ViduSuwa – Electronic Distant Healing: A Patient Centric Telemedicine Solution in Sri Lanka

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Abstract

This paper first investigates the issues and challenges faced by patients in a developing country with regard to inequality of resource distribution and the existing eHealth infrastructure. In order to solve these issues, it introduces VIDUSUWA, a simple patient centric three phased eHealthcare strategy using an evolutionary approach building on the existing infrastructure.

In phase one, the main emphasis of Vidusuwa is on setting up of an eConsultation Clinic to link the specialist in a general hospital in a city with a patient in a peripheral setting. This will consist of an eCare Clinic in a peripheral hospital, a web-based eHealth record system, m-Communication system and an e-Consultation centre with a medical specialist. The paper also looks at technologies to implement phase 2 which is eSystems Integration, and phase 3 which is Remote Patient Monitoring (RPM) in a manner suitable for a developing country.

Key words: Vidusuwa, eClinic, eHealth, Telemedicine, e-Consultation, Electronic Medical Record (EMR)

Background

According to the national health policy of Sri Lanka, the mission of healthcare is to ensure access to comprehensive, high quality, equitable, cost effective and sustainable health services. The average number of general practice consultations per year amount to 12.7 million[(1)]. Although there was no gender difference in out-patient attendance, children younger than 12 years accounted for 32.1% of consultations and the proportion of elderly at the consultations were significantly higher[(1)]. As hypertension and diseases of the upper respiratory tract are among the top ten causes of hospitalization and are more evident in the elderly population the proper follow up and monitoring of this category of patients can reduce the rate of hospital admissions considerably. This is one of the areas in which ICT can play a major role with regard to the Sri Lankan population.

The Importance of Bridging the Gap

The broad aim of the health policy of Sri Lanka is to increase the life expectancy and the quality of life of its citizens. One of the strategic thrusts in healthcare is empowering communities towards more active participation on maintaining their health, strengthening the stewardship and management functions of the health system. According to the demographic studies and survey, the proportion of the population below 30 yrs has decreased [(2)]. On the other hand, the elderly population has increased (data excludes North and Eastern provinces).

The Annual Health Bulletin 2004/2005 states that in some districts, some of the common specialties such as general medicine, surgery, obstetrics and pediatrics are notably absent[(1)]. Therefore, access to

highly specialized consultancies such as neurosurgical, oncological, oncosurgical, fertility medicine, nephrological and endocrine medicine to name a few would involve the patient having to travel great distances, incurring heavy expenditure in obtaining such services. Especially, the follow up of post-operative and re-convalescing patients after specialized treatment in a tertiary centre will have the greatest benefit from an e-consultancy strategy.

An appropriate eHealth strategy could reduce the risk of high dependence among elderly people and enhance access quality and viable healthcare. The main author's experience is that elderly people represent a relevant part of hospital admissions and are the leading consumers of acute healthcare services. Many elderly people in a rural setting will find it difficult to visit their local hospital on a regular basis, therefore, a system with distant monitoring such as eCare is a growing necessity. This epitomizes the current trend of moving healthcare from specialized clinical settings to primary care and when possible to patients homes. It must be stated that once such a scheme as telemedicine or telecare is in place, it will benefit all age groups with less cost to the individual and with regard to futuristic infrastructure development to the state.

eHealth Applications – A Global Perspective

Healthcare system is moving from a traditional hospital based system to a more patient centered approach[2]. ICT has been used in the health sector in developed countries[3] which demonstrated a 50% reduction in mortality or 25% to 50% increase in productivity within the health care system[4]. It has also been shown that a critical mass of professional and community users of ICT in health has not yet been reached in developing countries[5].

eHealth Applications in Developed Countries

There are many instances of using ICT for better healthcare around the globe. A few are stated below.

