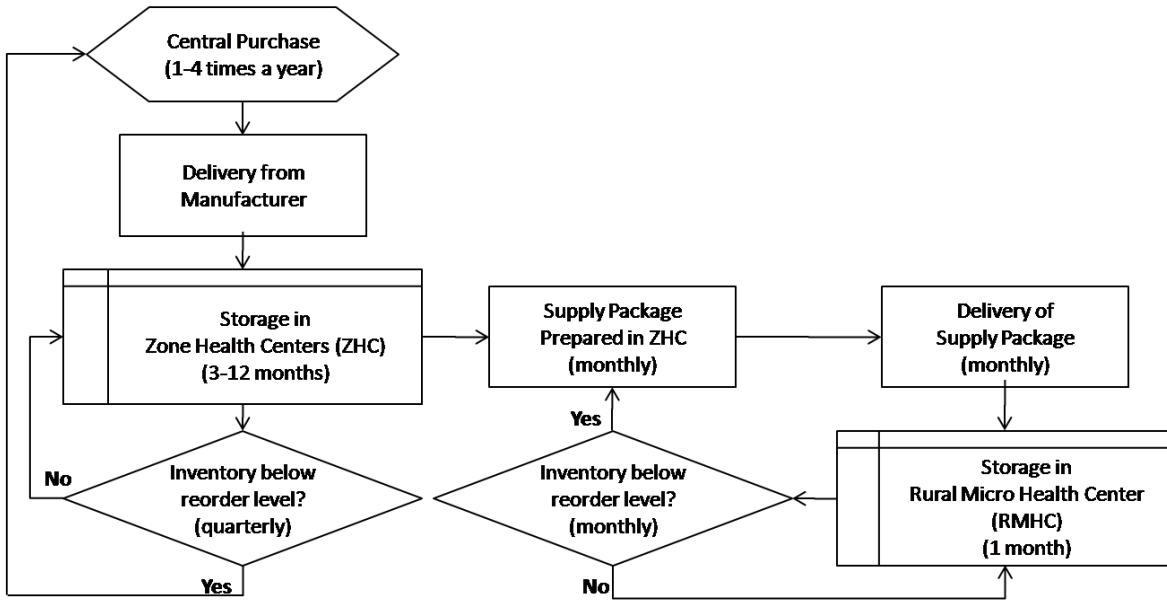
Similarly, the distribution routes are expected to work as waste collection and supervision routes. As supplies are delivered to one RMHC, its bio-medical waste is collected and the Regional Team is left for supervision. The vehicle continues its way delivering supplies and collecting waste. After distributing all supplies carried, the Regional Team goes back to the Zone Health Center to deliver the waste. Bio-medical waste is stored in Zone Health Centers until it is collected by a contractor (see *figure 3*). The supply route varies so that the Regional Team is able to supervise all health centers. By using the same vehicle to perform all these tasks, vehicle maintenance and transport costs are minimized.

Figure 3: Supply Chain Logistics
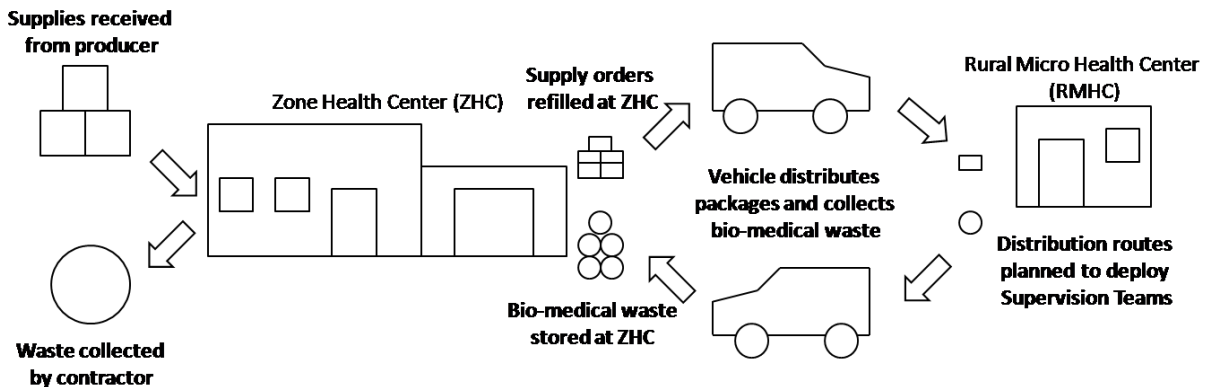
For the purposes of this document, health technology is defined as all physical pieces of hardware that need to be maintained in health centers.[25] The definition is not exclusive to equipment directly linked to healthcare, such as computers, diagnosis units, fridges and autoclaves, but also extensive to furniture, buildings, vehicles, and energy sources. Therefore, Healthcare Technology Management involves all the human and material resources, organizational structures, and logistics necessary to protect, maintain, update and make the best use of all the hardware.

Different activities performed systematically are essential for successful management of health technologies. For instance, it is necessary to: gather information about equipment, including model, age, and condition; plan technological needs as well as funding required for installation and training; monitor how resources are used and guarantee their safe and effective operation; and, disposal and replacement of old equipment. Even when these activities seem costly, there are many associated benefits[26] that give good reason for Health Technology Management:

- Protecting the investment in health technologies
- Service delivery without unexpected interruptions and with the expected results
- Longer equipment lifetimes, with proper operation, maintenance and storage
- Timely and reliable information available
- Lower maintenance costs by administrating resources efficiently

The relevance of Health Technology Management becomes apparent as the size of the healthcare system increases, because small problems can generate high costs. Replacing a computer might not be problematic for a single health center, but numbers add up as the number of health centers increase. SughaVazhvu Health Centers will be mainly operating in rural areas, so Health Technology Management is crucial as transportation costs will be higher and finding skilled individuals for technical support, maintenance and repairs could become an important challenge.

PROVIDERS OF HEALTH TECHNOLOGY MANAGEMENT ACTIVITIES

Health Technology Management activities are provided in different ways depending on the organization. For the private sector, these tasks are usually performed by inside staff hired as part of the organization, by companies contracted to provide specific services, by temporally contracted individuals, or by a combination of providers.[27] When the possibility is available, sharing resources with other organizations is also viable. The decision depends on factors like cost, expertise level, staff availability, equipment guarantees, and others. For example, repairing an

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[25] Lenel, A; C Temple-Birth; W Kawohl; and M Kaur. (2005). *How to Organize Maintenance of your Healthcare Technology.* How to Manage Series for Healthcare Technology, Guide 5. Retrieved on July 2010 from http://www.who.int/management/resources/equipment/en/index1.html 2.

[26] Idem, 4.

[27] Idem, 57-62.

autoclave may require repairs directly from the manufacturer, while painting a wall could be performed by an unskilled worker commissioned locally to do so.

In the SughaVazhvu Health Network, according to the human resource and skill requirements, it is possible to organize areas of support for health technologies into three categories:

- *Information Technology:* This equipment is critical in the SughaVazhvu Health Network, because the model of attention is strongly dependant on computer networks. It requires maintenance and technical support by skilled personnel, although they do not require product-specific knowledge[28] and components may be standardized. Nevertheless, it may be difficult or expensive to find these skills in rural areas, and reliable staff is essential. Considering its significance, contracting permanent IT staff is highly recommended, even if major overhauls are performed externally. They could respond fast to unexpected situations and provide specific technical support.

- *Diagnosis Services and Medical Equipment:* Even when these resources are important for the operation of the clinic, the delivery of most services can continue if an instrument is missing or breaks down. Maintenance requires skilled personnel with specific knowledge about the equipment, as most components are not standardized and spare parts are product-specific. For equipment in this category, it may be better to have a good contractual arrangement with the manufacturer or distributor that includes maintenance and replacements, as well as basic training of internal staff. Although some in-house staff would be an asset, their main task would probably be to evaluate the condition of existing equipment. A long term commitment with the same products is recommended so that both, personnel in the field and support staff, become familiar with its operation and repairs.

- *Facilities, Furniture and Power Backup:* Minor problems with these technologies should not compromise the operation of the Health Center. Although some repairs require skilled personnel, most pieces of equipment in this category are widely used in other industries or for domestic purposes. Local workers could be employed as per task basis, depending on the skill level required and availability. Even so, for administration purposes, temporal contracts could be complex and unreliable, so inside staff could be more cost-effective. In addition, staff performing other activities, such as driving, could perform or oversee these tasks.

If the Health Network is large enough, a workshop may be necessary to make repairs, store equipment, tools and spare parts.

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[28] Product-specific knowledge: This means skills required do not require special training from the manufacturer, as most parts and repairs are common for all or most elements. For example, a computer technician will be able to repair computers regardless on their brand.

ORGANIZATIONAL STRUCTURE FOR HEALTH TECHNOLOGY MANAGEMENT

The SughaVazhvu Health Network requires three levels for Health Technology Management: operation, support, and planning. While the operation is the responsibility of the staff in Zone Health Centers and Rural Micro Health Centers, support and planning require additional human resources. These responsibilities lay in the Regional Team and the Central Administration, something important to ensure that a technical perspective is present close to the operation where it is required as well as in decision making processes.[29] Responsibilities are arranged in the following way:

- ZHC and RMHC Staff:
    - Uses and takes care of equipment
    - Report problems
- Regional Team:
    - Provides technical support
    - Supervises operation
    - Responds fast to breakdowns
    - Monitors equipment condition
    - Gives maintenance
    - Oversees external maintenance
- Central Administration:
    - Makes purchases and contracts
    - Plans and coordinates health technology
    - Supervises general operation
    - Arranges external maintenance
    - Evaluates health technology performance

MAINTENANCE PROGRAM

An important part of Health Technology Management is to develop comprehensive planning focused on long term impact. When acquiring new equipment it is necessary to compare alternatives based not only on unit and operation costs, but also maintenance costs, availability of spare parts and skilled personnel, usability, price of consumables, transportation, and other related expenses. In addition, maintenance from the manufacturer can be part of the agreement.

As different health technologies will be in operation, it is compulsory to count with a systematic way of collecting and storing information about the equipment. Specific records about each unit should be kept together with information about their location, and past and future checks and repairs. All this data can be then used to develop a maintenance schedule, which should be paired to the supply chain to make the best use of resources.

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[29] Lenel, A; C Temple-Birth; W Kawohl; and M Kaur. (2005). *How to Organize Maintenance of your Healthcare Technology.* How to Manage Series for Healthcare Technology, Guide 5. 66. Retrieved on July 2010 from http://www.who.int/management/resources/equipment/en/index1.html

SUPERVISION-MENTORING AND CONTINUOUS TRAINING

The two major concerns to guarantee quality of care are: (1) to ensure that the health personnel are doing what they are supposed to, and (2) to make sure that they know how to do it. These points are particularly relevant for the SughaVazhvu Health Network, because the health personnel work mostly unaccompanied; with limited support from a medical doctor mainly for patient consultations. Essential things such as hygiene in the health center, disposal of bio-medical waste, storage of medical supplies, and equipment operation, have to be performed according to the predetermined protocols. Nevertheless, protocols may not be comprehensive, error-proof or recalled, so other actions have to be implemented to maintain healthcare quality. So while Supervision-Mentoring focuses on identifying the sources of problems to resolve them, continuous training seeks to maintain the health personnel prepared as well as to provide them with new and better tools.

ORGANIZATION

Supervision-Mentoring and Training are organized to encourage skill transfer and enhance operation. On one side, supervision visits are performed by the Regional Team with a high frequency to Zone Health Centers (ZHC) and with less frequency to Rural Micro Health Centers (RMHC). The multidisciplinary skills of the Regional Team allow them to make a comprehensive health center assessment and provide constructive on-site training and constructive feedback to the staff. Each Regional Team supervises two ZHCs and their corresponding 48 RMHCs. On the other hand, training sessions take place in ZHCs and bring together the nurses from 24 RMHCs (see *figure 4*). Training sessions can cover broader topics that are relevant to all nurses in the geographic zone. The Regional Team can alternate between training sessions taking place at each of their ZHC to support doctors.

The Regional Team is a multidisciplinary group of individuals from different disciplines. It is lead by a professional doctor that supervises clinical practice and outreach, and composed by an information technology technician, a bio-medical technician and a supply chain manager. Each of them supervises different elements and, at the same time, inspects, maintains and repairs any equipment under their area of responsibility or provides technical support to nurses and health workers.

Figure 4: Organization of Supervision-Mentoring and Training

Regional Team (1)
- Clinical Practice & Outreach
- Information Technology
- Bio-Medical Technology
- Supply Manager

Zone Health Center (1)

Rural Micro Health Centers (24)

Zone Health Center (1)

Rural Micro Health Centers (24)
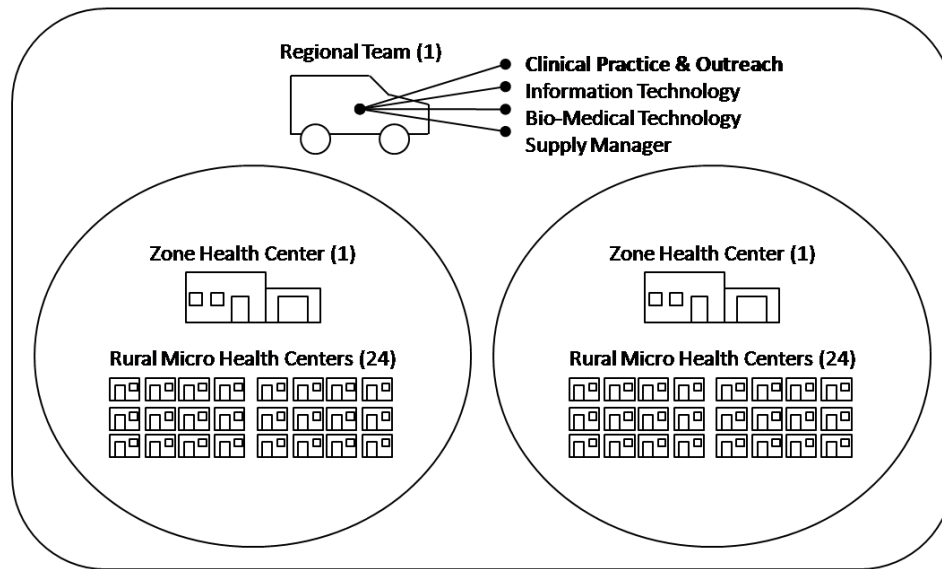
Each Regional Team supervises 2 Zone Health Centers and 48 Rural Micro Health Centers through scheduled visits. At the same time, Zone Health Centers supervise 24 Rural Micro Health Centers remotely. Nurses from Rural Micro Health Centers go to their Zone Health Center s for training.

SUPERVISION-MENTORING

Supervision-Mentoring is based on supporting to improve performance, rather than inspecting and controlling. This model is appropriate for SughaVazhvu Health Centers because supervisors become role-models for nurses. In every visit, they provide constructive feedback and transfer skills in a practical environment, which in turn motivates nurses and helps them improve. The visit focuses on processes and joint problem-solving.[30] Supervision-Mentoring follows a four step cycle[31]:

- *Set expectations:* Every member of the health team understands what he or she is expected to accomplish.
- *Monitor and assess performance:* Progress is monitored and evaluated through visits to health centers, information system reports and meetings.
- *Identify problems and opportunities:* The potential causes and solutions to problems are examined jointly.
- *Develop an action plan:* Health teams work together to develop an action plan with the specific measures for each team member to follow.

This cycle continues as new problems and solutions are implemented, always looking forward to improve the performance of the team (see *figure 5*).

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[30] Family Health International. (2008?). *STI Clinic Supervisory Handbook, Comprehensive STI Services for Sex Workers in Avahan-Supported Clinics in India.* India Country Office, Delhi. 11.

[31] Idem, 12.

Figure 5: Supervision-Mentoring Cycle
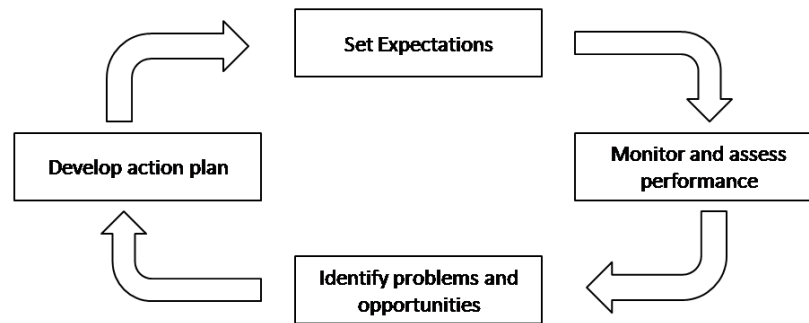
Adapted from: Family Health International. (2008?). *STI Clinic Supervisory Handbook, Comprehensive STI Services for Sex Workers in Avahan-Supported Clinics in India.* India Country Office, Delhi. 12.

SUPERVISION VISIT ELEMENTS.

Supervision visits have to cover multiple elements to ensure the quality of care, from assessing medical attention provided by the nurse to reviewing the condition of all the equipment and infrastructure. Detailed guides and instruments should be developed so that supervision visits are performed in a systematic manner, and the following topics[32] are verified accordingly:

- *Quality of Clinical Care:* Examine how patients are diagnosed, treated and followed up in the clinic, including medical history, diagnosis protocols, hygiene, waste management, prescriptions, waiting times, and others.
- *Community Outreach Activities:* Explore outreach activities of health workers in the community, such as community coverage, patients in control, risk populations, environmental factors, and others.
- *Information System:* Review the condition of information technology equipment, software and networks, and operational knowledge of health personnel.
- *Health Center Administration:* Examine inventory records and stocks, expiry dates, stock cards, cold chain supplies, cashier, and related areas.
- *Health Technologies:* Review the condition and calibration of diagnosis technologies, visual image of the health center (paint, furniture), cleanness, fans, power supply and others.
- *Problem Solving:* Identify, if any, the probable sources of problems and work with the health staff to find solutions.
- *Other:* Check the frequency of supervision visits by the different administrative levels, personal problems of the health personnel, vacancies, and any other relevant issues.

Supervision guides and instruments should give supervisors flexibility to use their common sense and expertise. They should be detailed enough to present an overview of the health center and its operation, but adaptable to specific situations. It should be clear that there will be some

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[32] US AID South Africa. (2006). *Clinic Supervisor's Manual.* Management Sciences for Health. Cambridge, MA, USA. 1-2.

circumstances that the health personnel cannot control. Supervisors should be able to identify those circumstances and direct the issues to the proper authority. In other words, supervisors are not only reviewing the performance of the specific health center, but of the health network altogether.

FREQUENCY AND DURATION.

Supervision visits should be planned and scheduled regularly. On the one hand, health center staff will be expecting the visit and take the necessary measures, such as convening health workers and reducing the workload. On the other hand, supervisors make sure that all health centers are visited with the expected frequency, so that visits become more productive and less disruptive.

In a similar manner, it is important to consider the duration and frequency of the visits. Shorter and frequent visits, focusing only on specific points, may provide increased control, but increase transportation costs. Longer and more spaced visits, on the contrary, provide an overview of all elements in the health center, but may be very disruptive. Ideally, a minimum amount of visits and hours per year per center should be established.

It is proposed that the Regional Team supervises Zone Health Clinics in a bimonthly basis and Rural Micro Health Clinics in a trimonthly basis. The expectation is that this frequency would reduce transportation costs while still allowing regular control of health centers. These visits could also be used to give regular maintenance and install equipment. The schedule should be flexible to increase frequency of visits to a certain health center if this is required.

CONTINUOUS TRAINING

Together with Supervision-Mentoring, there is a need to create a space for continuous training. This is different from supervision visits because nurses and doctors from a zone are brought together, and formal schedules and courses are followed. Nurses may even be expected to review books or papers in their spare time. Training sessions present an opportunity to:
- *Deploy seasonal health actions:* Training sessions to identify patients with symptoms specific to seasonal diseases could be performed at the beginning of seasons with high disease prevalence.
- *Respond to disease outbreaks:* If the outbreak of a disease is detected on a village, measures could be taken to teach nurses how to treat patients, to encourage health workers to seek for diseased, or to communicate other significant information.
- *Provide formal education:* Courses or seminars could be taught to prepare staff with recognized certifications or higher degrees.
- *Instrument new activities:* Training sessions could be performed whenever new protocols, software or equipment are introduced.
- *Strengthen strategic areas:* For critical areas, or where problems are continually found, training sessions could be performed to improve performance.