- Doctors/nurses transferring electronic medical records (using tablet PCs) on to PDAs in Spain[6].
- Nearly 90% of doctors using the electronic medical record applications in Sweden and Denmark[6].
- Doctors from 16 Spanish hospitals using satellite videoconferencing system & online consultations for specialized diagnosis in radiology, cardiology, surgery and dermatology[7].
- Reaching greater number of patients through electronic participation of chronically ill patients which reduced their visits by over 20% [6].
- Usage of wireless devices for 24 hour wireless ambulatory, mobile and remote patient monitoring[8].
- Usage of online web-based health information systems (Pubmed, Websurg) for eLearning[9,10]

Trends in eHealth and Telemedicine clearly depict that patient centered remote health care monitoring is possible within the existing technology in developed countries. One example is the eCare system to monitor post operative patients with chronic or long term illnesses such as diabetes, cardiovascular diseases and orthopedic states[11]. The system includes 9 components deployed across 2 primary elements, patient monitoring and the central system.

There is a wireless intelligent censor network, biomedical sensors and a radio terminal from the patients side. There is a medical data manager, e-care repository, collaboration module, workflow systems, security system and user web application in the central system[11].

eHealth in the Developing World

Poor telecommunications infrastructure, limited number of Internet Service Providers (ISP), lack of access to international bandwidth, and high Internet access costs continue to be barriers to widespread use of ICTs.

Least Developed Countries (LDCs) where per capita wealth is low have lower levels of tele-density. However, this has not prevented some countries in introducing ICT to better healthcare. A few examples could be stated:

- India has many telemedicine, tele-education, tele-consultation and tele-follow up initiatives that have helped their rural population tremendously[12].
- South Africa- mobile phones are used to send sms reminders to patients for medication[13].
- Uganda- email enabled palm hand-helds deliver medical/journal content to health workers[14].
- In India, eConsultations are done through filling up of a pre-designed consultation form with the use of PDA between the specialist and healthcare workers[15].
- The Ruwanden treatment and Research AIDS center uses a network for monitoring the delivery of anti-retroviral agents to patients and clinics[16].

According to Heeks (2002), properties of the information system can be changed to better match local realities to make them more receptive to information systems interventions.

The Sri Lankan Scenario

Sri Lanka has three main levels of curative healthcare institutions: primary level in the rural sector, secondary level in the peripheral or urban sector and tertiary level teaching and large hospitals in the cities. There are 10 tertiary level hospitals, 27 secondary level hospitals and over 285 primary health care institutions[1]. It is also stated that 35% of the medical specialists in the curative sector are concentrated in the Colombo district according to the same sources.

It is said that the LDCs have the poorest information infrastructure. Sri Lanka is fortunate in that the penetration of fixed line and mobile technology to rural areas is increasing at a rapid pace. According to the Telecom Regulatory Commission (TRC) statistics, the numbers of cellular mobile subscribers are placed as over 8 Million[17]. The mobile phone density (mobile phones per 100 persons) is over 40 and the total tele-density (fixed and cellular) is nearly 60 in Sri Lanka[17].

Sri Lanka is fortunate to have almost 100% fixed line connectivity to all the hospitals in the urban and rural areas of the country. With the software localization projects happening in Sri Lanka, mobile phone users have the benefit of using community specific language preferences overcoming the language barriers.

The rapidly growing population of elderly patients and the rising healthcare expenditure demands newer healthcare initiatives such as eHealthcare and Telemedicine[18]. However, the challenge is in the introduction of eCare services to real life practice in a semi-urban and rural population in Sri Lanka. This is due to the fact that patient decision making is generally influenced by various factors in a developing country:

- Social factors according to their lifestyle
- Economic factors (low income, transport cost, etc.)
- Ignorance with regard to illnesses and healthcare

- Religious and superstitious beliefs
- Opinions of relatives/friends
- Fear or mistrust of new technology
- Availability of alternative medicine such as ayurvedic, traditional, etc.

Literature survey on existing solutions for eHealth suggest four main methods of Systems Implementation that can be identified[7].