In addition, continuous training builds team spirit and generates institutional dependence. Low-skilled workers have the opportunity to improve their education and attain higher education; which is an important step for rural populations.

LOGISTICS, FREQUENCY AND DURATION.

Finding an optimal frequency and duration of training sessions is important. Longer training sessions would make it possible to teach more complex topics, but they could also increase expenses related to food and overnight stays. Frequent trainings make it possible to discuss up-to-date topics, respond to environmental changes, and increases team spirit, but it may increase transportation costs and become a planning challenge. An optimal frequency and duration would have a high impact while keeping costs down.

Monthly half day sessions (about 4 hours) may be appropriate for the SughaVazhvu Network. Nurses working in Rural Micro Health Centers in a 2-hour radio from Zone Health Centers (ZHCs), where the trainings take place, would have enough time to travel to and from the center in the same day. In most cases, they will be able to travel through public transportation, so transportation costs would be limited. The Regional Team, alternating between two ZHCs, would present a different topic every two months, which leaves enough time to prepare sessions. Nurses would also have time to study and review topics covered in previous sessions. Besides, monthly sessions are frequent enough to implement actions associated with seasonal epidemiology or time specific matters.

EVALUATION

A basic definition of evaluation is "the systematic acquisition and assessment of information to provide useful feedback."[33] This feedback is important to health programs because it provides information about impact and performance. In other words, evaluation explores if health actions are conducted efficiently and effectively. Evaluation is both a tool to communicate interiorly by comparing the performance and impact in different centers, zones or regions, and to communicate externally, by showing outside audiences the results of the program. In a similar way, evaluations can be performed internally or externally. Internal evaluations are usually a management tool to monitor performance and progress towards objectives. On the contrary, external evaluations seek to inspect, validate, understand or examine certain aspects of the program. In other words, external evaluations are appropriate when vested interests within the organization could influence results, so a neutral judgment becomes necessary or increases the validity of the study.

The SughaVazhvu Health Network would require both internal and external evaluations. Internal evaluations would take place regularly, while external evaluations would be performed in a project basis. Therefore, information should be systematically acquired at specific intervals to create exploitable databases. In particular, it is important to keep track of information used by national and international organizations for comparison purposes. In case of capturing percentages, indexes or indicators, consistency in calculations and formulas is crucial. For each record, basic information such as date and location should be stored.

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[33] Trochim, William M K. (2006). Introduction to Evaluation. Research Methods Knowledge Base. Retrieved on July 2010 from http://www.socialresearchmethods.net/kb/intreval.php

The SughaVazhvu Network could adapt international tools for program evaluation. These tools are not only useful to track performance, but also show results to external audiences. A widely used tool is the logical framework matrix because of its structured way of presenting results in a compact manner. It employs a predefined table or matrix where expected objectives and their current progress are presented for different impact levels. Objectives are matched with indicators, the assumptions considered to reach those results and sources where the data can be found. The key elements of the logical framework matrix are four rows representing objectives for goals (or impact), purpose (or outcome), components (or intermediate results) and outputs (or activities), and four columns with information of each objective, including the verbal description, quantitative indicator, sources of verification and assumptions (see *table 3*).

Table 3: Logic Framework Matrix

	Description	Indicator	Source of Verification	Assumptions
Goal				
Purpose				
Components				
Outputs				

The **Goal** is the overall objective that the program seeks to accomplish. The **Purpose** represents the direct benefits to the target groups. The **Components** are the strategies or services delivered. And, the **Outputs** are the tasks or activities performed.
Adapted from: European Commission. (2009). Project Approach, the commission way. External cooperation programmes. Retrieved on July 2010 from
http://ec.europa.eu/europeaid/how/delivering-aid/project-approach/index_en.htm

NETWORK GROWTH

SughaVazhvu growth will have to be carefully planned to use resources effectively while maintaining quality and control to reach a fully operational network. At first, it will be possible to handle most tasks centrally, but as complexity increases and economies of scale become relevant, more human resources will be required. The same will happen for intermediate infrastructure (or Zone Health Centers): at first minimal storage space and logistics will be required. Once the number of Rural Micro Health Centers reaches a critical point, the supply chain will have to be formally managed. In this context, it is possible to foresee the network growth in the following three phases (see *figure 6*):

- **Phase 1:** The Central Administration performs all activities. One doctor supports all Rural Micro Health Centers (RMHC), and the operation is generally simple, so economies of scale do not make sense. In this phase, the strategy centers in improving the operation of the RMHC, so data collection systems are put into practice, and protocols and guidelines are developed.

- **Phase 2:** The number of Rural Micro Health Centers reaches a critical point where a single doctor cannot manage all centers. Operations in RMHCs are standardized and

economies of scale for supply management begin to make sense. A Zone Health Center comes to scene to store supplies, and host staff. However, the Central Administration can still supervise all RMHCs and operations. The strategy centers in improving the supply chain, supervision and training plans.

- **Phase 3:** A second Zone Health Center is required to host an additional doctor. Equipment maintenance and supervision require specialized personnel. A Regional Team appears to oversee all centers. The strategy focuses on the operation of the network and evaluating performance.

After Phase 3 is completed, new Regional Teams will be required as the number of zones increases. Initially, Regional Teams and Zone Health Centers would be shared until reasonable numbers of Rural Micro Health Centers are built.

Figure 6: Phased Network Growth
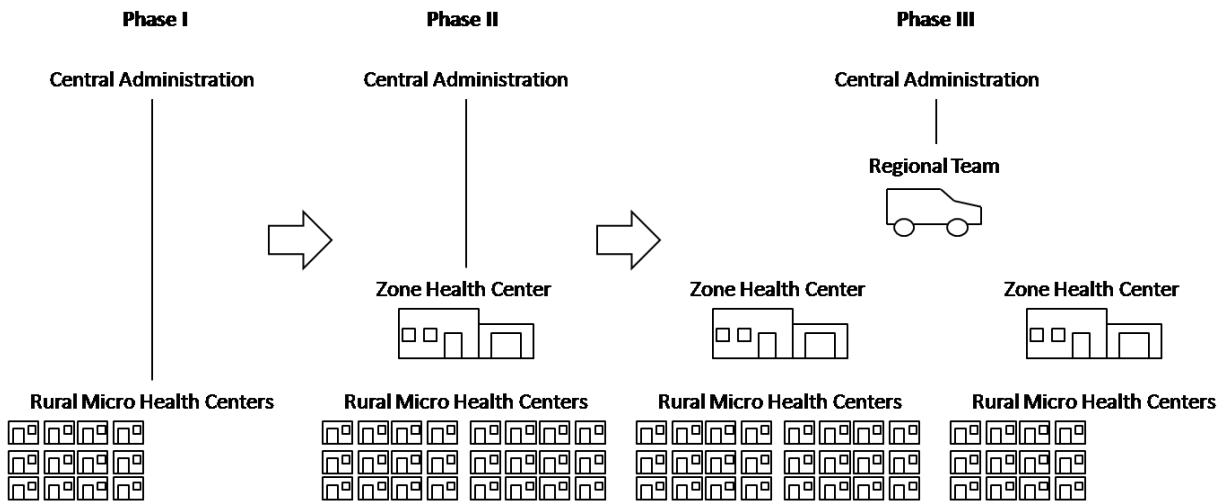
In **Phase 1** the Network is entirely managed by the Central Administration. As the number of Micro Health Units increases, in **Phase 2** a Zone Health Center becomes necessary to support logistics. With a growing number of zones, in **Phase 3** Regional Teams appear to manage regional operations.

MODELING SUPPLY CHAIN EXPENSES

The proposed supply chain model is based in the highly successful hub-and-spoke distribution system implemented by Walmart. In the hub-and-spoke distribution system, goods are sent to a central location and then sorted for delivery to different destinations. This system is particularly effective when a large number of goods from different suppliers have to be distributed to a large number of destinations. By employing a hub-and-spoke system, Walmart encouraged "an efficient distribution system that allowed for joint purchasing, shared facilities, systematic ordering and

store-level distribution of a large number of different goods.[34]" Even when the SughaVazhvu Health Network will operate with a considerably lower number of stock keeping units, it is expected that a hub-and-spoke system will increase the efficiency of the system, decreasing direct supply chain expenses from SughaVazhvu Health Care and drug and equipment suppliers.

To challenge the implementation advantages of a hub-and-spoke distribution system in the SughaVazhvu Health Network, a dynamic financial model was developed using MS Excel. The model contrasts expenses in a hub-and-spoke model, where supplies are delivered to Zone Health Centers and then distributed to Rural Micro Health Centers, with a model with no hub-and-spoke, in which supplies are directly distributed to Rural Micro Health Centers. The model incorporates different assumptions that affect the financial estimates, and requests input parameters to model diverse scenarios. In an attempt to increase the validity of the estimates, limitations such as vehicle capacity were included.

After validating the model assumptions and entering input variables, the model generates Pro Forma Balance Sheets and Indicators. The Pro Forma creates a 5 year estimate of the expenses given the initial infrastructure and desired annual growth. The indicators show important non-financial estimates, such as the utilization of the vehicle, the amount of time a nurse spends in inventory management activities, and others. It's important to note that indicators only reflect the scenario of the first year.

MODEL ASSUMPTIONS

The model requires the validation of four groups of assumptions: human resources, equipment, inventories and medical waste, and ratios. The initial three groups are expected to include the main drivers of expenses in the supply chain. For instance, the price of fuel is one of the main assumptions in the model. The fourth group establishes the relationship of Zone Health Centers and Rural Micro Health Centers. For simplification purposes, the model only requires average values for every unit in the network. In other words, if the distance between three RMHCs is 40, 60 and 80 km, only an average value of 60 km has to be computed.