- Tele-assistance systems - based on GSM & GPRS which are expensive and need a huge capital
- Home telemedicine oriented systems – Require cable and XDSL lines
- Internet based systems – Patients need PC along with high bandwidth internet connections
- Mobile Pervasive systems (m-health) – Great applications and opportunities for the developing world

Out of these broad categories, Internet based solutions could be adopted in the Sri Lankan context as the technology infrastructure is available in all teaching hospitals, base hospitals and some district hospitals. Though Internet penetration in Sri Lanka is low, accessibility is increasing due to cyber cafés, Nanasalas and many such resource centers being available island-wide. However, the most widely available technology in Sri Lanka is the mobile technology[17], hence this technology is considered in the proposed strategy.

Developing a successful eHealth strategy for a developing country requires the involvement and contribution of several key players. Dzenowagis (2007) identifies six major groups[19]:

- Citizens (including patients),
- Professionals,
- Hospitals,
- Academia,
- Health-related businesses,
- Governments and International donor agencies

In addition to the above, private and government ICT and Telecom service providers can play a major role in assisting the infrastructure needed for an eHealth system.

The Proposed Solution – "Vidusuwa"

In a developing country, due to the resource restrictions, lack of funds, lack of proper infrastructure and low level of patient know-how, transfer of technology among the general public is slow. In order to move from proof-of-concept of a proposed solution, to the large scale implementation in the appropriate setting, the process has to solve an existing problem while offering huge benefits to the users. It is also crucial that the process starts in a non-complicated environment which is easy to use by the patients, doctors and other healthcare workers. Therefore, the best would be to:

- Keep the technology simple and local,
- Build on existing technology being used by all,
- Involve the users in the design to feel ownership,
- Use a participatory approach to introduce ICT
- Use a strategy that is relatively resilient in the face of developing-world conditions and
- Strengthen the infrastructure and create a conducive environment for the society [adapted from[20]]

Sri Lanka processes an extensive network of healthcare institutions in comparison to other developing countries. A western type government healthcare service is available within 4.8 km of a patient's home[1]. Hence, the proposed strategy is to recruit patients from them to the peripheral e-clinic which connects them to the specialist in a general hospital using a virtual mode.

The proposed solution Vidusuwa (www.vidusuwa.com)[20] meaning, Electronic Distant Healing (**Vi**dyuth **Du**rastha **Suwa**ya in the Sinhala Language), is designed to be implemented in three phases using an evolutionary approach in order to have a smooth etransformation.

The three phases are as follows:

- Phase One: eConsultation Clinic
- Phase Two: eSystems Integration
- Phase Three: Remote Patient Monitoring System

Phase One: The eConsultation Clinic

This paper will mainly focus on the phase 1 of the Vidusuwa (www.vidusuwa.com) [20] project which is the "eConsultation Clinic". The main focus here is to link the specialist in a general hospital in a city with a patient in a peripheral setting via a doctor using easily acquirable relatively inexpensive technology that is currently being used. This simple concept can be done with a very little extension to the existing technology. The whole scenario for phase 1 will consist of:

- an eCare Clinic in a peripheral hospital,
- a web-based eHealth record system,
- m-Communication system and
- an e-Consultation centre with a specialist in a base hospital or above.

The details are explained in the next section.

Phase Two - eSystems Integration

Lack of integration and interoperability across public health systems lead to the duplication of efforts and frustration among consultants, healthcare workers and patients as they are asked to provide the same information on multiple forms of varying formats on different instances[22]. At this phase, data integration and linking of laboratories, radiological units, out patient clinics, wards, hospital reception and MOH clinics will come into existence. The exchange of data between departments can be done via the web based e-system using a Local Area Network within the hospital.

Phase Three-Remote Patient Monitoring (RPM)

This will incorporate Remote Patient Monitoring (RPM). In developed countries, this is done by patients being in their own home environment using wireless sensors[23]. In developing countries such an environment is setup within a tertiary care hospital as a separate department or block[24]. Equipment may need to be carefully inventorised, maintained and financed on a regular basis. These categories of patients are strictly selected where the indication for such monitoring is justified. Usually these are cardiac patients and those who have undergone transplant surgery.

Phase One: The eConsultation Clinic

As stated before, this phase will need an eCare Clinic in a peripheral hospital, a web-based eHealth record system, m-communication system and an e-Consultation centre with a specialist in a base hospital. Each of these components is explained in detail below.

eCare Clinic

A District Hospital, Rural Hospital, MOH (Medical Officer of Health) or Peripheral Unit will form the first level of an eCare clinic. At this level of care, in a rural setting, a trained doctor competent in using a computer, Internet, E-mail, SMS (Short Messaging Service) and data recording experience is an essential factor. This doctor should have at his disposal, a computer, a printer, a high resolution digital camera, a webcam, broadband internet connection (preferably wireless), headset or audio facility, telephone facility and a healthcare assistant (nursing officer).

There will be a standard diagnosis checklist (e-Clinic patient record checklist), in this instance, through the web-based system, that the doctor needs to fill by examining the patient, prior to starting the eConsultation with the specialist. Still images of particular medical and surgical lesions will be transmitted via the e-system to the specialist for opinion. In addition to the above ICT technology, the clinic will have all the basic amenities of a medical or surgical outpatient clinic. Relevant information with regard to patient appointments and tests to be carried out will be sent to personal mobile phones from the eCare clinic through the m-Communication system.

Web based eHealth record system

The peripheral eCare clinic is connected through a web-based patient medical record (herein referred to as an e-health record). This consists of the patient profile and a detailed checklist for every visit to the e-care clinic. This could further be subdivided in to medical, surgical, dermatological, orthopedic or gynaecological data. As patient privacy is a major concern when dealing via a public infrastructure, data security measures are taken which include password protection and data encryption. Patient consent for electronic data transfer and disclaimer need to be incorporated in to the security protocol. Each patient will have a unique eRecord access number for exclusive identification purposes.

The e-clinic patient record checklist

The checklist will contain data pertaining to

- the patient's current complaints,
- condition of surgical wounds,
- general medical status such as blood pressure, pulse rate, respiratory rate, SPO_2, peak respiratory flow rates, temperature, investigations such as Haematological reports, Urine report, Bio-chemical data, Radiological data, Ultrasound scan reports etc.

The m-Communication System

At the diagnosis stage of this research project, a preliminary survey was done in a base hospital in Sri Lanka at an outpatient clinic to find out the accessibility to mobile phones among patients. The results show that over 51% of the patients have access to their own personal mobile phone, out of which 50% use SMS tool for communication. Nearly 80% of patients have access to mobile phones through an immediate family member. These results depict a high penetration of mobile phones in the peripheral sector which can be used very effectively for communication. Therefore, the m-communication system is used in phase 1 for sending important information to patients. Such information will be on: Clinic date and Reminders on Operation date, Precautions, Re-admission date, Vaccination dates, Medical tests, Postponement or cancellation of appointments due to various reasons, Checkup dates (dental, eye, ENT), etc.