MODEL INPUTS

The model requires six input parameters: the current infrastructure (Regional Teams, Zone Health Centers and Rural Micro Health Centers), the rate of growth of the infrastructure per year, the number of times that RMHCs would be resupplied, and the number of suppliers (required for comparison purposes). These parameters help model different scenarios according to the given assumptions. For instance, it helps model the optimal interval to supply RMHCs.

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[34] Moore, James. (May-June 1993). The Evolution of Wal-Mart: Savvy Expansion and Leadership. Predators and Prey: A New Ecology of Competition. Harvard Business Review, Reprint 9330. P. 83.

In other to illustrate the potential of the model, we analyze the impact of increasing the number of times a Rural Micro Health Center is supplied every year and the effect of increasing fuel prices in the supply chain expenses. We assume that the infrastructure in the first year is already large enough to generate economies of scale. In other words, we begin with 48 Rural Micro Health Centers, 2 Zone Health Centers and 1 Regional Team. Assumptions and model inputs remain constant in both models for all parameters with the exception of the number of times the RMHCs are resupplied and the gas price. The assumptions and model inputs used to compute these results are available in *Appendix 1*.

CHANGING THE SUPPLY INTERVAL

Three supply interval scenarios were modeled: one in which RMHCs are supplied once every month, another in which they are supplied every two months, and lastly where they are supplied every three months. As shown in *Table 4*, given the assumptions used in the model, the most cost-effective interval to resupply RMHCs is every two months. When RMHCs are resupplied every month, the cost of the fuel required to distribute supplies increases. On the other hand, when RMHCs are resupplied every three months, the cost holding inventories is greater than the savings generated by fewer laps around the network.

Table 4: Comparison of Expenses with Different Supply Intervals

		Year				
Total Expenses Hub-and-Spoke:		**1**	**2**	**3**	**4**	**5**
Supply interval:	One month	$ 426,939.48	$ 482,627.78	$ 562,248.13	$ 790,264.18	$ 885,697.69
	Two months	$ 387,477.38	$ 436,051.72	$ 507,456.26	$ 740,661.72	$ 825,745.23
	Three months	$ 431,740.86	$ 489,075.91	$ 580,200.71	$ 843,321.91	$ 949,043.71
Total Expenses No Hub-and-Spoke:		**1**	**2**	**3**	**4**	**5**
Supply interval:	One month	$ 956,569.98	$ 1,111,915.07	$ 1,402,645.90	$ 1,598,387.58	$ 1,938,652.92
	Two months	$ 598,553.79	$ 740,745.53	$ 937,950.95	$ 1,102,198.59	$ 1,361,469.06
	Three months	$ 554,841.64	$ 692,535.68	$ 880,237.40	$ 1,061,891.18	$ 1,331,841.38

* All values calculated using a supply chain financial model in MS Excel.

When comparing the hub-and-spoke system with system with no hub-and-spoke, it is interesting to note that as the supply interval increases, the system with no hub-and-spoke becomes less expensive. The model assumes that suppliers will maximize the use of their resources and, hence, only the cost of the time invested supplying the SughaVazhvu Health Network is accounted. Nevertheless, even when the use of those resources is fully accounted in the hub-and-spoke system, the vehicle remains to be used in other activities, such as supervision.

FORECASTING DIFFERENT FUEL PRICE

To evaluate the impact of different fuel prices in the supply chain, a scenario with gas prices of 35 rupees per liter was contrasted with a scenario of 60 rupees per liter. These scenarios were combined with supply intervals of once a month and twice a month. As expected, the increment in the fuel price increases the cost of delivering goods to RMHCs (see *Table 5*). Then again, it is

important to highlight that the system with no hub-and-spoke is affected by the increase in a higher magnitude. Since each supplier has to visit each RMHC independently, more fuel is necessary in an aggregated level.

Table 5: Comparison of Expenses with Different Fuel Prices

			Year			
Total Expenses Hub-and-Spoke:			**1**	**2**	**3**	**4**
Supply interval:	One month	Gas Price: 35 rupees	$ 426,939.48	$ 482,627.78	$ 562,248.13	$ 790,264.18
	One month	60 rupees	$ 460,689.75	$ 523,494.25	$ 611,723.71	$ 849,956.06
	Two months	35 rupees	$ 407,969.69	$ 460,862.00	$ 538,234.09	$ 778,689.91
	Two months	60 rupees	$ 440,369.69	$ 500,012.00	$ 585,484.09	$ 835,389.91
Total Expenses No Hub-and-Spoke:			**1**	**2**	**3**	**4**
Supply interval:	One month	Gas Price: 35 rupees	$ 956,569.98	$ 1,111,915.07	$ 1,402,645.90	$ 1,598,387.58
	One month	60 rupees	$ 985,631.39	$ 1,147,030.94	$ 1,445,027.13	$ 1,649,245.06
	Two months	35 rupees	$ 623,358.34	$ 770,717.70	$ 974,124.26	$ 1,145,606.56
	Two months	60 rupees	$ 639,558.34	$ 790,292.70	$ 997,749.26	$ 1,173,956.56

* All values calculated using a supply chain financial model in MS Excel.

LIMITATIONS OF THE MODEL

Even when the model is a useful tool to evaluate how each parameter affects the supply chain, it is not exempt from limitations. The model does not intend to provide precise estimates for each parameter, but rather show the main cost drivers in the supply chain as well as to provide general guidance for critical parameters. The strength of the estimation is highly dependent on the validity of the Assumptions, so it is advised to use more precise methods in further stages.

There are also design limitations of the model. For instance, optimal configuration of the network (the number of Regional Teams and Zone Health Center required for any amount of Rural Micro Health Centers) can only be determined theoretically and has an impact in the model computations. On the other hand, the number of Regional Teams determines the number of vehicles available, which is consistent with the proposed supply chain management plan. An additional limitation is that values in the model are nominal and do not account for inflation or cost of opportunity (interest rates). Other limitations include the implicit assumptions in the model, such as a fixed annual inventory cost of 20% per year. The relative impact of this assumption can be reduced by reducing the SKU average cost.

RECOMMENDATIONS

This document presents a proposal for the organization of SughaVazhvu services into a health network. The need to incorporate several support services for medical attention since the early stages of the network is clear. The better areas are connected, the better the quality of the services and sustainability of the project. For this reason, the following recommendations preset a general overview of the topics covered in this document:

- *Organizational Structure*
  - Develop a human resources strategy that considers all support services, so that a few individuals can perform multiple tasks

- *Supply Chain*
  - Assess the adequacy of a hub-and-spoke supply chain distribution system.
  - Consider storage space requirements and supply chain logistics when building new infrastructure and purchasing new equipment
  - Develop and implement inventory management tools and guidelines with special focus on cold chain requirements, expiry dates, and restocking
  - Implement bio-medical waste management procedures and incorporate collection to the supply chain
  - Create plans to respond to special circumstances, such as increased demand of supplies in specific health centers, seasonal epidemics, and emergencies
  - Develop procedures to receive payments, store and deposit cash, and keep track of all movements
  - Establish the responsibilities and interactions of the different levels of the organization (central, regional, zone or operation)

- *Health Technology Management*
  - Incorporate long term impact when selecting health technology management solutions, such as human resource requirements (availability, skill level, and reliance) and technology's relative significance for medical attention
  - Establish an organizational system that addresses the needs for operation, support and planning of health technology
  - Develop a maintenance program to provide regular service and keep track of equipment, and to monitor contractual agreements with manufacturers

- *Supervision-Mentoring and Continuous Training*
  - Establish a supervision-mentoring program to constantly monitor and improve the quality of care in health centers, considering comprehensive reviews as well as the frequency and duration of the visits
  - Implement a continuous training program to improve the educational level of the personnel, create team spirit and evaluate past performance

- *Evaluation*
  - Create systems to record and store health and performance information at specific intervals, in particular data related to international indicators
  - Prepare program evaluation tools to monitor and improve the performance of the network, and to publicize its progress

- *Network Growth*
  - Anticipate the growth of the network to determine procedures to transfer responsibilities, build new infrastructure and hire human resources

CONCLUSION

The creation of a Health Network can generate several benefits, including improved healthcare quality, lower costs and more efficient operation. Nevertheless, containing costs and logistics will be a big challenge. Careful planning will be critical for the success of the Network, not only for healthcare delivery, but also for all the associated support services. If these challenges are effectively undertaken, the SughaVazhvu Health Network will certainly become opportunity for rural populations across India to improve their health, and become a model for health programs around the world.

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APPENDIX: 1 MODEL ASSUMPTIONS AND INPUTS

Assumptions

Human Resources:

Work day:	9	hours
Work days per month:	26	days
Pharmacist:		
Salary (monthly):	9000	Indian rupees
Benefits (%):	20%	
Driver:		
Salary (monthly):	4500	Indian rupees
Benefits (%):	20%	
Nurse:		
Salary (monthly):	7000	Indian rupees
Benefits (%):	20%	

Infrastructure:

Rural area rent cost, per m2:	45	Indian rupees
Semi-rural area rent cost, per m2:	45	Indian rupees
Average distance between RMHCs:	40	kilometers

Equipment:

Vehicle:			
Capacity:	4	cubic meters	
Cost, new vehicle:	670000	Indian rupees	680 kilograms
Maintenance + Insurance (monthly):	2250	Indian rupees	
Gas price, per liter:	variable	Indian rupees	
Gas consumption:	10	kilometers per liter	
Average Speed:	40	kilometers per hour	

Inventories and Medical Waste:

Medicines:			
Stock Keeping Units (SKU):	35	units	
SKU Average Cost:	40	Indian rupees	
SKU Average Volume:	750	cubic centimeters	100 grams
Turnover (%), per month:	50%		
Medical Supplies:			
Stock Keeping Units (SKU):	20	units	
SKU Average Cost:	35	Indian rupees	
SKU Average Volume:	2000	cubic centimeters	200 grams
Turnover (%), per month:	50%		
Medical Waste			
Volume, all types (per month):	30000	cubic centimeters	5000 grams

Model Inputs

Starting Quantities:

Regional Teams:	1	units
Zonal Health Centers (ZHC):	2	units
Rural Micro Health Centers (RMHC):	48	units

Rate of growth, per year:	20%	percent

Resupply RMHC every:	variable	months

No Hub-and-Spoke:

Number of Suppliers:	4

Note: These assumptions and input parameters may be used in MS Excel to replicate the results presented in this document.

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Literature Review Prepared for the
IKP Centre for Technologies in Public Health (ICTPH)
Cornell University, June 10, 2010

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INTRODUCTION

The World Health Organization dedicated its World Health Report 2008 to Primary Health Care. The framework for Primary Health Care was shaped in the Declaration of Alma-Ata in 1978, where health was reaffirmed as "a state of complete physical, mental ad social wellbeing, and not merely the absence of disease or infirmity[35]." Thirty years later, Primary Health Care has re-emerged, not only as an alternative to provide access to healthcare to underprivileged populations, but as the most appropriate path to face the world's health challenges. The concern now is how to improve the quality of health care services for everyone, including disfavored populations in rural communities.

In this context, health personnel, and particularly nurses, play a fundamental role. Nurses are the first contact with patients, perform initial triages, keep health records, manage pharmacies, and many times train community health promoters, as well as perform other vital functions. In addition, nurses in remote locations may be part of the community and occasionally work part of the day unsupervised. In this respect, the quality of healthcare relies in creating better ways for nurses to engage patients through organized and standardized procedures.

RATIONALE FOR PROTOCOL DEVELOPMENT

The Institute of Medicine in the United States defines practice guidelines as "systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances."[36] The popularity of guidelines and protocols for healthcare professionals has increased in recent years.[37] Although the focus has been primarily in physicians, the implementation of protocols for other professions associated to medicine, such as nursing, is increasing as potential benefits appear. The systematization of processes helps provide standardized care, which offers many potential benefits both from a medical and from a management perspective.

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[35] World Health Organization (WHO). September 1978. Declaration of Alma-Ata. International Conference on Primary Health Care, Alma-Ata.

[36] Woolf, S H; R Grol; A Hutchinson, et al. 1999. "Potential benefits, limitations, and harms of clinical guidelines." BMJ, Volume 318: 527

[37] Thomas, L E; E McColl; N Cullum et al. 1998. "Effect of clinical guidelines in nursing, midwifery, and the therapies: a systematic review of evaluations. Quality in Health Care." Quality in Health Care **7**:183

The main medical advantage is to decrease inappropriate variations in the clinical practice, so patients are treated with the best interventions that are scientifically proved. Two patients with the same illness would be treated similarly independently of their care provider.[38] If the guidelines are adequately developed, they promote practices with proved benefit to the patient and discourage ineffective ones.[39] Therefore, guidelines help keep the quality of the care at high standards. On the other hand, guidelines assist practitioners and patients to make decisions in situations of uncertainty by providing them authoritative recommendations about treatment policies.[40] In certain situations, guidelines can also be useful to aid skill substitution: where a nurse following a guideline would provide care normally provided by a physician[41]. Something that can be useful in many circumstances, such as: locations with limited availability of health personnel to alleviate the workload of physicians, or other similar circumstances.

From a management perspective, guidelines offer on the one hand, the possibility to contain costs and, on the other hand, to evaluate the performance of health facilities and personnel. Although with some flexibility, guidelines help assure that resources are adequately used to treat each patient. The standardization process also makes it possible to evaluate the costs of interventions with similar effectiveness, which increases the efficiency of healthcare provision. In addition, it provides the opportunity to develop performance indicators to monitor the productivity and performance of health centers.[42] Lastly, from an institutional perspective, guidelines can improve the patient's experience when receiving healthcare by reducing time cues, improving personnel-patient communications, and creating a brand that people can recognize and value care offered by the same provider.

In summary, the developing and implementation of clinical practice guidelines can offer the several potential benefits:
- Promote interventions with evidence-based benefits;
- Reduce inappropriate variations in practice;
- Ensure higher quality of care;
- Open ground for skill substitution;
- Assist practitioner and patient decisions;
- Help contain costs;
- Increase opportunities for evaluation, and
- Generate institutional benefits

The effectiveness of practice guidelines and protocols, however, will depend on how they are developed and implemented, as well as the objectives they pursue.

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[38] Woolf et al, 1999. "Potential benefits, limitations, and harms…": 527

[39] Ibid.

[40] Woolf et al, 1999. "Potential benefits, limitations, and harms…": 528; Grimshaw, J; N Freemantle; S Wallace, et al. 1995. "Developing and implementing clinical practice guidelines." Quality in Health Care 4; 55

[41] Thomas et al, Effect of Clinical Guidelines in nursing,1998: 189

[42] Grol, R. 2001. "Success and Failures in the Implementation of Evidence-Based Guidelines for Clinical Practice." Medical Care, Volume 39, Number 8, Supplemental 2. 46-47

PROTOCOL EFFECTIVENESS AND LIMITATIONS

Different studies have shown that guidelines can provide positive results by improving patient outcomes at acceptable costs. For example, it has been recognized that the implementation of protocols by nurse midwives in the management of births increased the frequency of vaginal examinations.[43] Similarly, literature reviews have found that, although with different degrees of success, "care driven by guidelines can be effective in changing the process and outcome of care."[44]

Nevertheless, the risk of producing unwanted effects on healthcare exists. Practice guidelines may as well produce negative effects if they are not developed and implemented correctly. All throughout the process, it is important to be aware of this risk to minimize its probability of occurrence, and evaluate the relation between positive and negative outcomes.

The most evident risk when implementing guidelines is to provide erroneous recommendations. Even if guidelines are carefully developed, they could still be harmful under certain conditions or when treating a specific patient. To prevent this, it is necessary for guidelines to provide sufficient flexibility so that the health personnel are able to use their best judgment when making decisions.[45]

During the development process, guidelines are often strongly influenced by the composition development group, which can have varying degrees of knowledge and expertise. The patient, for instance, may not be the only priority of some of the group participants who may advocate certain interventions or procedures motivated by other interests.[46] For example, the use of a specific medicine could be encouraged to favor one pharmaceutical company. This group influence increases when scientific evidence is insufficient, misleading or incorrectly interpreted.[47]

PROTOCOL DEVELOPMENT

IDENTIFYING AREAS OF INVOLVEMENT

Before initiating the development of clinical guidelines or protocols, it is critical to determine the explicit objectives and scope of the guideline development project. What goals protocols intend to achieve and in what areas their implementation could be more beneficial. Although guidelines could be desired in many areas of care, substantial resources are necessary to develop

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[43] Thomas et al. ,1998. "Effect of Clinical Guidelines in nursing": 189

[44] Ibid, 190

[45] Woolf et al, 1999. "Potential benefits, limitations, and harms…": 529

[46] Ibid.

[47] Ibid.

broad and evidence-based guidelines.[48] Limitations in the availability of resources, especially time and funding, make it necessary to address only those areas where protocols would be more valuable. Different strategies may be followed to identify these areas.

Developing a needs assessment could be an initial strategy to identify the potential areas of involvement.[49] Analyzing the mortality and morbidity affecting the population help identify these areas.[50] Different criteria may be established depending on the aim of the intervention, for example, recognizing the main health risks suffered by a given population may support creating protocols to improve the quality of interventions addressing them. A different strategy would be to identify areas where the appropriateness of care is uncertain, or where the health personnel are prone to inaccuracies. In a similar way, areas where considerable resources are spent or where resources are scare could also be potential areas for protocol implementation.

Another method to define the clinical question is the construction of models or casual pathways.[51] Pathways are visual diagrams that show how processes are linked together for certain interventions. For instance, a diagram may illustrate the path of a patient initiating with her arrival to the clinic and finalizing with her discharge or referral to a different level of attention. Tools like the root-cause analysis may also be used with this objective.

GUIDELINE DEVELOPMENT GROUP

Guidelines are usually developed by a panel or group of individuals who may be experts or important stakeholders in the intervention process. Evidence suggests that multidisciplinary groups are better balanced than single specialty groups, because it reduces biases towards interventions favored by specific specialties.[52] The ideal number of individuals in the group should be between 6 and 15 member in order to open ground for discussion but without impeding its functionality. It is often good practice to include a moderator or facilitator who understands the management of the clinical condition and is familiar with the scientific literature available.[53] Facilitation may also be helpful to reduce frictions within the group and to stimulate the acceptability of the team.[54]

As groups may be easily influenced by individuals' opinions and personal experiences, knowledge of scientific literature is important to increase the validity of the guidelines. Many

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[48] Shekelle, P G; S H Woolf; M Eccles, and J Grimshaw. 1999. "Developing clinical guidelines." BMJ, Volume 170: 348

[49] Grol, R. 2001. "Success and Failures in the Implementation…", 51

[50] Shekelle et al, 1999. "Developing clinical guidelines.": 348

[51] Ibid.

[52] Ibid, 349

[53] Ibid.

[54] Hearnshaw, H; S Reddish; D Carlyle, et al. 1998. "Introducing a quality improvement programme to primary healthcare teams." Quality in Health Care **7**: 208

authors recommend conducting systematic reviews that identify, synthesize and interpret evidence. In addition, if the task is assigned to local staff, it is necessary to make sure that the group has the necessary resources and skills.[55]

Other important things to consider when assembling the development group include: having commitment and support from the people responsible for decision-making processes in the organization; recognition by the health personnel of the proficiency of the group; and the existence of a fixed time in which the team can meet together without interfering with the everyday activities of its members.[56] Besides, it may also be important to make part of the team individuals from areas not related to medicine; even when clinical effectiveness pays a major role, other issues, such as the cost-effectiveness of treatments, are also relevant.[57]

DEVELOPMENT PROCESS

Guideline development processes are established according to national regulations and the organization of the health systems, availability of resources, institutions involved, and other factors Therefore, there is not a single format to follow in the development process.