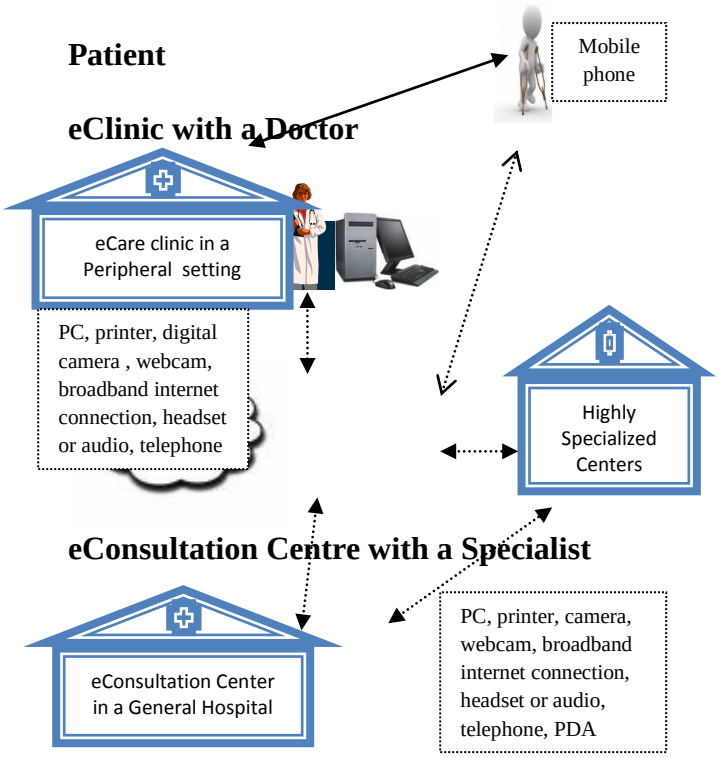
The eSpecialist

The e-specialist (consultant) is based at the Teaching Hospital, District General Hospital or Base Hospital at an eConsultancy centre which would also have the basic system requirements as in the rural

eCare clinic. In addition to the specialist's advice, Medical prescription notes, Diabetic advisory charts, postoperative mobility regimens, dietary advice etc. are transmitted to the rural eCare clinic via the web based system. The e-care clinic in the centre can also be linked to another e-clinic in a Centre of Excellence or tertiary care institute where a sub-specialty such as neurosurgical or cardiothoracic follow up is needed.

Figure 1: Phase 1: eConsultation Clinic

Proposed Patient Centric eConsultation Strategy (Phase 1)



Benefits of "Vidusuwa"

The system provides accurate data transfer over a distance creating a virtual presence of the patient in relation to the specialist and vise versa.

For the Patient

The main beneficiary of Vidusuwa[20] is the patient as his travel expenditure and travel time will be reduced tremendously. Unnecessary secondary visits to tertiary centers and specialist clinics will be reduced. The greater benefit would be for patients on long term follow up at highly specialized clinics where laboratory results play a major role in chronic health evaluation e.g; patients with chronic renal failure. When data is electronically stored and transferred the clarity of such data and finer details will be recorded without discrepancies arising from hand writing errors. The problem of diagnostic cards being often lost due to patient negligence, ignorance or natural calamities could be avoided in the virtual clinic as all data is securely stored.

For the Peripheral Hospital

The cost of transfer of patients from peripheral hospitals to tertiary centers also can be drastically reduced. This will facilitate the availability of ambulances for critical and emergency transfers between institutions. The availability of patient health records electronically will help these hospitals to make pro-active decisions on resource allocations and patient care. The eClinic data record could be evolved to send data like a summarized diagnostic card to the patient's mobile phone at a later stage. This e-diagnosis card will give the same information as is available in a normal hospital diagnosis card.

For the Specialist (Consultant)

The eSpecialist makes himself or herself available across a distance at many e-clinics within the shortest possible time frame. This has the added impact of specialized care reaching out to the periphery. Needless to say that knowledge transfer occurs with benefit to the doctor at the peripheral e-clinic and a closer professional link is established between the specialist and the peripheral doctor.

For the Base Hospitals and above

Specialist hospitals and tertiary care institutes will have less congestion with regard to inward patients and clinic attendees. This will lead to improved quality of care at these centers leading to better resource utilization.

Architecture of the Proposed Solution

In the patient centric web-based health information system, it was decided to use the FOSS approach (Free and Open Source Software) due to the low initial cost (as compared to proprietary s/w), the evolutionary nature [(25)] proposed and the possibility of enhancing the software to suit local requirement that would provide inter-operability[(26)].