In general, the development group meets several times throughout the year to address the issues that arise in the development process. Although the development group is small, their members are informed by other stakeholders. Time between group meetings should allow sufficient space for feedback —which can include comments on guideline drafts from colleagues, opinions from experts or technicians in other areas. For instance, the development group may need to explore feasibility issues that are not directly in their area of expertise and may require consultation.[58] In the Netherlands, guideline development team meeting occur 10 to 15 times a year.[59]

Results of group discussions have shown to be better if they take place in formal rather than informal settings.[60] In other words, it is encourages for meetings to follow predefined agendas, generate specific outcomes, etc. As often scientific evidence about specific clinical practices will be non-existent, inapplicable, or conflicting, the group will have to be prepared to make decisions through discussions.[61]

After the guidelines are completed, it is usually necessary to verify the validity of the recommendations. A good practice is to share a copy of the guidelines to physicians (or other

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[55] Grimshaw et al, 1995. "Developing and implementing clinical practice guidelines." 61

[56] Hearnshaw, H; S Reddish; D Carlyle, et al. 1998. "Introducing a quality improvement programme…", 208

[57] Grimshaw et al, 1995. "Developing and implementing clinical practice guidelines." 61

[58] Shekelle et al, 1999. "Developing clinical guidelines.": 351

[59] Grol, R. 2001. "Success and Failures in the Implementation…", 47

[60] Shekelle et al, 1999. "Developing clinical guidelines.": 349

[61] Grol, R. 2001. "Success and Failures in the Implementation…", 47

relevant personnel) in the organization. Their feedback can then be used to improve the guidelines. A pilot test may also be performed to assess feasibility and validation issues. In some countries, the official approval of national guidelines is required from an independent scientific board.[62] Finally, indicators to measure guideline adherence may be developed.[63]

Research shows that guidelines developed by physicians themselves had better acceptance, so involving health personnel, rather than external experts, may be important. Guidelines where the desired performance was explained in detail, compatible with the existing culture of the organization, and that did not have major consequences in the organization of health care were more successful.[64] However, guideline dissemination and implementation procedures played a major role in guideline adoption.

PROTOCOL IMPLEMENTATION

Once a guideline has been developed, tested and approved, the dissemination and implementation process begins. This is a crucial part of the process because it refers to the specific objective for which guidelines were created: adoption by health personnel of the desired behavior. Nevertheless, this part is usually performed through conventional but non-effective media. The success of implementation relies on using the best method for the specific circumstances.

Protocols have to first change the knowledge of the health personnel, then their attitudes and finally their behaviors to affect patient outcomes. Although behavior change may occur through indirect manipulation, it may be more reliable to influence knowledge and attitudes.[65] The implementation process follows three stages: first, increase the knowledge of the health personnel by informing them about protocol recommendations; at the same time, changing their attitudes by showing the potential benefits of adherence, and, finally, supporting behavior change through reminders and training.

PRINTED MATERIALS

The most common means of guideline implementation is through printed materials —from the publication of guidelines in medical journals to the distribution of leaflets, direct mailing, training materials and others. Conversely, several studies have found that these are the least effective methods in changing clinical practice.[66] A situation that could be explained by the

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[62] Ibid.

[63] Ibid, 48

[64] Ibid.

[65] [65] Cabana, M D; C Rand; N R Powe, et al. 1999. "Why don't physicians follow clinical practice guidelines?: A framework for improvement." JAMA. 282(15): 1462

[66] Jamtvedt, G; J M Young D T Kristoffersen, et al. 2006. "Does telling people what they have been doing change what they do? A systematic review of the effects of audit and feedback" Qual Saf Health Care 2006;15: 435; Thomas et al, Effect of Clinical Guidelines in nursing,1998: 183

difficulty for health personnel to keep track of publications, lack of reminders at the moment when information is required, and use of complex language.

Nonetheless, there are also examples of printed materials used successfully, although using non-conventional channels. Donihi et al[67] describe the implementation of a protocol for insulin prescription through a preprinted order form. The guideline did not only describe different scenarios of insulin prescription, but also provided a checklist for health personnel to chose the most appropriate procedure and submit the order form. The high adherence to the protocol was not only related to its availability in a timely manner, but also because it was faster to complete the new form than to write a complete order.

ACTIVE PARTICIPATION

Most authors give credit to implementation strategies involving active participation as the most successful. Educational strategies, such as outreach visits and targeted seminars, have shown to be more successful than passive approaches.[68] Although these conclusions have not been proved for nurses and midwives, it can be expected to hold true. In addition, it was found that these strategies were more successful when paired with software reminders and financial incentives.[69]

INVOLVING PATIENTS

There has been an increased interest to get patients involved in quality improvement processes. This idea emerged because patients know their medical background, have personal interest in outcomes, and are available and nearby.[70] In some cases, patients may even be the first to inform doctors about certain guidelines or interventions when asking advice about medical procedures.[71] Yet, there are important concerns that need to be addressed before formally involving patients. Primarily, there are serious doubts about the reliability of patients in taking these responsibilities —especially if they are experiencing fatigue, stress, pain or discomfort; their judgment could be impaired and unreliable.[72] In such circumstances, involving patients could reduce barriers of the health personnel and risk the quality of care, rather than improve it.

BARRIERS TO ADHERENCE

Adherence to guidelines may not depend in the guidelines or the implementation process themselves, which could be cause by external barriers. Barriers can be defined as factors that limit or restrict adherence from the health personnel to guidelines. Scholars have identified common

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[67] Donihi, A C. M M DiNardo, M A DeVita, and M T Korytkowski. 2006. "Use of a standardized protocol to decrease medication errors and adverse events related to sliding scale insulin." Qual Saf Health Care;15: 89

[68] Grimshaw et al, 1995. "Developing and implementing clinical practice guidelines." 61; Thomas et al, Effect of Clinical Guidelines in nursing,1998: 190

[69] Grol, R. 2001. "Success and Failures in the Implementation…", 52

[70] Lyons, M. 2007. "Should patients have a role in patient safety? A safety engineering view." Qual Saf Health Care.16:140

[71] Woolf et al, 1999. "Potential benefits, limitations, and harms…": 527

[72] Lyons, M. 2007. "Should patients have a role in patient safety?" 141.

external barriers, such as: not having reminder systems, counseling materials not available, excessive workloads, lack of economic incentives, and high treatment costs.[73] An important barrier identified was the tendency to follow demands of patients to avoid conflicts,[74] which could be, for example, a cause of unnecessary prescriptions. To avoid these barriers it may be necessary to create strategies specifically tailored to target possible obstacles.[75] Grol (2001) proposes developing an assessing the implementation process by answering the following questions:

- Who are the stakeholders?
- Whish aspects of care should be addressed?
- What recommendations should be followed?
- Which groups appear to experience problems?

In general, guidelines are more successful when recommending a new behavior, rather than eliminating a previous practice.[76]

RECOMMENDATIONS

This literature review presented an overview of protocols in healthcare, in particular, focusing in their implementation in nurse practice. The following recommendations for the IKP Centre for Technologies in Public Health (ICTPH) emerged after completing this revision:

- Implementing nurse protocols in ICTPH clinics could bring highly positive results, such as: higher quality in healthcare, greater potential for replicability, cost controls, skill substitution, service branding, and others.
- Nevertheless, guideline development processes are delicate, complex and expensive, so it would be necessary to identify the areas where protocol implementation would be more valuable.
- After identifying these areas, ICTPH could create a guideline development group to lead the development and implementation process. Ideally, this group would be trained to gather scientific data, seek expert recommendations, and involve all the stakeholders.
- Although guidelines developed by other organizations could be used as references, it is not advisable to implement them without prior evaluation from a qualified team within ICTPH.

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[73] Cabana et al, 1999 "Why don't physicians follow clinical practice guidelines?": 1462

[74] Grol, R. 2001. "Success and Failures in the Implementation…", 51

[75] Ibid, 50

[76] Cabana et al, 1999 "Why don't physicians follow clinical practice guidelines?":1462

CONCLUSION

Several studies have shown the potential advantages of implementing nurse protocols to improve clinical practice. The effectiveness of guidelines, however, relies on successful development and implementation processes. As explained in this review, successful development processes included systematic approaches to collect scientific evidence while at the same time involving all stakeholders. A reliable development team and strong scientific data increases the validity of guidelines. Similarly, good practices of implementation processes include the active participation of the target group, and generating strategies to face barriers for adherence.

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Thiruppuvanam Vision Center
July 20, 2010

LOCATION AND COVERAGE

The Vision Center in Thiruppuvanam is situated 35 km from the Aravind Eye Hospital in Madurai. Most Vision Centers are located in villages with populations over 10,000 people, and serve a 5 km radius to cover a population between 45,000 and 50,000 people. The farthest Centre is located about 200 km (or 5 hours) from one of the five Aravind hospitals.
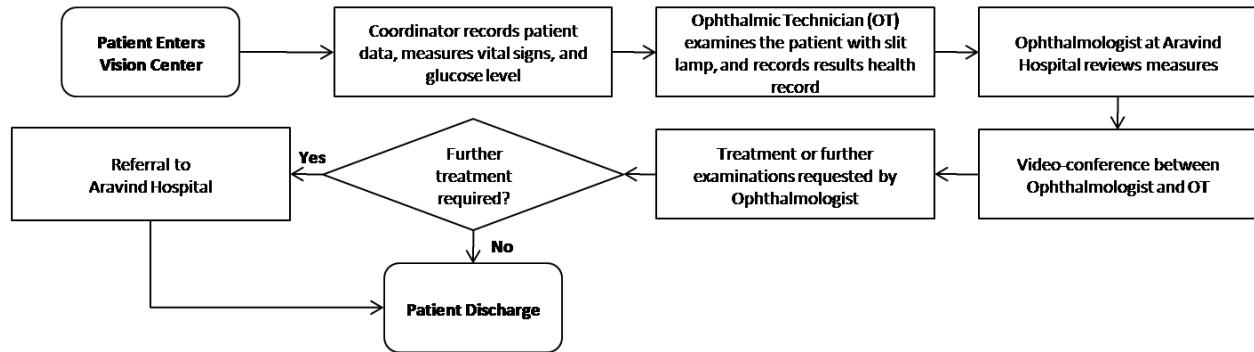
MODEL OF ATTENTION

Each Vision Center is equipped to provide basic ophthalmic care and vision correction. When a patient enters the Center, she is received in the reception by the Coordinator, who records name, address and other personal information in the patient's Electronic Health Record (EHR). The Coordinator also measures vital signs (such as pulse, temperature, and blood pressure), and tests the glucose level with a glucose meter. All the data is recorded and added to the (EHR).