The system will initially have the following features:

- eClinic login (rights to access, edit, delete & add)
- Consultant login (rights to access/add/edit /share)
- Specialised eClinic login (rights to access & add)
- Patient Registration, Clinical Scheduling, Clinical Record System
- Prescriptions, Integration of laboratory test results
- E-appointment diary creation, Specialist database
- Management Information System (MIS), Decision Support System (DSS)

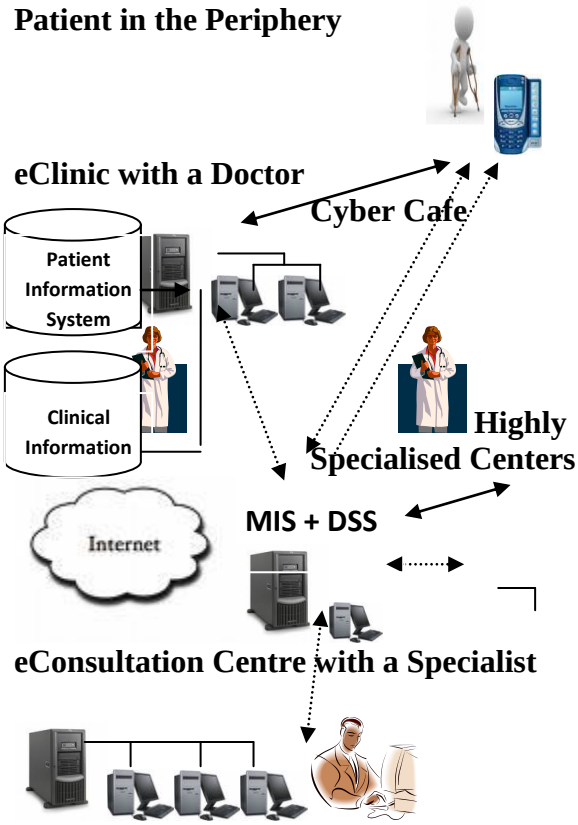
"Start Small and Evolve" will be the overall approach used in the development of this phase.

The Pilot Project

An initial survey was carried out to see the usage of mobile phones by patients attending two surgical out patient clinics in a Base Hospital in Sri Lanka. The results show an accessibility of nearly 80% of patients to mobile phones with self or immediate family. The TRC statistics state that the number of mobile phone subscribers in Sri Lanka have more than doubled over the period 2004 to 2006 [(17)], whereas the number of subscribers for fixed phone lines increased by 25% over the same period. Therefore, it is evident that mobile phones are emerging as the preferred choice of communication devices among the Sri Lankan population.

The pilot project for phase one is successfully being done at the Base Hospital Marawila in Sri Lanka which is the specialist e-consultation centre in collaboration with the District Hospital Dankotuwa which has the eClinic.

Figure 2. The Architecture of Phase 1 of Vidusuwa



Overview of Strategies for Phases 2 and 3

Phase 2

Integration of data within a specialized hospital has to conform to some specifications and take into consideration ground realities with regard to existing financial and technical support.

- Image capturing and display with data storage
- Speech recognition for faster reporting
- choice between digital dictation, offline and online recognition
- customizable user interface (ease & effectiveness)
- online monitoring of performance

Integration requires the laboratory and radiological facilities to be linked to the eClinic via a system that is interoperable and standard with flexibility in design for future expansion to take place [(27)].

This phase should aim at resolving a number of difficulties commonly encountered by information repositories in other sectors, such as costly customization, reusability, high maintenance and poor information modeling[(28)]. It is important to maintain full interoperability with existing systems and other heterogeneous systems over the web by means of XML. This significantly reduces the

complexity of developing distributed healthcare systems and e-health applications[29]. Affordability and adaptation to local environment are the critical factors in deciding on this approach and there are any basic HISs (Health Information Systems) that can be customized to suit the local scenario[30]. By incorporating PACS (Picture Archive and Communication System) along with their Electronic Medical Records (EMR) system, the efficiency of decision making will be improved as the specialist will be able to view the relevant medical records and the archived records simultaneously [31]. In fact this phase may be protracted over a period of time to enable recruitment of financial and other technological resources as the cost maybe considerably high. Hence an evolving approach is necessary for this phase.