The patient enters the Consultation Room, where the Ophthalmic Technician (OT) examines her eye with the Slit Lamp, and other ophthalmic equipment, and reports her findings to the EHR. Once the examination is completed, the OT initiates a video-conference with an ophthalmologist in the Aravind Hospital and provides her the patient's registration number. The ophthalmologist enters the number into the system and views the patient's EHR. If she has questions, she may request feedback from the OT while she evaluates the patient's information.

Based on her finding, the ophthalmologist may provide the diagnosis and directions for treatment, request further examinations, or refer the patient to the Aravind Hospital for specialized treatment. For instance, if the patient requires spectacles, the OT would use the trial sets and exam charts to establish the shape of the lenses. After the examination is completed, the patient may choose from different spectacle frames. If she decides to acquire glass lenses, they are customized in the Vision Center itself, and, if she decides instead to acquire plastic lenses, these are ordered from the Hospital and sent by courier to the Center. If no further treatment is required, the patient is discharged (see *chart 1*).

Chart 1: Visual Center Model of Attention

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┌──────────────────┐      ┌──────────────────────┐      ┌──────────────────────┐      ┌──────────────────────┐
│  Patient Enters  │ ───> │ Coordinator records  │ ───> │ Ophthalmic Technician│ ───> │ Ophthalmologist at   │
│  Vision Center   │      │ patient data,        │      │ (OT) examines the    │      │ Aravind Hospital     │
│                  │      │ measures vital signs,│      │ patient with slit    │      │ reviews measures     │
│                  │      │ and glucose level    │      │ lamp, and records    │      │                      │
│                  │      │                      │      │ results health record│      │                      │
└──────────────────┘      └──────────────────────┘      └──────────────────────┘      └──────────────────────┘
                                                                                                  │
                                                                                                  ▼
┌──────────────────┐  Yes  ╱◇◇◇◇◇◇◇◇◇╲      ┌──────────────────────┐      ┌──────────────────────┐
│  Referral to     │ <──── ◇ Further  ◇ <─── │ Treatment or further │ <─── │ Video-conference     │
│  Aravind Hospital│       ◇ treatment◇      │ examinations requested│      │ between Ophthalmologist│
│                  │       ◇ required?◇      │ by Ophthalmologist    │      │ and OT               │
└──────────────────┘       ╲◇◇◇◇◇◇◇◇╱      └──────────────────────┘      └──────────────────────┘
        │                       │ No
        │                       ▼
        │              ┌──────────────────┐
        └───────────>  │ Patient Discharge│
                       └──────────────────┘
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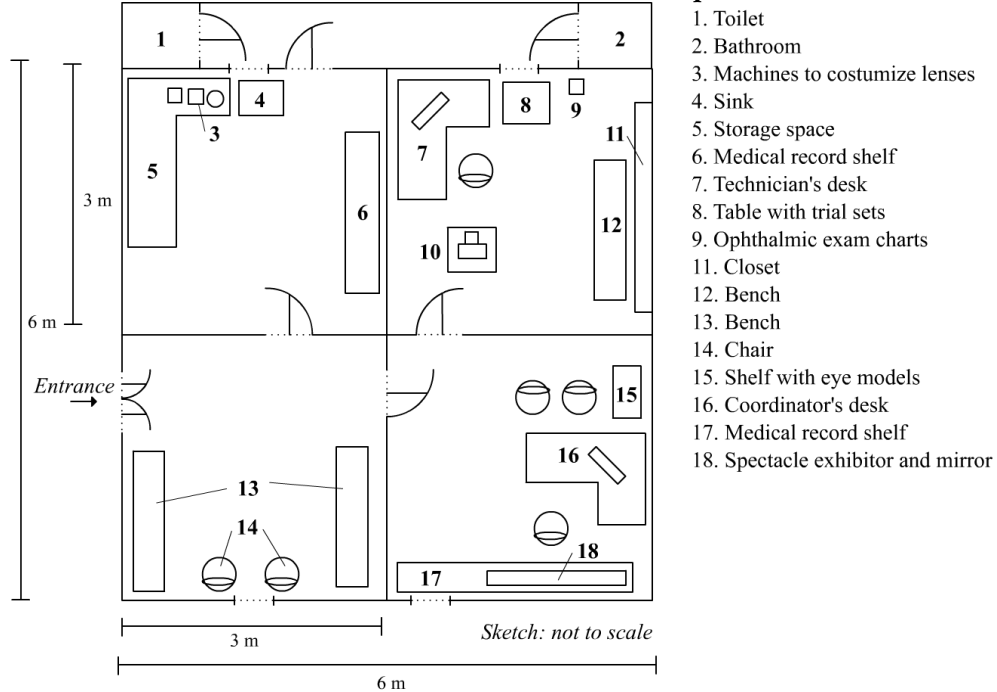
All patients interact with the Ophthalmologist through the video-conferencing system, so all their questions can be immediately resolved. The personnel at Thiruppuvanam Visual Center referred that the system is well accepted by patients, who are happy to speak to the doctor. Visual Centers are open Mondays through Saturdays from 9 am to 5 pm. The busiest days of the week are Mondays and Thursdays, and Saturdays are especially popular for school children.

EQUIPMENT AND INFRASTRUCTURE

INFRASTRUCTURE.

All Visual Centers follow a standard design, although adapted to local conditions. As most buildings rented, there are some variations in the setup and size of the Centers. According to Aravind Staff, the Visual Center at Thiruppuvanam is an example of the minimum space required to function. This center has four rooms of approximately 3x3 meters: waiting room, reception, consultation room, and workshop and storage room (see *chart 2*).

Chart 1: Visual Center Setup

1. Toilet
2. Bathroom
3. Machines to costumize lenses
4. Sink
5. Storage space
6. Medical record shelf
7. Technician's desk
8. Table with trial sets
9. Ophthalmic exam charts
11. Closet
12. Bench
13. Bench
14. Chair
15. Shelf with eye models
16. Coordinator's desk
17. Medical record shelf
18. Spectacle exhibitor and mirror

Sketch: not to scale

EQUIPMENT.

All Visual Centers have the same equipment, which is useful to provide a standard quality of attention and facilitates administration, maintenance and technical support. The equipment if listed below, according to the room where they are located:

- Reception
  - Desktop computer
  - Printer
  - Glucose meter
  - Eye disease models
  - Spectacle exhibitor and mirror
  - Medical record shelf
  - Cash box
  - Medicine rack

- Consultation Room
  - Slit Lamp Topcon SL-1E
  - Desktop computer with webcam
  - Digital camera attachable to Slit Lamp
  - Mercury manometer
  - Ophthalmic trial sets
  - Other ophthalmic equipment
  - Ophthalmic exam charts

- o Hand Antiseptic

- Workshop and Storage Room
  - o Electric backup (3 hours)
  - o Internet Modem
  - o Machines to customize glass lenses

- Other
  - o Antenna for Internet Connection

STAFF

Currently, Visual Centers are staffed by two persons, a Coordinator and an Ophthalmic Technician. They are recruited from a pool of Mid Level Ophthalmic Paramedical graduates trained in Aravind Hospitals, which includes around 10,000 people. They are invited to occupy the positions depending on their proximity to the Center and academic achievement. Salaries start on a predetermined amount and increase with seniority. The general responsibilities and qualifications of the staff are the following:

- *Coordinator:* In charge of basic administration of the Center. Receives patients, measures vital signs, records information in the system, and provides counseling when required. She is in charge of processing payments, and reviewing the productivity of the Center.
  - o *Education:* Higher Secondary Exam. Mid Level Ophthalmic Paramedical specialized in counseling (2 years). Bridge Course, Position Training (43 days).
  - o *Uniform:* Plain light violet Sari .

- *Ophthalmic Technician*: Examines patient with Slit Lamp and performs other eye exams, communicates with Ophthalmologist, and records data in the electronic medical record.
  - o *Education:* Higher Secondary Exam. Mid Level Ophthalmic Paramedical specialized in refraction (2 years). Bridge Course, Position Training (43 days).
  - o *Uniform:* Turquoise sari with white decorations.

FINANCING

Patients pay low fees for consultations and treatments. Consultations and treatments have fixed prices. All transactions and inventories are tracked in the Center's software. The Coordinator receives payments and deposits are made in a daily basis to the bank, so only small amounts of money are present in the Center. According to calculations by Aravind, 20 patients a day are enough to cover the day-by-day operation costs (it is not clear if this includes indirect costs, such as the ophthalmologist salary, administration and others).

MANAGEMENT

ADMINISTRATION.

The responsibility of the administration of the Visual Centers lies on the Hospital Administrator. Therefore, each hospital administrator is in charge of 5 to 10 Centers. The overall performance of the Centers is overseen by a Central Office. Many of the procedures —such as keeping track of inventories, productivity and accounting— are automatically performed by the Center's software, which decreases the workload and complexity of administration.

SUPERVISION, EVALUATION AND MAINTENANCE.

The Coordinator of the Visual Center has a binder with a map of the towns and villages close to the Center. It also contains a calendar with the day-by-day productivity of the previous year to compare it with the current year, and a table to keep track of the visits by patient location.

Every month, a team of 5 people visits the Center to supervise its operation and give maintenance to the equipment. The team includes an ophthalmologist, an information technology expert, an administrator, and maintenance personnel.