Phase 3

The health sector has usually been using wires and cables in their sophisticated medical monitoring systems, diagnostic equipment, therapeutic equipment, physiological monitoring equipment and drug delivery. These restrict the mobility of the patient extensively and have the risk of getting disconnected during the transfer of patients and their movements to attend to their personal needs. In monitoring the patient's activities, it is also essential to monitor them under active conditions than to keep them static and under a controlled environment[32]. These have lead to healthcare professionals adopting wireless sensor technologies to improve flexibility, convenience and also enhanced functionality[8]. Recent developments in the wireless vital signs sensors technology, in sensor hardware designs and their software platforms suggest a rising interest in sensor networks in the health sector[33]. Wireless Sensor Networks (WSN) can be broadly categorized in to environmental sensors, extra-corporeal sensors and implants. Advantages of WSN are portability and unobtrusiveness, ease of deployment and scalability, always on real time, re-configuration and self-organization possibility[34]. The above properties lead to greater patient mobility, continuous monitoring of the patient's condition taking in to consideration the comfort of patient through miniaturization and micro-fabrication technology.

Environmental sensors pick up patient movements (useful in the assisted patient monitoring facility) where the sensors are unobtrusively located in the immediate vicinity of the patient. These sense the environmental temperature, pressure of atmosphere, amount of light, humidity, etc. Extra-corporeal body sensors are attached to the patient's body surface. It can sense heart rate, pulse rate, temperature, non-invasive blood pressure, SpO2 (Oxygen saturation), ECG (Electrocardiogram) data (two-led, three-led or 5-led), EMG (Electromyogram), EEG (Electroencephalogram), a tilt sensor to monitor body position, glucose levels, etc.[15, 23]. There are many wireless technologies that could be used in the health sector such as:

RFID (Radio Frequency Identification) Tags – Powerful enough to get all the personal data of the patient at entry to clinic where the records could be updated remotely.
Bluetooth –widely available in mobile phones and are inexpensive, versatile, robust and secure.
Zigbee – IEEE 802.15.4 technology which is low-powered, inexpensive & affordable to all. ideal for applications such as handheld blood sugar monitors.
Wi–Fi – IEEE 802.11 wireless local area network. Ideal for patient monitoring and patient record systems within a local area network in a hospital [6].

Future Work

Telemedicine has grown to such an extent that there are many systems that exist[29].

- Point to point system - One end connects the patient to a specialist at another end within the hospital

- Point to multi-point system - One end at a time connects a patient to any of the specialist doctors' end within the hospital
- Multi-point to multi-point system - Several patients' end simultaneously connect to different doctors' end at different hospitals at different geographical locations

It will take Sri Lanka a long time to reach this kind of multi-point eHealth system due to slow adaptation of technology.

Conclusion

This paper explores the benefits, issues and challenges in evolving healthcare methodology with regard to setting up of a realistic eHealth plan in a developing country. The existing ICT infrastructure in the Sri Lankan health setup can provide the initial platform to launch eClinics at the peripheral level. Vidusuwa, the three phase methodology described in this paper can provide the eHealth ICT solution for the introduction of eHealth to the Sri Lankan healthcare system. A phased approach is proposed to minimize initial huge expenditure and to optimally build on existing resources. The first phase has a patient centric approach, the second phase focuses on the EMR and the third phase emphasizes the benefits of Remote Patient Monitoring using wireless sensor networks.

eHealth solutions such as Vidusuwa (www.vidusuwa.com)[20] can do the job provided the right balance is reached between information technologies and the existing ground realities and the will to implement such changes. In order to successfully implement a sustainable and evolving system of eHealthcare the following aspects have to be considered:

- Public - Private sector partnership, Community Participation and Human Resource Development
- Multi-sectoral involvement and Awareness Building
- Resource Mobilization and Active governmental cooperation[9].

Due to the increasing demand on healthcare institutions and systems to deliver better quality services for patients, ICT in Health has evolved to bridge the gap between the urban healthcare specialist and their rural patients. Vidusuwa[20], with its phased approach will improve the quality of healthcare by way of enabling sustainable healthcare solutions for disadvantaged patients to meet professionals to make better decisions on their patients.

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