SUPPLY CHAIN

Aravind Hospitals serve as central warehouses for Visual Centers. Equipment and consumables are acquired through a Central Purchasing System, and delivered monthly to the Centers by vehicle. For supplies that need to be delivered in a shorter time frame, for instance spectacles, they are sent through courier. In addition, several goods are produced internally by the Aravind System, such as Aurorub —a hand antiseptic used in the Visual Centers.
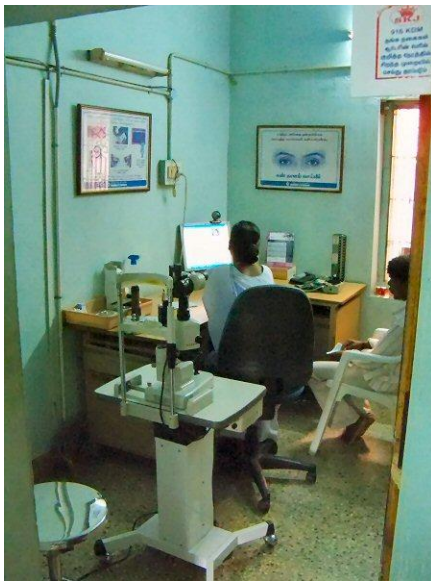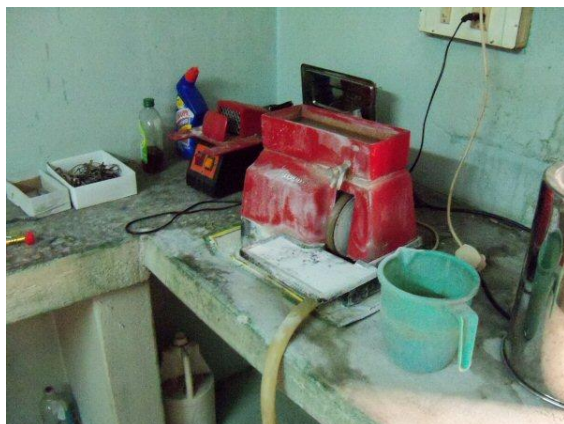
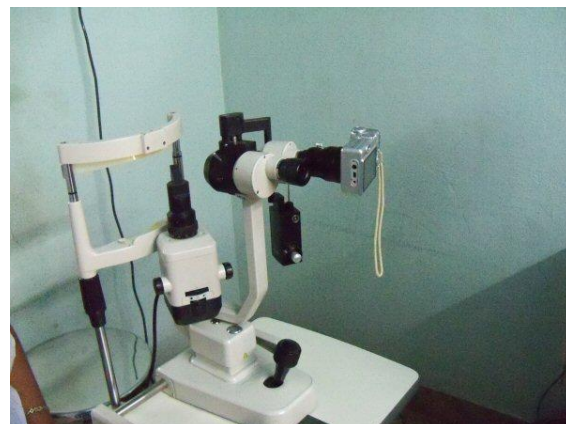*Outside View*

Coordinator in the Reception

Left Side View of Consultation Room

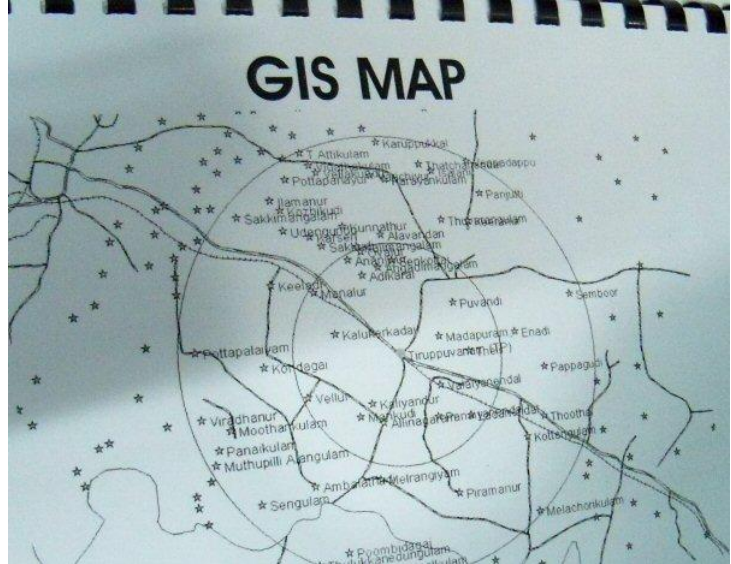*Right Side View of Consultation Room*

Glass Lense Costumization Machines

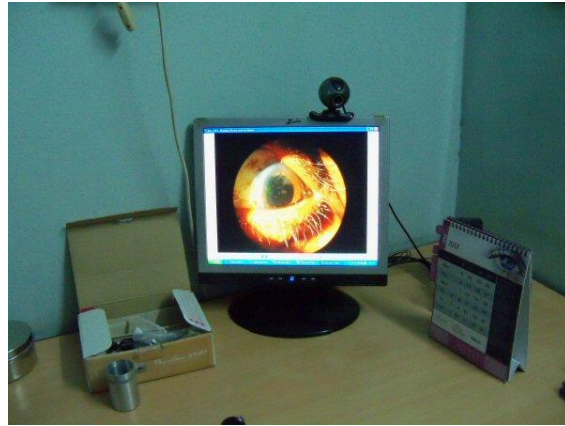*Slit Lamp with Camera Attached*

Waiting Area View

Binder with GIS Map

Coordinator Screen with Productivity Report

OT Screen with Digital Photo of Eye

Ophthalmic Trial Set

Models of Eye Diseases

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Dhan Foundation
July 20th, 2010

</div>

OVERVIEW

The Dhan Foundation began working in community building programs. In 1992, it started working in water projects, focused in its use for agricultural production —such as tank restoration for irrigation to provide low cost water to low-income farmers. The Foundation how now expanded and developed different programs. In 2000, Dhan initiated several programs:

- Tata-Dhan Academy: A post-graduate education center in development management.
- Rain fed agriculture
- Democratizing the Panchayat to create missing processes and links, generate a debate process, and build the non-existent democratic structure.
- Other projects include:
  - Migration and development
  - Youth and development
  - Climate change

In their experience, developing a model an adapting it to the local conditions takes between 5 and 8 years. Once the model is fully developed, it is possible to scale up.

DHAN FOUNDATION'S MODEL

The Dhan Foundation is based in the idea of creating People's Institutions. These are organization that have community governance structures, but are supported by a professional management team. People's Institutions share human resources and infrastructure, although they are financially independent and legally separate institutions. The network is also strongly supported by inside and outside training to keep the staff updated. Human resources include 650 professionals and support staff and over 2,000 paid community staff, mostly based in Madurai.
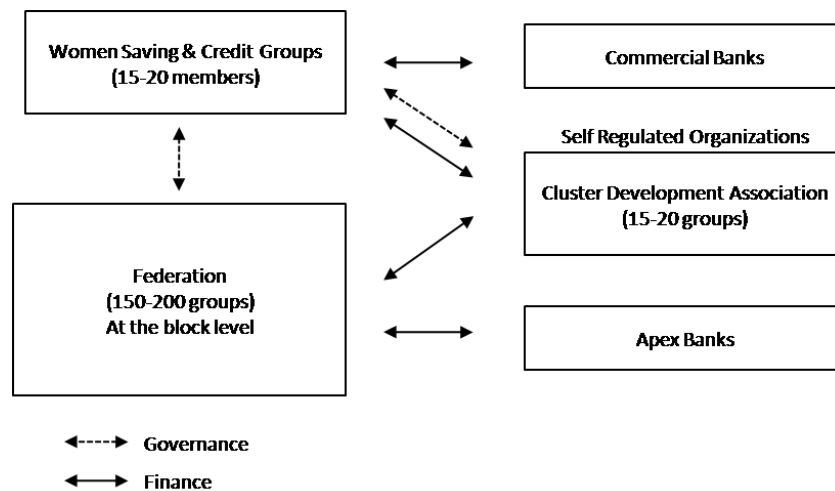
FEDERATIONS

A Federation is the name given to the collection of Women Saving & Credit Groups (WSCG). Each Federation has affiliated between 150 and 200 groups, and each WSCG has between 15 and 20 members (see *Chart 1*). WSCG groups and Federations start by providing access to savings to women members that otherwise do not have access to banking services. These savings later become the investment for internal lending, helping women smoothen their consumption through credit. This phase focuses in creating collaboration and building capacity inside the group and is expected to take around 3 years. As the Federation grows stronger, the complexity of

the services offered by the federation may expand, first increasing financial services, then promoting businesses, and finally creating civic services.

There are several characteristics of the Federation model that have contributed to its success. Although the general scheme is similar, each place is treated differently and WSCG groups can take their own decisions. All funds come from the group itself, and thus encourage self regulation. Federation members have strong contact and the groups grow beyond the Panchayat, which helps avoid falling for political pressures.

In addition, Dhan Foundation has promoted a secular approach and relied on the internal fabric of the communities. Even when cast tensions were observed, these were resolved internally by each group. Therefore, the system has been integrated into the culture at a local level. Dhan Foundation encourages sensitivity to local culture and to the existing roles of people in the community.

Chart 1: Federation Organization

HEALTH INITIATIVES

REDUCING FEMALE INFANTICIDES.

In order to help reduce female infanticides, the Dhan Foundation and Federations have created different programs. For example, they have promoted capacity building of traditional birth attendance, counseling with pregnant women and her family, as well as creating especial micro-finance products for health issues —for instance, quick access credits for emergencies and pregnancies.

SELF HEALTH GOVERNANCE.

These groups operate in the Federations with 3 representatives from each group. In total, they have 15 representatives that are non-compensated. The groups meet regularly every month and set the agenda for the village. They explore the hospitals in the area to provide recommendations to people in need.

In some instances, there is a Primary Care Unit operated by the Federation. These Units work together with Health Guides and Health Associates that receive a 5 day training program two times a year. Additionally, nurses give one class a week on specific health topics.

Old Campus - Entrance

Old Campus - Yoga Area

New Campus - Entrance

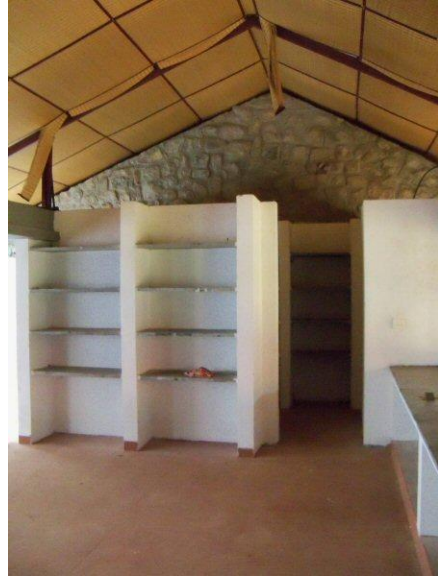
New Campus - Corridor

New Campus - Library

New Campus - IT Room

New Campus - Library

New Campus - Kitchen

New Campus Site - View

New Campus - Dormitories

New Campus - Dormitories View

New Campus - Guest House